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Preface

For the twenty-first year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is sponsoring the publication of these Proceedings. Papers published in this volume were presented at the National AECT Convention in Houston, TX. A limited quantity of these Proceedings were printed and sold. It is also available on microfiche through the Educational Resources Clearinghouse (ERIC) system.

REFEREING PROCESS: Papers selected for presentation at the AECT Convention and included in these Proceedings were subjected to a rigorous blind reviewing process. All references to authorship were removed from proposals before they were submitted to referees for review. Approximately fifty percent of the manuscripts submitted for consideration were selected for presentation at the convention and for publication in these Proceedings. The papers contained in this document represent some of the most current thinking in educational communications and technology.

This volume is indexed by both author and descriptor. The index for volumes 1 – 6 (1979 – 1984) is included in the 1986 Proceedings, and the index for volumes 7 – 10 is in the 1988 Proceedings. After 1988, each volume contains indexes for that year only.

M. R. Simonson
Editor

TABLE OF CONTENTS

COMPELLING CASE EXPERIENCES: CHALLENGES FOR EMERGING INSTRUCTIONAL DESIGNERS: by Marti F. Julian, Valerie A. Larsen & Mable B. Kinzie	7
THE INSTRUCTIONAL TECHNOLOGY CLINICAL EXPERIENCE: EXPECTATIONS AND REALITIES: By Katherine S. Cennamo & Glen Holmes	29
A REVIEW OF COLOR CODING AND FIELD DEPENDENCE RESEARCH: By Francis M. Dwyer & David M. Moore	39
EFFECT OF VISUALIZATION (JOB AIDS) IN FACILITATING COGNITIVE DEVELOPMENT: By Karen L. Spaulding & Francis Dwyer.....	45
EFFECTS OF LEARNING STRUCTURE AND SUMMARIZATION DURING COMPUTER-BASED INSTRUCTION: By Jenny Lynn Werner & James D. Klein.....	53
USING COOPERATIVE LEARNING AND OBJECTIVES WITH COMPUTER-BASED INSTRUCTION: By James D. Klein & Jamie C. Cavalier	63
INDIVIDUALLY-GUIDED EDUCATION AND PROBLEM-BASED LEARNING: A COMPARISON OF PEDAGOGICAL APPROACHES FROM DIFFERENT EPISTEMOLOGICAL VIEWS: By B.A. Bichelmeyer & Yu-chen Hsu	73
WEB-BASED MENUS: FONT SIZE AND LINE SPACING PREFERENCES: By Janice Pacheco, Barbara Taylor Day, Susan Cribelli, John Jordan, Brandon Murry & Kay A. Persichitte.....	81
CBT DESIGN: A FEEDBACK APTITUDE TREATMENT INTERACTION: By Roy B. Clariana	87
INSTRUCTIONAL PRINCIPLES FOR SELF REGULATION: By Kathryn Ley & Dawn B. Young	93
A SYSTEMS APPROACH TO ADOPTING NEW TECHNOLOGIES IN EDUCATION: By Jared A. Danielson & John K. Burton.....	101
NAVIGATIONAL STRUCTURE ON THE WORLD WIDE WEB: USABILITY CONCERNS, USER PREFERENCES, AND “BROWSING BEHAVIOR”: By Theodore Frick, John A. Monson, Richard F. Xaver, Gulsen Kilic, Aaron T. Conley & Beatrice Wamey	111
IMPACT OF NAVIGATIONAL MODELS ON TASK COMPLETION IN WEB-BASED INFORMATION SYSTEMS: By Theodore Frick, Eric Kisling, Weijia Cai, Byeong Min Yu, Frank Giles & J. P. Brown	119
MULTIDIMENSIONAL KNOWLEDGE STRUCTURES: By Kathy L. Schuh.....	127
THE RELATIONSHIPS BETWEEN NAVIGATIONAL PATTERNS AND INFORMATIONAL PROCESSING STYLES OF HYPERMEDIA USERS: By Mi Jar Lee & Francis A. Harvey	137
INTEGRATING SCIENCE AND MATHEMATICS CURRICULA USING COMPUTER MEDIATED COMMUNICATIONS: A VYGOTSKIAN PERSPECTIVE: By Christina Wotell Charnitski & Francis A. Harvey.....	157
DUAL STRUCTURED INSTRUCTIONAL SYSTEMS APPROACH: AN INTEGRATION OF SYSTEMIC AND SYSTEMATIC APPROACHES FOR INSTRUCTIONAL DESIGN: By Su-Hong Park, Young Hwan Kim & Yung Kye Byun	165
THE EFFECTS OF METACOGNITIVE TRAINING ON PERFORMANCE AND USE OF METACOGNITIVE SKILLS IN SELF-DIRECTED LEARNING SITUATIONS: By Joyce Kincannon, Conrad Gleber & Jaehyun Kim	171

EVALUATING NARRATIVE SIMULATION AS INSTRUCTIONAL DESIGN FOR POTENTIAL TO IMPACT BIAS AND DISCRIMINATION: By Nancye McCrary & Joan M. Mazur	187
EVALUATION THEORY IN PROBLEM-BASED LEARNING APPROACH: By Yu-chen Hsu.....	199
EQUIVALENCY THEORY AND DISTANCE EDUCATION: By Michael Simonson.....	207
BEST OF BOTH WORLDS:THE NOVA ITDE MODEL OF DISTANCE EDUCATION: By Charles A. Schlosser & Marsha Burmeister.....	211
INSTRUCTIONAL DESIGN FOR DISTANCE EDUCATION: By Sharon Smaldino & Michael Simonson...	215
USING MULTIMEDIA TO COUNTER STEREOTYPES IN SCIENCE CLASSROOMS: NEW PERCEPTIONS OF WHO BECOMES A SCIENTIST: By Leslie D. Edwards	221
EVALUATING THE ACCESSIBILITY OF WEB-BASED INSTRUCTION FOR STUDENTS WITH DISABILITIES: By D. Michelle Hinn.....	233
THE USE OF AUDIO IN COMPUTER-BASED INSTRUCTION: By Carol M. Koroghlanian & Howard J. Sullivan.....	241
WHERE IS MY BRAIN?: DISTRIBUTED COGNITION, ACTIVITY THEORY, AND COGNITIVE TOOLS: By Linda S. Gilbert.....	249
DISTANCE EDUCATION: LEARNER-TEACHER INTERACTION AND TIME SPENT BY TEACHING FACULTY: By Veena Mahesh & Marina Stock McIsaac.....	259
EFFECTS OF FACULTY MOTIVATION IN DISTRIBUTIVE EDUCATION ENVIRONMENTS AT INSTITUTIONS OF HIGHER EDUCATION: By Marlon R. Mitchell	269
IMPACT OF INSTRUCTIONAL GROUPING ON NAVIGATION AND STUDENT LEARNING IN A WEB-BASED LEARNING ENVIRONMENT: By Angel Jannasch-Pennell, Samuel A. DiGangi, Alex Yu, Sandra Andrews & John S. Babb.....	275
WHICH WAY TO JUMP: CONVENTIONAL FROG DISSECTION, CD-TUTORIAL, OR MICROWORLD?: By Christine S. Marszalek & James Lockard.....	281
DESIGNING INSTRUCTION FOR THE TECHNOLOGY-SUPPORTED K-12 CLASSROOM: By Greg Sherman	295
INSTRUCTIONIST VERSUS CONSTRUCTIONIST WEB-BASED COLLABORATIVE LEARNING ENVIRONMENTS: By Greg Sherman.....	311
MODELS FOR WEB-BASED INSTRUCTION: A DISCUSSION OF RECURRING THEMES: By Craig Edwards	319
MULTIPLE INSTRUCTIONAL DESIGN MODELS: NECESSITY OR EXCESS BAGGAGE?: By David Beck.....	323
WHAT CAN WE LEARN FROM COMPUTER GAMES: STRATEGIES FOR LEARNER INVOLVEMENT: By Marshall G. Jones	327
COMPARISON OF GENERATIVE LEARNING STRATEGIES: By Christian Volk & Donn Ritchie.....	333
PROBLEM-BASED LEARNING: A DECISION MODEL FOR PROBLEM SELECTION: By Jiunde Lee	341
TEACHING INSTRUCTIONAL DESIGN: REFRAMING THE RELATIONSHIPS BETWEEN TEACHERS AND DESIGNERS: By Susan G. Magliaro & R. Neal Shambaugh	349

MOTIVATION: GOALS, AGENCY BELIEFS, AND EMOTIONS IN WEB ASSISTED LEARNING; By Yi Guan, Jianjun Wang, Michael Young, Steve Owen & Richard Andrew.....	359
PROBLEM BASED LEARNING: A HISTORICAL ANALYSIS: By Alan Januszewski & Robert Pearson....	371
SECONDARY TEACHERS' PROFESSIONAL USES OF COMPUTERS: By Robin T. Chiero.....	377
RESEARCH ON TECHNOLOGY COURSES AT COLLEGES OF EDUCATION: By Amy Sheng Chieh Leh	385
PORTRAYING THE WORK OF INSTRUCTIONAL DESIGNING: AN ACTIVITY-ORIENTED ANALYSIS: By Gail A. Rathbun	391
DEVELOPMENT RESEARCH APPLIED TO IMPROVE MOTIVATION IN DISTANCE EDUCATION: By Lya Visser, Tjeerd Plomp & Wilmad Kuiper	403
FROM ABILITY TO ACTION: DESIGNING INSTRUCTION FOR CRITICAL THINKING DISPOSITIONS: By Lars F. Leader & James A. Middleton.....	413
PLANNING AND IMPLEMENTING WEB-BASED INSTRUCTION: TOOLS FOR DECISION ANALYSIS: By Stephen W. Harmon & Marshall G. Jones	423
SCREEN MINIATURES AS ICONS FOR BACKWARD NAVIGATION IN CONTENT-BASED SOFTWARE: By Elizabeth Boling, Guoping Ma, Chia-Wen Tao, Cengiz Askun, Tim Green, Theodore Frick & Heike Schaumburg.....	429
PSYCHOLOGICAL FACTORS INFLUENCING WORLD-WIDE WEB NAVIGATION: By Amy L. Baylor	437
THE EFFECTS OF GOAL INTENTIONS ON PROBLEM SOLVING AND READING COMPREHENSION IN GENERATIVE HYPERTEXT PROCESSING: By Jianjun Wang, Michael F. Young, Sasha A. Barab & Yi Guan.....	443
PROJECT-BASED LEARNING WITH THE WORLD WIDE WEB: A QUALITATIVE STUDY OF RESOURCE INTEGRATION: By Susan M. Land & Barbara Greene.....	451
MAXIMIZING BANDWIDTH: GUIDANCE FOR THE DESIGN OF NETWORKED INSTRUCTION: By David R. Moore, Barbara B. Lockee & D. Michael Moore.....	461
NO COMPARISON: DISTANCE EDUCATION FINDS A NEW USE FOR “NO SIGNIFICANT DIFFERENCE”: By Barbara B. Lockee, John K. Burton & Lawrence H. Cross.....	465
STUDENT MODEL CONSTRUCTION :AN INTERACTIVE STRATEGY FOR MENTAL MODELS LEARNING: By Ray Bland & Martin Tessmer	473
PINNING THE CORNERS: USING SCENARIOS IN INSTRUCTIONAL DESIGN: By Jason Cole	479
THE MAJOR THEMES AND TRENDS IN DOCTORAL DISSERTATION RESEARCH IN EDUCATIONAL TECHNOLOGY FROM 1977 THROUGH 1998: By Edward P. Caffarella.....	483
A CASE STUDY OF USING GROUPWARE TO SUPPORT COLLABORATIVE ACTIVITIES IN A DISTANCE LEARNING COURSE: By Lara M. Luetkehans	491
THE INFLUENCE OF DESIGNER AND CONTEXTUAL VARIABLES ON THE INCORPORATION OF MOTIVATIONAL COMPONENTS TO INSTRUCTIONAL DESIGN AND THE PERCEIVED SUCCESS OF A PROJECT: By Bonnie J. Shellnut	503

THE ARCS MODEL FOR DEVELOPING MOTIVATIONALLY-ADAPTIVE COMPUTER-ASSISTED INSTRUCTION: by Sang H. Song & John M. Keller	513
INTERNATIONAL TEAM TEACHING: A PARTNERSHIP BETWEEN MEXICO AND TEXAS: By Lauren Cifuentes & Karen L. Murphy	531
TECHNOLOGY, TEACHING, AND LEARNING IN IOWA HIGH SCHOOLS: By Nancy Maushak, Lynn Manternach Wigans & Caryl Bender.....	537
USING DISCOURSE ANALYSIS AS A RESEARCH TOOL FOR UNDERSTANDING USER NAVIGATION MODELS: By Richard J. Voithofer	543
PERSON-ENVIRONMENT INTERACTION IN THE VIRTUAL CLASSROOM: AN INITIAL EXAMINATION: By Susan M. Powers, Michaelleen Davis & Eileen Torrence	553
ASYNCHRONOUS AND SYNCHRONOUS PERFORMANCE SOLUTIONS: DEVELOPING A COMMUNITY OF TECHNOLOGY-USING TEACHERS: By Annette C. Sherry, E. Barbara Klemm, R. Ian McKay, Jim Edens & Patty Miller.....	561
DESIGNING ON-LINE INSTRUCTION USING MULTIDISCIPLINARY APPROACHES: By Sandra Andrews, Samuel A. DiGangi, David Winograd, Angel Jannasch-Pennell & Chong-Ho Yu.....	565
AUTHOR & KEYWORD INDEX	573

COMPELLING CASE EXPERIENCES: CHALLENGES FOR EMERGING INSTRUCTIONAL DESIGNERS

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Abstract

Instructional design (ID) case studies, which pose authentic ill-defined design problems in realistic environments, can help instructional design students bridge the gap between novice and expert practice. Over the past three years, we have explored aspects of this educational approach through the development of Web-based instructional design cases at the Curry School of Education, University of Virginia. This paper begins with a look at case study methods and how they are used to help students gain experience in ID practice. We describe the design and development of our Web-based ID Case Competition, the 1998 IT Case Event, and follow with a report on the competition involving seven universities. Officials and students felt that the Case experience was valuable for developing ID expertise and preparing students for professional practice. These advantages, and the opportunity for team collaboration, were noted as motivators for participation. Most of the students were enthusiastic about the inclusion of emergent ID issues in the case and felt the experience expanded their knowledge of ID practice and application. We close with a discussion of implications for the preparation of instructional designers and recommendations for future development activities.

Challenges for Emerging Instructional Designers

The professional practice of instructional design (ID) requires high level problem-solving, critical thinking, and interpersonal skills; design problems are complex and multi-dimensional. An effective designer must be capable of identifying critical issues in a situation, and more importantly, select those issue(s) that can or should be addressed (Ertmer & Russell, 1995). In a comparative study of novice and expert designers, Rowland (1992) observed that experts tend to interpret an instructional design problem as ill-defined and immediately link the given information to previous experiences addressing similar problems. In this way, the expert is able to infer additional information in order to develop a preliminary concept of what the problem is and then apply templates for examining the situation such as the needs analysis model. As a result, experts reflect on a wide range of factors and spend considerable time interpreting the design problem (Perez & Emery, 1995; Rowland, 1992). Novices, on the other hand, do not possess this body of knowledge and, therefore, accept the given information and move on to generation of solutions without developing an in depth understanding of the problem itself.

Instructional design is commonly taught as a set of procedures with clear cut examples that do not match the complexities of real-world situations (Rowland, 1992). Ideally, students are given the opportunity to apply what they learn to an actual design project so they can discover the strengths and limitations of the process and theory. These projects require considerable time, a finite commodity in IT programs. Students, therefore, are exposed to a limited number of professional practice settings (Kinzie, Hrabe, & Larsen, 1998). Consequently, novice designers frequently enter the workforce with an understanding of the ID process but without the knowledge base that can help them solve instructional design problems and develop solutions.

Case studies, which pose authentic ill-defined design problems can help bridge this gap. In case analysis, instructional design students draw connections between their emerging knowledge of ID and the complex demands of actual practice. Cases can supplement student design projects, allowing further opportunity to reflect on relevant theory and methods as students explore a greater number of design issues in a broader array of environments. Furthermore, students are provided an opportunity to broaden their knowledge base as they collaborate with colleagues to identify effective design solutions (Kinzie et al., 1998).

Over the past three years, we have explored aspects of this educational approach through the development of Web-based instructional design cases at the Curry School of Education, University of Virginia. The World Wide Web enables students at any institution or any interested individuals to access our multimedia case studies and we use this venue to sponsor an annual competition, the IT Case Event. (<http://curry.edschool.virginia.edu/go/Itcases>) Each year, Teams from up to seven participating universities analyze an instructional design case, while expert officials pose probing questions, evaluate case responses, and contribute their own perspectives on the case.

Evaluations of our first two Case Events suggest that case analysis can serve as a valuable supplement and may help expand the depth and breadth of novice designers' expertise (Kinzie et al., 1998). In this paper, we built on this past research, with the intent of describing the case event experiences of students and officials during the 1998 event. We identify skills used during the case analysis, and offer some observations on perceptions of preparation and challenge. We also examine the perceived value of integrating an emerging ID practice: the design of

performance support. Our primary research question was, "Is an instructional design case competition a worthwhile medium for expanding professional knowledge and exploring emerging issues in instructional design?" We were also interested in whether developments in our case study and approach to interface design would enhance the sense of realism, thereby encouraging a deeper exploration into the ID issues.

We begin this paper by providing background information on case study methods and how they are used to help students gain experience in instructional design practice. We follow with a description of the 1998 IT Case Competition, focusing on the developments in case design and methods we implemented. Evaluative data based on the results of the competition, follow-up surveys and individual interviews serve as the focal point of this study. We close with a discussion of implications for the preparation of instructional designers and recommendations for future development activities.

Case Methods and Instructional Design

Case methods have long been used extensively in professions such as law, business, and medicine and more recently have gained popularity in other professions such as teacher education, engineering, nursing, and instructional design (Ertmer & Russell, 1995). The growing interest in this method of instruction reflects recent advances in the cognitive sciences, which suggest that knowledge and skills are best learned in contexts that reflect the way they will be useful in real life. Because of this situated cognition, the individual is able to apply this knowledge to new situations through recall of the experience and the environment in which it occurred (Bednar, Cunningham, Duffy, & Perry, 1991; Teslow, Carleson, & Miller, 1994). Constructivism builds on this theory by acknowledging a belief in multiple realities; each learner creates his or her own perception of reality based on previous knowledge and experience. Instruction that is based on this paradigm, such as case methods, focuses on student-centered, active learning experiences where learners are encouraged to use prior knowledge to explore and create new interpretations of the world around them. (Perkins, 1992; Teslow et al., 1994).

As the use of cases has grown, case methods have continued to evolve, and can now be found in a variety of forms. In teacher-education and instructional design, case methods have taken the form of complex fictional narratives which are grounded in actual problems and challenges that occur in the real world (Ertmer & Russell, 1995; Kinzie et al., 1998). Grabinger (1996) has identified these methods as one way of providing rich environments for active learning. They allow students to construct knowledge in an authentic environment where they assume personal responsibility for learning and work cooperatively to produce something of real value. Effective cases are those that are immediately realistic and meaningful to the learners and, like professional practice, are ambiguous and messy, offering opportunity for analysis and consideration of multiple solutions. Presentation within specific contexts makes the case more believable and makes what is learned more readily retrieved from memory when the learner is placed in similar circumstances (L. Shulman (1992) as cited in Ertmer, 1995; Grabinger, 1996).

The cases we have developed for the IT Case Event are intended to serve as a useful supplement for instructional design students by exposing them to various professional practice settings in a context that offers "enough depth and complexity to provide realistic challenges" (Kinzie et al., 1998 p.55). Since cases can be analyzed in much less time than a design project, there is often the opportunity for students to analyze multiple cases. As a result, students can gain exposure to ID practice in industry, education, museums, and the military and the unique problems that may exist in each type of environment (Kinzie et al., 1998). We recommend that students follow a collaborative problem solving process based on the work of McNergney, Herbert, and Ford (1994):

- identify key issues,
- consider multiple perspectives on the events in the narrative,
- apply current professional knowledge,
- develop appropriate solutions, and
- predict the consequences of their proposed courses of action.

The need to solve problems through collaboration, frequently with others who have different skill sets and perspectives, is a common occurrence for most instructional designers. Students have limited opportunities to learn how to effectively deal with the conflicting values and multiple points of view that are inherent in the group work. Likewise, they have few occasions to advance and develop support for their own perspectives. Case scenarios encourage professional collaboration, providing students opportunities to improve their oral communication and interpersonal skills as they discuss, debate, justify, and integrate their ideas into what they agree is the best possible solution (Ertmer & Russell, 1995; Kent, Herbert, & McNergney, 1995; Stepien & Gallagher, 1993). Ellsworth (1994) found that collaborating students take on a more active role in the learning process, becoming problem solvers, contributors, and discussants. Competition can be a useful adjunct to collaboration, allowing this experience to reflect the real world, where design Teams must often compete with others to identify the best possible solution (Kinzie et al., 1998).

IT Case Event: Web-based Case Media

Our Web-based cases are designed to emulate the complexities of real-world events within a selected area of professional practice in ID. The design and development of each case is a team effort, with selection of the case environment and characters based on the previous experience of the primary author. The design dilemmas emerge from this experience, the ID experience of the team members, and from problems alumni have encountered in professional practice in particular, those that are not addressed by standard ID theory and methods alone. We design cases to enhance the realism necessary to compel exploration of the ID issues. Starting in 1998, we began conducting needs assessments in the selected case environment. We conduct multiple interviews of stakeholders at various levels across several organizations. Our aim is to obtain stakeholder perspectives about the environment and the ID issues and to identify typical characteristics of individuals working at various levels within this industry.

Next, the primary author begins construction of the case with an outline of potential events and critical issues. The team uses this outline to brainstorm potential case materials and possible thematic formats. The author then creates a draft of the entire case, attempting to build a realistic environment and believable interplay between the characters and the issues presented.

Production of the case materials involves coding the files that present the case documents in HTML (HyperText Markup language), recruiting talent for the character representations, and creating the media for the case (graphics and audio and video clips to illustrate the characters and events). Once production begins, we start prototyping the case with one-to-one and small group evaluations, followed by revisions. Final modifications and revisions are made once the case has been released and used by a large group of students. For the 1998 case, we also solicited case reviews by several of the industry professionals we had interviewed in the needs assessment to check for consistency and accuracy in the content.

We have found that this combination of text and media on the Web can foster both inductive and deductive strategies as the students navigate through the hyperlinked ideas, events, and artifacts. For instance, students can analyze ID methods that have been integrated into the case study or test ID models and processes as they map out what is known or unknown about a given design problem or solution. This process of reasoning is in line with the analytical processes instructional designers must engage in as they create order and coherence out of disparate sources of information (Kovalchick, Hrabe, Kinzie, & Julian, 1998).

In this study, we explore student and official perceptions of reasoning employed by Student Teams in the 1998 IT Case Event. We also consider whether the changes imparted in our design and of the Web-based cases enhance the learning experience of the learning participants. We ask the following primary question:

- Is a Web-based case competition a worthwhile medium for expanding professional knowledge and exploring emerging issues in instructional design?

And the following secondary questions:

- Did this case experience alter student perceptions of skills they need for professional practice in ID?
- Have the developments in the design and delivery of our Web-based cases enhanced the sense of realism so they are compelling and sufficiently complex for exploration into ID issues and practice?

Methods

Participants

A total of 42 students, 28 female and 14 male participated in the 1998 IT Case Event. The seven Student Teams, ranging in size from four to seven members, were from the following academic universities: Colorado at Colorado Springs, Colorado at Denver, Northern Illinois, Purdue, San Diego State, Virginia Polytechnic Institute, and Virginia. The students were enrolled in both master's and doctoral programs and six of the Teams had received training in instructional design as part of their programs. The seventh team was enrolled in an introductory design course that had met only twice before the beginning of the competition and its members were participating for course credit. Four of the Teams received course credit for their participation and three Teams participated as an extra-curricular activity. As in previous Case Events, the majority of the students (72%) had more than four years of full-time work experience in a variety of professions from K-12 and adult education to engineering, the military, and business.

The seventeen officials included Team Sponsors, Provocateurs and Judges. The Team Sponsors nominated Student Teams and relayed case event communications to the students. They were also encouraged to analyze a case with their Teams prior to the event. The Team Sponsors each nominated one or more professionals to participate as Judges or Provocateurs. Additional officials volunteered or were recruited by the development team.

Materials

The case developed for the 1998 IT Case Event, "*The Chronicles of RocketBoy*," takes place in the digital animation sector of the feature film industry (Julian, Kinzie, & Larsen, 1998). This fictional narrative is based on real issues advanced by the case authors, industry experiences of the authors, and the perspectives shared by the individuals from the digital animation industry who were interviewed. This case also advances ID problems selected in advance by the case authors, including the emerging practice of performance support. The case is written in the first person, through the eyes of an instructional designer, Jason, (Figure 1) who is brought into a large digital animation house to assist in designing an electronic performance-support system (EPSS). With five years instructional design experience, Jason is charged with the task of identifying performance-support measures to increase productivity on the production line and help the company turn a profit. Through several interviews, Jason peels back the complex layers of this organization, identifying the key issues that will help him design the best possible solution. The case concludes as Jason begins to analyze the data from his needs assessment and assures the training department team that a performance-support solution can be developed within the nine-month time frame that has been budgeted for this endeavor.

Navigation through the site is guided by a hyperlinked index designed to look like a movie marquee listing the events in the case (Figure 2). The user can also navigate through hyperlinks provided at the bottom each page. Five case ancillaries (letters, charts, and descriptions) are presented as part of an orientation packet for the instructional designer (Figure 3). These documents help depict the structure of the company. Photographs of characters in action and graphics dispersed throughout the case add depth to the case events (Figure 4). Links to articles defining EPSS and its applications in ID were also embedded in the case. The case may be examined at the following URL: <http://curry.edschool.virginia.edu/go/ITcases>.

Figure 1: Introduction to Jason in the Web-based case, "The Chronicles of RocketBoy"

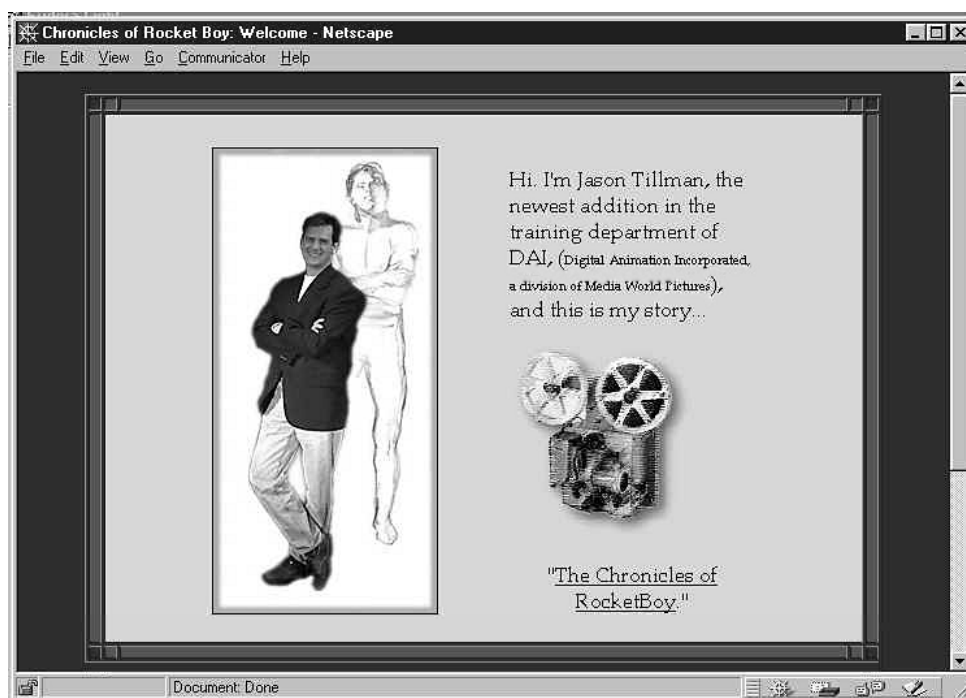


Figure 2: Movie marquee as index for the Web-based case, "The Chronicles of RocketBoy"

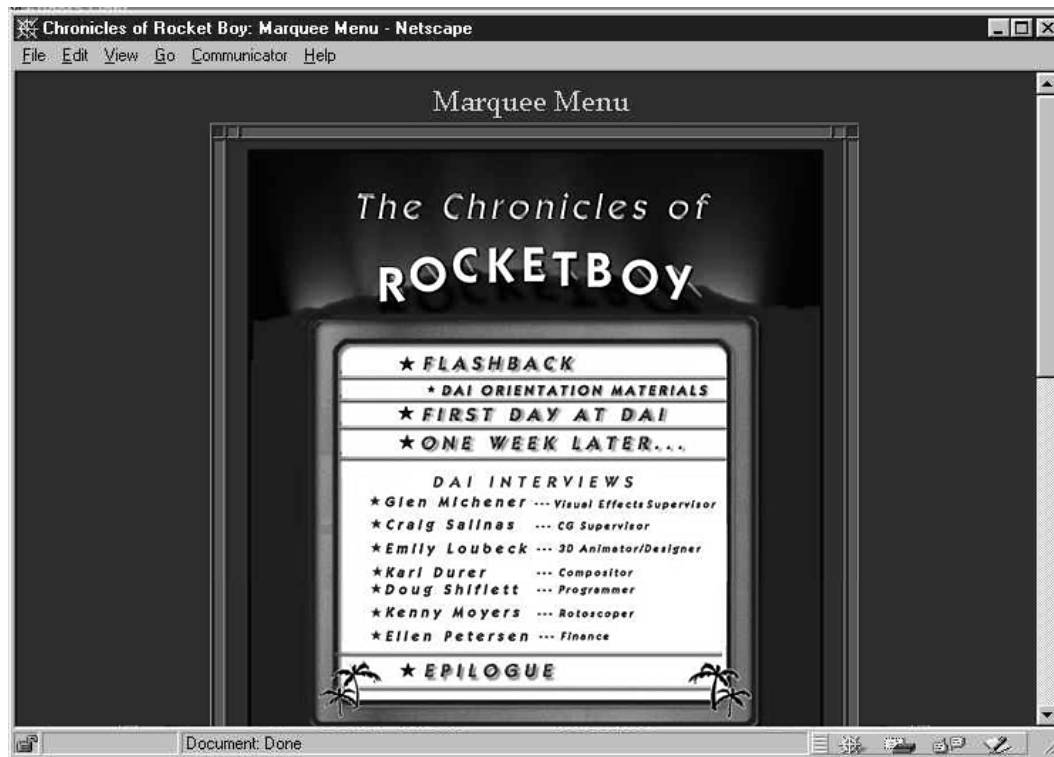


Figure 3: Ancillaries from the Web-based case, "The Chronicles of RocketBoy"

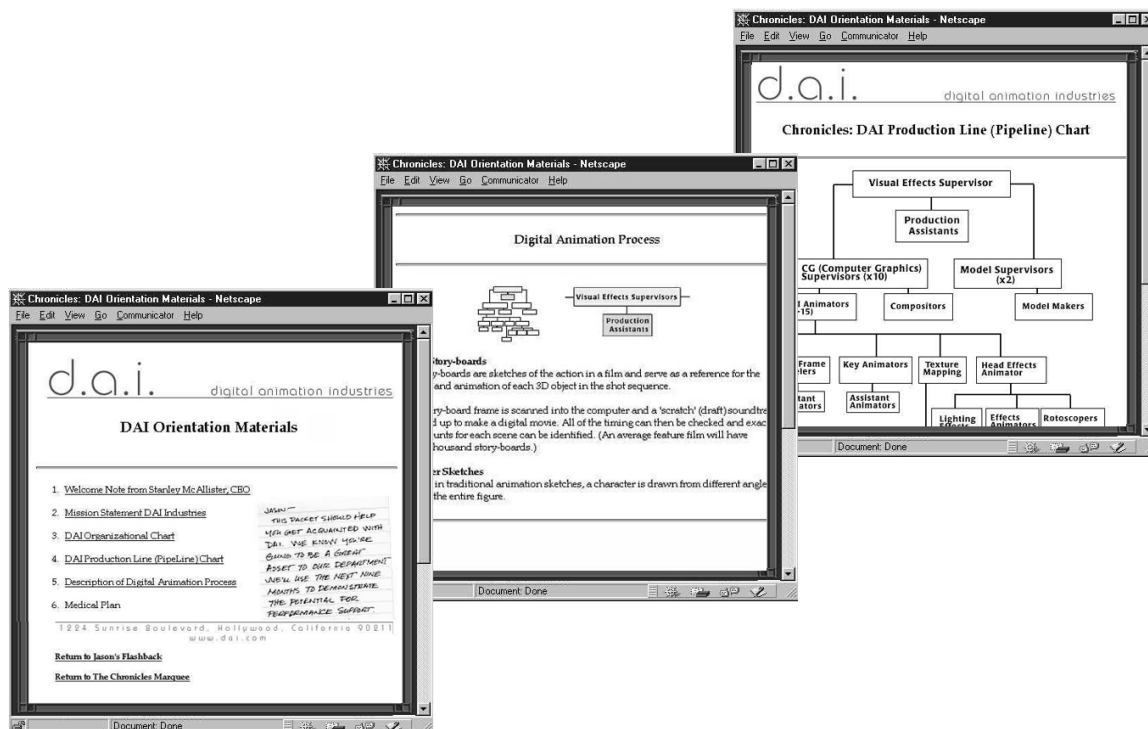


Figure 4: Interview Screens from the Web-based case, "The Chronicles of RocketBoy"



Procedures

Teams were encouraged to prepare for the event by analyzing a case from previous events, and by reviewing case responses and the Judges comments. Participants were also informed that EPSS would be an issue embedded in the case and were encouraged to review the recommended articles that would be linked into the case documents. Once the case for the 1988 event was available, a three-week time-period was provided for analysis response development. Teams were limited to meeting for a maximum of six hours with team members. This time limit applied to face-to-face meetings and to asynchronous discussions (such as e-mail communications) between as few as two team members or with the entire team. No limits were placed on individual review, analysis, or writing, and Teams were encouraged to reference any resource materials they desired. Teams were instructed, however, to respond to the case without participation from others.

The entire case response was limited to 2000 or fewer words to encourage concise expression of ideas and to keep the review work of event officials manageable. In developing their responses, the Teams were directed to complete the needs assessment, including analysis of needs and alternative performance support solutions. They were asked to include in their final recommendations an outline of a preliminary design based on the needs assessment, specifying goals, strategies, and target groups where appropriate and to base their case responses on each of the following tasks:

- Identification of the key issues present in the case,
- Consideration of the issues from different perspectives, including those of the key players (stakeholders) in the case, and
- Relevant professional knowledge/experience that team members possess.

Following their review of the submitted case responses, the four Provocateurs met asynchronously via e-mail to compose a general question for all of the Teams and a specific question for each team in reaction to their analysis. The Teams were allowed up to two hours working together on their response to the Provocateur questions. There was no length limit, however, to this phase of the case activity and the Teams had one week to produce a response to the questions. The case and question responses were then forwarded to the Judges who reviewed the materials individually, evaluated the Teams' responses using a rating scale, and wrote evaluative feedback for each team. The ratings were tabulated and a winner was announced. All of the team responses were posted along with the Provocateur questions and Judges' comments and the participants were encouraged to review and discuss the various solutions presented by the Teams. These materials can be reviewed at the URL:

<http://curry.edschool.Virginia.EDU/go/ITcases/Site/98Teams/Outcomes>.

Measures

While the Teams were responding to the Provocateur questions, the panel of six Judges met via email to review the rating scale from the previous Case Event. They adapted it from the 1997 Case Event to reflect the challenges presented in *The Chronicles of RocketBoy*, adding three new items pertaining to emerging issues in ID (see items 13-15 in Table 1). Ratings were made using a four-point scale from Strongly Disagree [1] to Strongly Agree [4]. The following table contains a listing of the response rating items. (Table 1):

Table 1: Judge Rating Scale for Team Case Responses

1. The team identified all of the important issues in the case.
2. The team effectively addressed all of the important issues in the case.
3. The team defined the perspectives of all the relevant stakeholders in this case. (e.g., artists, technicians, supervisors, administration, trainers, organization.)
4. The team effectively responded to all of the relevant perspectives in this case.
5. The team effectively analyzed the needs identified.
6. The team identified appropriate alternative solutions for each need.
7. The team developed an instructional goal that was appropriate for the case.
8. The team recommended an appropriate overall solution.
9. The team's specifications for personnel to be involved in the solution were appropriate.
10. The team effectively integrated relevant professional knowledge (theories and practices) into their response.
11. Overall, the team's Needs Assessment and Preliminary Design were appropriate for the case.
12. Overall, the team's Needs Assessment and Preliminary Design demonstrated excellence.
13. The team was proactive in making recommendations and/or modifying the environment, as opposed to being only reactive and giving the client what they said they wanted.
14. The team identified all major project risks and developed plans to manage them.
15. The team presented an appropriate quality management plan.

Once the students had submitted their responses to the Provocateur questions, we sent an e-mail request asking them to evaluate their Case Event experience by completing a Web-based survey. We sent similar requests to Provocateurs, Team Sponsors, and Judges, as they completed their contributions to the Case Event. Both students and officials were asked nine common questions with slight variations displayed in the table below (Table 2). In addition, the students were asked whether they had participated as part of a class or some other form of academic credit. The students were also asked if there were other factors that had prompted their decision to participate. This survey is closely aligned with the survey used in the previous study, with the addition of questions reflecting our focus on emergent issues and our interest in the application of the case experience to actual practice. Responses to the surveys were submitted electronically through the survey Web-forms. They were analyzed using simple descriptive statistics (means and standard deviations) and simple qualitative analysis for the open ended questions.

Table 2: Survey Questions Answered by All Participants (Text in brackets represent variation in student Survey)

<i>Survey Question</i>	<i>Response Type</i>
Number of years you have worked in a field related to ID [full time job]: (Officials: 1-5 years, 6-10 years, 11-15 years, 16-20 years, 21 or more years) (Students: 0 years, 1-5 years, 6-10 years, 11-15 years, 16-or more years)	Multi. Choice
Prior to this event, had you ever used cases as a teaching [learning] tool?	YES/NO
If so what was the content (ID, teacher education, law, medicine) and how did you use the case(s)? Please describe:	Fill in
How did you prepare for the case competition? I read previous ITcases: (Prescription: Instructional Design, Harvesting Cooperation, Trials of Terry Kirkland, None) I explored the ITcases Web site: (Previous Case Responses, Expert Perspectives from Previous Cases, Case Method Publications, None) Other preparation:	Check boxes Check boxes Fill in
Did you have any difficulties accessing the case materials? If so, please describe:	YES/NO Fill in
Participation in this case competition helped prepare the students (me) for future instructional design projects. (Strongly Agree, Agree, Disagree, Strongly Disagree)	Likert scale
The use of the case study method is valuable in developing expertise related to instructional design. (Strongly Agree, Agree, Disagree, Strongly Disagree)	Likert scale
In what areas of professional development do you feel the students (you) were most prepared for the case analysis?	Fill in
In what areas were they (you) most challenged?	Fill in
What issues presented in the case do you perceive as most relevant to actual practice in the field?	Fill in
Taking this experience as a whole, what was most valuable? What was least valuable?	Fill in
Do you have any suggestions for future modifications of this event, the case study, or the Web site?	Fill in

Participants who completed the surveys received an email request asking if they would participate in a telephone interview. The interviews with the participant volunteers took between 25 and 50 minutes, and were tape recorded and later transcribed for analysis. The interview questions were adapted from the previous study to reflect our foci. A common set of questions was posed to all participants (see Table 3) and specific questions were directed to students and officials, respectively. Interviewees were encouraged to elaborate on their ideas and add additional comments at will during the course of the interview. Additional questions emerged during the interviews in response to participant comments. Table 4 presents questions that were addressed to students only, with several questions focusing on team process and preparation. Table 5 presents questions posed to the officials. In addition, Team Sponsors were asked if they had a perspective on how the Teams discussed the materials. Provocateurs were asked how they organized their approach to developing the questions, and the Judges were asked how they coordinated the evaluation and feedback of the case.

Table 3: Interview Questions Answered by All Participants

Was <i>The Chronicles of RocketBoy</i> case study realistic? Was it sufficiently compelling that you were able to enter it and explore the ID issues?
If so, what contributed to this sense?
If not, are there any aspects of the case that should have been adapted to increase the sense of realism?
What qualities of professional instructional designers do you feel the students (you) reflected during the event? (Theoretical base, management skills, organizational management, awareness of current trends, etc...)
In what areas do you feel the students (you) were most prepared for the Case Event and in what areas were they (you) most challenged?
What issues presented in the case do you perceive as most relevant to actual practice in the field?

Table 4: Interview Questions posed to Students

How did you organize your team's approach to the case analysis?
How did you assign responsibilities among team members? What role(s) did you have?
How did you coordinate the case analysis and response generation?
What kinds of discussions did your team have? How would you characterize them?
How did you feel about them?
How did you address conflicting viewpoints within the team?
Is there any other group dynamic that you think is noteworthy?
Did knowing that the response was going to be judged influence your approach to the activity? How?
Did it affect your performance? How?
How did you make sense of the case? (process information, organize it)
How did you feel about your case response?
How did this activity differ from those you might engage in within a class or within your school's program?
How did you feel about the questions you received from the Provocateurs? Did they encourage your team to consider other important issues? In what way?
Do you feel the case experience enhanced your skills as a designer?
If so, in what way?
If not, why?
Did you learn anything about needs assessment that you didn't know before?

Table 5: Interview questions posed to All Officials

Do you feel the students had the appropriate skills to analyze the case?
Do you feel the case analysis contributes to the development of the students' professional skills?
Do you have a sense of what skills the students used to make sense of the case?
How do you feel about the coordination of the Case Event?

Data Analysis

Quantitative data were analyzed with simple descriptive statistics (means, standard deviations, percentages). The qualitative data included responses to the open-ended survey questions and all of the interview comments. The survey and interview data from each individual were labeled for cross-referencing before creating categories to avoid duplication of individual perspectives in the data analysis. A conventional mode of qualitative inquiry was employed:

The corpus of data was read repeatedly until tentative categories emerged to describe the issues reflected in the data. Through an inductive process, the categories were revised and a final coding of the data was completed. Matrices were used to compare individual and team responses to case questions. All data within each category was then studied to determine the strength of the sentiments reflected. Where useful, direct (blind) quotes are included to better describe the outcomes. In addition, results of the previous study are reviewed to identify whether developments in the design and structure of the case have produced anticipated outcomes.

Results

In the following section, we present our findings, organized according to the categories emerging in the qualitative analysis.

Response Rates

Sixty-seven percent of the participating students responded to the surveys. We received 28 surveys out of the 42 student participants. An average of four members per team responded with one team having the minimum response of three students. We received survey responses from 14 of the 17 event officials yielding an 82% response rate.

Following completion of the surveys, 43% (19 of the 42 students) agreed to be interviewed. Each team was represented in the interviews by at least two students. Seventy-one percent (12 of the 17) event officials agreed to participate in the interviews as well.

Reasons for Participation

Four of the seven Teams participated as a part of their class, yet the majority of the respondents who commented on their reasons for participation (85%) felt that their participation in the case competition would be beneficial whether they received course credit or not. The students described several motivations for participating in the Case Event, ranging from opportunities to bond with peers to engaging in a healthy competition. Most of the students felt it would help them gain experience and exposure to current ID problems. One student saw this as an opportunity to "gain insights from the professionals in Instructional Design who do this everyday for a living." Several students were attracted to the challenge of the problem, "I think the challenge, the intrigue, the puzzle, and the thrill of working with a great group of people were the most motivating factors for me." One of the Teams had been promised substantial credit and opportunity to interact with doctoral students (they were in their first semester of graduate studies at the master's level) and were disappointed that this had not been realized due to lack of follow through from the Team Sponsor.

Preparation for the Event

54% (15) of the students and 79% (11) of the event officials had previously used cases as a learning tool. Of this group, 67% (10) of the students and 45% (5) of the officials had used cases as an instructional design learning tool. All but one student read at least one of the IT cases, Prescription ID, Harvesting Cooperation, Trials of Terry Kirkland, in preparation for the event. Most of the students reviewed other resources on the Web site: 85% read previous case responses, 71% read expert responses, and 39% of the students indicated they read some of the publications linked into the Web site. Of the officials, 68% indicated they read case responses and 44% reviewed the expert responses and publications, while 86% of the officials indicated they had read at least one of the IT cases.

Prior to the release of the competition case, we announced that EPSS would be an issue embedded in the case study and provided the URLs to the articles that would be linked into the case documents. Six of the students indicated they reviewed the recommended articles and conducted research on the topic. Other preparation included research on learning theory and review of instructional design literature, while other students analyzed ID cases in their class.

Three of the Teams met with their sponsors prior to the release of the case to discuss Event rules, the nature of previous IT Cases, and performance support. One of the Teams indicated that they had reviewed basic procedures for collaboration as well.

Consideration of the Case

Interviews with the participants suggest that several different approaches were used to analyze the case, yet there were some similarities among the Teams' coordination of the analysis. All but one team read the case before their first meeting and used that session to share individual perspectives; the exception was from a team that had been formed just prior to the release of the case. One of the Teams went a step further, completing individual analyses and conducting research on related topics before their initial meeting. At this team's first meeting, they compiled their perspectives in a database, grouping similar issues and removing 'non-issues' and created a single list which served as their analysis:

We all came in with our issues list ...and of course there was some redundancy, but there were a lot of things that came out from each individual person that we wouldn't have picked up if we had all met as a team to do that; It gave us a clear focus at the beginning of the what the issues were. We also did quite a great deal of research on EPSS and performance support systems. Which again lended itself to having focus.

All but one participant commenting on how the case was accessed, worked from a printed copy and made sense of the issues by reading through the case at least two times, recording key issues in the margins or highlighting them. One individual printed the case's organizational charts and used them to read the case on-line. She subsequently printed only those pages she found particularly relevant to the issues she had identified.

All of the Teams met two or three times as a whole group, although two divided into two subgroups during the first meeting to complete the case analysis. They used the second meeting to integrate the analyses produced by the subgroups and formulated a solution. Three Teams met as a whole group to discuss the key issues and then chunked the tasks according to the competition guidelines (needs assessment, performance support, goals, strategies, etc.). Individuals or pairs were responsible for specific tasks according to their perceived strengths. In two Teams, completed tasks were accepted without evaluation or consideration of alternative perspectives.

Two Teams commented that they used the second meeting to evaluate and integrate individual contributions with their selected approach to the case analysis and generation of the solution. This was a session where they engaged in debate, voting "yea or nay" and offering suggestions for editing. One of the Teams relied on the more experienced team members to guide this process:

The second session was purely challenge and defense. Even though you were presenting your ideas and trying to be informative, people were like, "no, that can't work because of this and you've got to remember we are Jason". We kept trying to anchor ourselves as Jason...Some of the people had been in the working world and they were explaining to us why our ideas just wouldn't work in the real world. Everybody was more grounded in the personalities and they were explaining why this person wouldn't accept that or that person wouldn't accept that, reminding each other. It was really stimulating. I enjoyed it.

Although there were various approaches to the generation of the case response, each team designated one or two individuals to compile the ideas into a single document, which was then sent to the entire team for review. The team that had conducted research before their first meeting had a unique approach to the generation and formatting of their solution: After completing the analysis, the team members continued researching topics related to the issues identified in the case and spent their second meeting formulating a solution together. They created a chart with the key issues on one side and possible solutions on the other side. The team leader used this chart to compose a solution in two or three different presentation formats:

I think that probably was the most organizing we did as far as the data goes... I wrote one and then read over it and waited a day and went back and read it again. Then, I wrote another one that was all the same content, but organized and presented entirely differently. So, when we met to decide what we were going to send or submit to you, we looked at the two or three different versions that I had written...and decided on the one that we sent which is kind of an introduction. Then we outlined what we thought the key issues were and then the outline of the strategies and the next steps...

Collaboration

Prior experience, group size, and the responsibilities adopted by team members are some of the factors influencing team dynamics. All of the Teams perceived collaboration as an important factor in their productivity and several participants described ways their teams met the challenges of team process. Most of the Teams felt the degree of their prior experience contributed to their effectiveness as a team. One Team commented that their previous experience as a group contributed to their positive team dynamic.

It was the right chemical mix. ...We had been in class together, we had studied together, and we had had open discussions in class, heated discussions in class. Academic discussions. We were prepared, we were a good team, and we wanted to work together.

Another team felt prior experience working together resulted in a team that was "homogenous" with very few disagreements. Two of the Teams commented that it took a while for them to gel as a group. A third team noted that they never achieved a sense of team cohesiveness and consequently did not feel able to "adequately flesh out all of the issues as a group."

Maybe of importance was the fact that we had not actually gelled as a group because it was very near the end of the semester. We didn't get an opportunity to go through all of the steps that groups working together go through.

Six of the seven Teams had six or more members and three of these Teams commented that the lack of prior experience working together in a large group diminished the effectiveness of their meetings. "Our discussions were out of control with so many different perspectives."

Two Teams felt that dividing the larger group into two sub-groups affected their productivity. One team found that forming subgroups to edit sections resolved the challenges of compiling the multiple perspectives of the whole group. The second team had arranged to work in subgroups prior to the event. Members of this team felt there was some redundancy in the work produced by the small groups. However, as one team member observed,

We said that perhaps it was a mistake for us to divide into two separate Teams. We had thought, that had we been in the one group from the beginning, then repetition wouldn't have occurred. However, I think we actually accomplished more in the smaller groups than we did in the bigger group. I think having just one large group would have brought about other problems that would have been just as significant or even more so.

One team felt their smaller size contributed positively to the process because "you have enough differences of opinion, but you have also got a small enough group where you are not taking forever to express your ideas." This team identified additional factors that led to their successful collaboration. Prior to the competition, the team set ground rules and designated a team leader who had full autonomy to control discussions. They also created a specific agenda for whole group meetings; they were strictly about decision making and all brainstorming and research was done independently. They used a stopwatch at meetings to guard time which resulted in rapid fire discussions "that were focused and to the point."

I think that was one of the most important things that we had to keep us on time, on track, and to the issue. She was the referee and the lead. So, if we discussed an issue, she was sitting there entering it, asking questions when something wasn't being explained or was going in the wrong direction. She would stop and say, 'This is a dead issue, let's go to the next one...'

Leadership, or lack thereof, emerged as one of the important facets of team collaboration. Five of the Teams began the event without designated leaders. Roles were defined as the need arose and team members took responsibility for completing various tasks. One of these Teams felt that without designated roles, there were too many leaders resulting in, "just a lot of information...and it was hard agreeing and disagreeing with each other." Two others remarked that they were able to share leadership roles, and one of them felt this resulted in varying levels of commitment to the project. A fourth team felt that one or two people dominated the group and some of the team members were consequently withdrawn during discussions.

Another team began with designated roles, but found they shifted once the analysis began and different personalities of the team members began to emerge. The locus of control shifted as well, to the person who took on the responsibility of compiling the results and writing the response.

Once the document was created, the writer had control and power over the document because he had written it in a voice that was comfortable for him. Trying to get any changes in that document was sort of like a lobbying effort. You had to make a case. He was like the judge. It was like a lawyer going up for the judge.

Two of the Teams expressed frustration from the lack of commitment exhibited by team members. They felt this might have resulted from the way their Teams had been recruited; they did not volunteer and participated as a part of their coursework in ID.

One or two of the members felt coerced into participating and did not invest in the process...That they had no choice. So, they were participating, but on a limited level. Whereas there were others that went ahead and accepted it and worked very hard.

Although most of the students interviewed reflected some challenges experienced with team dynamics, 79% (15) felt that these challenges were one of the most valuable aspects of the case experience.

Interacting with my group and seeing the different ways individuals approached the same case. I would do it again in a heartbeat.

Reading the case individually, each member of our team felt lost and ill prepared for the task. By discussing the case in a group, sharing ideas and pooling experiences the problem didn't seem quite so monumental. By nature, I prefer working alone and usually dislike team efforts. This project was an excellent example of why the team approach to design is often superior to individual efforts.

Competition

The competition and prospects of being judged were considered by over half of the participants (11 out of 19, or 58%) to be incentives for participation in the Case Event. When asked about the effects of the competition on the Case Event experience, there were differing perspectives, however, between students who volunteered and students who were required to participate as a function of their class. Students who volunteered (five Teams) felt the competition was an important component in the case event. It was an opportunity to represent their university and learn from students in other schools:

Whether you win or lose, the competition gives you a measuring stick on where you are at and what you need to learn. I think it is good for a university too, because they can find out what they are doing right and maybe what they need to improve on. It is a very good tool. I would like to see two of these a year, three a year.

and increase the sense of challenge, motivating them to participate:

I don't know if it influenced our initial approach, but I know it influenced our motivation level. Without a doubt, we wanted to represent the university to the best of our ability. Knowing that these things are going to be published on the Internet, we didn't want to go out and make fools of ourselves, so we tried to do the best job that we could.

Students from the Teams who had been required to participate regarded the event as another assignment;

"We were able to get some credit for it in the class that we're doing so it could have just been a group project."

The students' we interviewed were asked to comment on whether they felt that knowledge of the judging had affected their performance. Their perceptions ranged from those who felt they did not take notice to those who focused the generation of the response on the Judges. Respondents from two of the Teams felt the judging added to the 'real-world' experience:

Having to sit down and seriously look at our case response that was going to be judged. That made a very big difference. The Judges are almost like your employers in that sense; the people who have contracted you to do the instructional design.

I think the judging is good because of the fact that it is like the response you would get from upper management... Anybody who judges cases is actually in the role of upper management. In this case study, the young ID expert is not going to make a decision. He is going to put out a proposal and upper management is going to make the decision. This is what would happen when you are out in the real world and you do this type of thing and make this type of proposal.

Other respondents felt motivated to search beyond the information at hand and study the topic...

I think the fact that it was either judged or graded forced us to really do our homework. We went on the web and for instance, did searches on EPSS and we looked through our textbooks. ...it made us really look at things in detail and try and back them up with research.

And draw from previous experiences...

I think it made us more aware of the importance of our answers, trying to incorporate everything we've ever learned and to certainly cover all bases. But, I don't think it hindered us in any way or produced any negative affects.

Two respondents from one Team described a negative influence on team performance that resulted from knowing the response would be judged:

We made the mistake of trying to second-guess the judging, because it was very conscious and talked about in our team meetings when we were talking about ideas.

I think we felt as though, since we weren't quite sure what was going to be looked at and what was going to be appreciated, we tried to put in as many different things as possible. ...And I didn't have a very secure feeling about that.

The team-sponsors for the aforementioned Teams felt their students became stressed as they tried to match their responses to what they anticipated the Judges wanted. They remarked that the students might have felt this way because they are high achievers and expect to be "100% successful."

They definitely saw the value in it, but for some reason, got awfully stressed about it. Maybe they were very competitive and that was just really critical. They really wanted to have the winning response.

Five officials commented on the value of the competition aspect of the case event. Three felt it motivated the students: "The competition is really the thing gets them cognitively and emotionally engaged." Two officials expressed concern as to the effectiveness of the competition aspect of the case event: "It's hard to be in a competitive situation where there's winners and losers. Trying to compete with doctoral students and other experienced people can be intimidating for master's level or beginning students."

Provocateur Questions and Case Responses

The provocateurs reviewed the case responses, posing a common question addressing an issue they felt all of the Teams should probe further and a specific question for each team based on the focus of their individual case response.

In formulating the questions, the four Provocateurs took the role of the company manager responding to the instructional designer's recommendations. The common question was posed to all of the Teams:

"Can we slow this down a little, Jason? You've only been here for what, a month and you've talked with a few people. And based on that, you're making an assortment of recommendations that resemble re-constructive surgery on our company. I don't think the boss will be all that impressed and, frankly, it seems like overkill to me, too. We're looking to add an EPSS, not restructure the company. What elements of your proposal can be implemented, realistically, within the existing corporate structure and timelines to get the EPSS going and support its operation?"

A specific question was developed for each individual team in reaction to the team's case response. For example, one team was asked to evaluate the effectiveness a proposed action would have in the in the immediate future:

One of your suggestions is to establish a debriefing period after each project is completed. That's an intriguing idea and I can see how it might help us identify successes and failures, but only after the fact. What about now? How do you suggest we use this idea to help us develop our EPSS?

Another team was asked to consider the effects their proposed solution would have on the successful collaboration already in place on the production line:

You've recommended a formalized pipeline-partnering program as part of your OPSS. There is already a lot of "mentoring" going on. Employees frequently consult with one another and this seems to be a very positive part of the pipeline. My concern is that a formal partnering program will be more disruptive than supportive. How do you propose to structure a partnering program so that it will support, rather than disrupt, the existing collaboration?

The specific and common questions and responses can be viewed on-line at: Case Event '98 "Outcomes" <http://curry.edschool.virginia.edu/go/ITcases>).

The case response and response to the Provocateur questions were reviewed (blind) by the six Judges over a two-week period. The quantitative results (Table 1) were compiled from the Judges' ratings of the criteria they had identified prior to the event and followed up with comments reflecting on each team's performance. Each team's ratings were totaled and averaged across the fifteen items (Low:1 to High:4). The outcome of the average team ratings were fairly high, ranging from a low of 2.82 ($SD=0.36$) to a high of 3.73 ($SD=0.29$). In general, the Judges felt positive about the Teams' performance in their application of ID theory and demonstrated insight into professional practice (see Table 6). The ratings suggest the Teams' weakest performance was in their identification of project risks and development of project management plans (see Table 6, 14 & 15) which influenced their preliminary design (Table 6, 12).

Table 6: Judges Ratings for Case Response

<i>Ratings for individual items</i>	<i>Averaged across Teams</i>
1. The team identified all of the important issues in the case.	($M = 3.36, SD = .32$)
2. The team effectively addressed all of the important issues in the case.	($M = 3.36, SD = .32$)
3. The team defined the perspectives of all the relevant stakeholders in this case. (e.g., artists, technicians, supervisors, administration, trainers, organization.)	($M = 3.40, SD = .28$)
4. The team effectively responded to all of the relevant perspectives in this case.	($M = 3.13, SD = .42$)
5. The team effectively analyzed the needs identified.	($M = 3.34, SD = .34$)
6. The team identified appropriate alternative solutions for each need.	($M = 2.93, SD = .34$)
7. The team developed an instructional goal that was appropriate for the case.	($M = 3.09, SD = .40$)
8. The team recommended an appropriate overall solution.	($M = 3.34, SD = .44$)
9. The team's specifications for personnel to be involved in the solution were appropriate.	($M = 3.04, SD = .37$)
10. The team effectively integrated relevant professional knowledge (theories and practices) into their response.	($M = 3.10, SD = .54$)
11. Overall, the team's Needs Assessment and Preliminary Design were appropriate for the case.	($M = 3.36, SD = .32$)
12. Overall, the team's Needs Assessment and Preliminary Design demonstrated excellence.	($M = 2.94, SD = .45$)
13. The team was proactive in making recommendations and/or modifying the environment, as opposed to being only reactive and giving the client what they said they wanted.	($M = 3.47, SD = .34$)
14. The team identified all major project risks and developed plans to manage them.	($M = 2.69, SD = .50$)
15. The team presented an appropriate quality management plan.	($M = 2.74, SD = .33$)

In line with our previous study, the officials we interviewed presented a range of perceptions about the relationship between the Teams' performance in the case competition and their design expertise. Two officials felt the Teams' ability to analyze the case reflected the philosophy of the University IT program the student team represented:

I think some might be in a more theoretical program so that's why in my eyes they may have missed some of the practical, real world things that were going to happen. Others seemed like they had a feel for both, the theory and practice together.

I think at each of our universities, we tend to have a certain style that we impart to our students and I think it was very evident they were all from different universities... Some took a more structured approach, and others took a more casual, more open-ended approach in their analysis.

Five of the officials agreed that, although the Teams reflected a working knowledge of the ID process and systematically conducted the needs assessment, they demonstrated a wide range of real world ID experience:

Every single team used traditional analytical ID approach to try to break the problem down... Yet, I personally felt that we saw along a continuum from the winning response to the weakest response, an increasing distance from experience in the real corporate world.

The students felt it was their experience applying the ID process that affected performance. Six of the seven Teams felt they had a strong background in ID theory and the seventh team noted additional confidence in applying the ID process through their prior work experience. Several respondents felt prior experience enhanced their performance and continued to develop during the case analysis:

I felt our team achieved a very high level of interpersonal relations and the use of instructional design theory. And, the use of relevant experience... All those were well applied in this case and I think we developed it even further during the process of working on this case.

One official felt that, in addition to their understanding of the theory behind instructional design, most of the participants understood what an EPSS is. However, their treatment of EPSS was limited to the surface features and did not consider the potential risks commenting, "which is not surprising, because that's not in the literature yet."

Three of the officials felt the Teams approached the needs assessment as a novice would, accepting the information presented at "face value." They commented that only two Teams went beyond the general needs assessment and had an awareness of the techniques they might use to obtain additional information so their needs assessment would be more thorough. One official reflected that an expert would not automatically pursue the solution requested by the client as many of the Teams did:

I think they did a really good job as beginning people. The solution to the client should have been to go back and do more of a needs assessment and not go into training at this point. But, I think that is experience. In my first five years, I would have pushed for training. It took a lot more experience, sophistication, and maturity to say to a client, 'Hey, I know what you want to have, but we are not ready to do this.'

One official felt the students exhibited a degree of inexperience in their proposed solutions as well, suggesting that novices tend to rush and throw many solutions at the problem simultaneously:

They were throwing so many solutions at the clients at one time that the client would have said this is just too much. This is not us...Whereas going in and fixing a couple of things and explaining to the client that this is a life-long change here and will take time to implement. A sign of youth is wanting to go in and fix the world...It is just a matter of learning and patience that comes with more experience.

Four of the officials thought the Teams exhibited inexperience with the treatment of performance support. One official felt most of the Teams neglected consideration of quality management issues, an important factor when designing an EPSS:

Not surprising for novice performers versus expert performers. They weren't taking into account the risk management issues involved in the case... They kind-of assumed they would wave a magic wand and the EPSS would happen and that it would happen well. They tended to underrate the large degree of re-do found in the organization as a quality management issue...

Respondents from most of the Teams felt they were challenged, as well, addressing the EPSS issues.

I was definitely challenged in the EPSS area never having ever worked on an EPSS and only doing the research to prepare for the case. So, I wasn't sure how those really worked. I've never seen one.

I was least prepared definitely for the whole kind of idea of EPSS. You know, we had gone over general kind of performance support systems but not specifically electronic. I wasn't experienced with that at all, so I actually learned a lot about that.

Quality of the Case

When we spoke with the students about the degree of realism in the case, we asked if they thought it was sufficiently compelling so they could enter the case and explore the ID issues. Most of them commented that it gave them the impression that it was real enough for them to take on the roles of the characters:

It *was* realistic. In fact, I must say that while I was doing it, I was convinced that there had actually been someone who had been in a similar experience and type of industry. That is actually the way I thought about the case.

The way you put it in a real world setting with somebody walking into a brand new company, and some of the other little things that you talked about to set the case up, were kind of enjoyable to read rather than just reading some dry facts. And, again, it was very clear and very straightforward to follow all the way through. The interviews were well written and really helped us focus on what the issues were and some of the solutions we decided on.

You really took the time to develop personalities. We understood where people were coming from... I found myself actually sort of getting into each character and sometimes even thinking about what else they might say...

One student commented that the case was not realistic because the animation industry is foreign to her. She did find, however, the personalities of the characters to be believable:

There aren't very many people who create animation and certainly none in my world, so, only like reading science fiction. That can be compelling, but, in terms of real, no. What I thought was good was there were a lot of different human elements in there; the different motivations and perspectives. I thought that was realistic.

Most of the officials found the work environment in the case to be extremely realistic:

The organizational context issues I thought were very reflective of the kinds of things you would see in a real organization. The details concerning the description of the work flow and the description of the tasks as far as they went were very plausible...

The way the interviews were written, the collection of interviews, they were presented in dialogue form that made them both seem very realistic and sort of present tense if that makes any sense. It clearly was not an abstraction of interviews, but it was presenting the actual interview and I thought that aided the realism.

When you have the two groups (characters in the case), particularly the older experienced people with the less technological background and the newer techie group; that certainly is very real in any kind of setting. I also saw the kinds of problems that really didn't matter what your industry was or whether it was industry or education. I mean this is a very realistic situation that everybody faces.

One official felt it helped fill a gap in instructional design training:

There was not just an obvious find, one or two answers. There was a provision for alternate agendas and politics and this kind of stuff is exactly what I have felt is lacking in an awful lot of instructional design training...

This official also commented that he found one aspect of the case only mildly realistic, and that was the amount of responsibility given to a junior hire. A second official began to feel the case had been contrived as he observed the team moving further into it, but this did not affect the students engagement in the process and they became a part of the story:

There were times when all of a sudden the thing seemed like a real-life project and the team was so involved in it that you wouldn't know they weren't working for the company...

Materials and Management of the Case

When we spoke to the students about the interface of the Web-based case, we were interested in identifying whether the navigational design was efficient. We also wanted to know whether our increased focus on textual character development, in place of audio and video clips, was effective in providing an environment that was easy to access, yet deep enough to present the complexities of the real world. Most of the students interviewed felt the materials at the site were easy to access and reflected that the writing style helped them to analyze the case:

I found that it was easier to process the case because of the way it was not only written, but the way you could access things. For example, the fact that each interview was a separate component on the web... you could read what Carl Durer said. You could chronologically look at what happened to Jason on the day he was hired. So, for content purposes...and for chronological purposes, it was easy to process and you could do things simultaneously by clicking back and forth.

I think the way that the interviews in the case were organized with the brief intro...made it more comprehensible. You got the whole picture in a very, I wouldn't necessarily say concise, but in such an organized manner, that we were able to understand it properly and get a picture in our heads. I think, if you can visualize things, it makes it a lot easier.

Respondents who had read previous Case Event cases thought the shift in focus from multimedia to character development improved the quality of the case:

I think it was a very professionally done job. Your web site looks better and better every year. The case responses are getting easier to read and more understandable every year. I think your learning curve has really gone up and you are putting together a classy act here.

Well, every year that these case studies have come out, and I have read all of them since you all started this, they are getting easier to read. Really, the writing that you guys have, the style that you use to build these cases, really lends itself to picking up the ideas that you want out of the case very easily.

A student, who was new to instructional design theory, found it difficult to identify the problem within the complex layers of the story: "It was a huge packet for us to digest in the short period of time. I would highly recommend that it be more compact and not as technical, or else make sure that first-year students are not allowed in. It was a real mismatch to try to put it all together and learn everything as we go." Another student from this team commented: "While this was frustrating, I think it mirrors the actual process in a real-life situation."

The graphic interface for the Web pages was designed so the case could be effectively viewed in versions of browsers that had been released within the past year. We found, however, that a few of the respondents were using older browsers that did not recognize colored table cells. Consequently, these students had trouble reading the case on-line because the light colored background of the table cells did not display. And they were viewing dark text on a dark background.

A few issues emerged concerning the coordination of the case event involving the limitations placed on the students and the format of the response. The time limit for group meetings was seen as difficult by some of the respondents. One student felt the word limit was enough of a time constraint: "Why the need for the time constraints? Isn't the 2000 word limit for the initial response enough of a constraint?" Another respondent suggested increasing the time limit to match a typical workday: "I understand the need for time constraints, it might be helpful if the six hour limit could be expanded upwards by a small amount such as 8 hours, a usual work day." A third respondent felt that, although a challenge, this is reflective of real life: "You could always use more time, but, I think given the case and the situation, ...it was probably proportionally appropriate to real life."

Two of the Teams had contrasting views concerning the format of the case response. A member from one team felt that the restriction to develop a text-only response enabled them to focus on the case analysis and design. Another team felt that the text-only restriction diminished the quality of the response they could produce. They suggested that it would be more reflective of actual practice and allow for greater creativity if Teams could place their responses in the form of a report on the Web, including tables, graphics, and links to relevant Web resources.

Relevance to Actual Practice

Eighty-nine percent (25) of the student survey respondents and 95% (18) of those interviewed commented on issues presented in the case they found to be relevant to actual practice and several issues immersed. The limited time frame for producing results was seen as a challenge for "managing multiple priorities simultaneously" and this, in turn, fed into the organizational dynamics an instructional designer must contend with in a corporation:

The issues surrounding the great gaps that exist between the younger, "techie" types and the older, more experienced employees were particularly important. Being able to provide solutions to bridge this gap was especially relevant. Also, the fast-paced working environment in this particular case is probably very reflective generally of work environments today where deadlines are too short for the amount of work required.

Perspectives on needs assessment ranged from those who had limited prior experience applying the ID process, and learned "the importance of the environmental assessment and how very complicated that can be as part of the overall picture..."

It gives you a whole different perspective on front-end analysis in a real-world type setting as opposed to a classroom situational-type project where you're just going through the motions.

...The degree to which you can't rely on individual interviews and the need for a composite whole of many different interviews became clear to me. It helped me understand that you can't just jump in and do something. You need to do thorough, thorough needs analysis. You need to analyze everything, consider everything.

We don't really get a chance to do as many needs assessments, I think, as we'd like to do before we leave the program. So, I think every one of them has got some major learning issues in it. The more we do, the better off we are.

Two students who felt they were well grounded in design theory and application, yet saw new challenges they would face when conducting a needs assessment in environments similar to the case:

I think the other part that's relevant to the practice of ID is the Jason Tilmans', which we all may be in the future... Where, you're told, 'This is what the need is.' You do the assessment and, albeit, it's a need, but combined with a whole bunch of other stuff... Then, how do you choose to link the need that you've been hired to address, but still

be realistic? I felt this was very germane to ID practice because it's rare that you get, 'Here's the need, meet it,' and everything's hunky dory.

I blush when I think about how I probably analyzed situations at work before doing the case. Whether they were ID or just performance technology issues, I feel like they were limited in terms of how I would analyze needs or how I would not be so multi-perspective as I am now. I feel that critical thinking skills and my writing has had to change to really document, if you will, with evidence, why I believe an assumption or why I'm making a statement. I believe this has grown and, for that, I'm very grateful, and I think that'll serve me well no matter what I do.

Most of the students interviewed commented on emergent issues such as EPSS and how they must be integrated with the ID process. Some of the students went on to express how their experience addressing these issues during the case has motivated them to continue learning about the topic:

We thought it was very interesting. In fact, the whole team was really excited about it. We thought that the challenge of EPSS was relevant to things that are going on right now in a lot of industries...

What's relevant, is that EPSS seems to be an emerging trend all of us need to understand. I spoke to some of my colleagues in California, Silicon Valley, and it's a hot issue out there. They're all getting involved in it. This is very relevant. I have to tell you, I was very grateful that the case brought this to the forefront of my mind.

Performance support is absolutely crucial and something that I am going to explore further because of this case study. I think these skills are necessary for an instructional designer to work with a company where you are going to have to increase productivity, justify training, and work with EPSS systems. So, my reflection is that this really opened my eyes to a whole different world. I think I am going to have to pursue it and get better at it if I am going to do instructional design...

Although most of the students commented on team dynamics when reflecting on the case analysis process, seven of them remarked upon their heightened awareness of the need for these skills in actual practice. They compared this need to the challenges of team dynamics presented in the case:

I mean, just taking it from Jason's perspective, I think it is really very important to have a good understanding of what will gain support and develop a team that you can work with. Not that he necessarily did that, or we necessarily suggested it, but this is what I learned from the experience.

I think we came out of it with a really increased awareness of what can go on: The experience of hurrying through the needs analysis and linking the need to some practical issues in your solution. Then writing up a formal proposal and possibly presenting it to a group of people who you don't really know...the emotional response might come back with things that you hadn't anticipated. Also, the dynamics of working in a big team like that using electronic collaboration.

The issues were secondary to the personalities involved. Often in my studies, I forget about the people and focus on strategy and theory.

Six of the students commented on the need to consider multiple perspectives and solutions as well:

In the process of identifying key issues from a complex array of concerns and issues, it is important to quickly identify what are the biggest causes or factors. Also, being able to identify training versus non-training issues and, of course, working with people is always a useful skill in the real world.

The most important thing about this case was when we first jumped into it, we thought, 'OK, they want EPSS as a solution.' And it helps to remember that, even though this may be Jason's talent, it is not the only solution... The good thing is to look at all the possible solutions.

The officials were asked to reflect on how this experience contributes to the development of ID students' professional skills. Four officials commented on the benefit of reading all of the case responses and officials' comments at the conclusion of the event:

If you read someone else's perspective and response, it remains in the back of your mind where you can call on it when you encounter that type of situation or challenge in your career.

One official agreed that the case experience provides an opportunity to practice knowledge and skills and get feedback on the results from several resources. However, he reflected on the difficulty in determining how much the case experience contributed to the students' development of their professional skills:

I am hesitating only because I think it is going to be difficult to tell exactly how much or in what way. They got to compare what they came up with against other students, against Judges, against expert responses, so they got a lot of feedback from several different sources that they could use to do a self-assessment... I've just got to believe that is a growth experience, although we don't know anything about how they use that feedback.

Another official noted that his students were interested in learning more about the issues that were identified in the case:

They wished they knew more about some of the issues that came up in the case study, for example, different ways to conduct task analyses. Now they want to learn that in the class. The students involved in this project would jump at the chance to get some more instructional experiences over the things they realized they didn't have much experience in; task analysis, EPSS, and project management.

Value of Participation

The students and officials were asked to share their opinion on the value of the case study method and the case competition using Likert response options from 1 (strongly disagree) to 4 (strongly agree). The students overwhelmingly felt that the use of the case study method is valuable for developing ID expertise ($M = 3.61$, $SD = 0.50$) and that the case event was of value in preparing them for future ID projects ($M = 3.57$, $SD = 0.50$). This perception was shared by the officials in regard to the value of the case study method ($M = 3.93$, $SD = 0.27$) and the value of the case competition in preparing ID students for future projects ($M = 3.64$, $SD = 0.50$).

Several of the students and officials share their perspectives on the value of the case experience. Most of the students were positive, describing how the experience enhanced their preparation for professional practice:

The opportunity to solve a problem in an area that I knew so little about was very valuable. I was able to make the connection that instructional design isn't always for stand-up training or CBT... This is by far the best learning experience I have had in my entire educational career.

and

I just read in the newspaper ads last Sunday about trainers needed with skills in knowledge management. I thought, this is kind-of neat that this case study addressed all these things that we don't really address in a classroom setting or in some work settings, like the one I'm in. Normally, or before this case study, when I thought of instructional design, I thought of designing instruction for stand-up training or computer-based training or self-based training. I never really had the context to put it in a real-life production environment and it just kind-of opened my eyes to a whole new use for this skill set.

All of the officials who responded were positive and shared their perspectives on what was most valuable. There were several enthusiastic comments about the value of the case competition experience:

I think this is one of the most significant events that has occurred in their ID education...

I thought this case was wonderful! Having spent some time in a Glen Michener type of role, I fully understood the different perspectives and felt that the designers of this case were thoughtful, accurate and insightful!

As my team captain said, this was the most valuable learning experience of her career. What made it so? In my opinion the following elements were key: Competition, particularly with some big-name schools and people, time limits, word limits, and the high quality of the case itself: Well written, creative, engaging, relevant.

and...

All the theory in the world is useless unless practitioners know their roles as change agents. This case placed the students in a situation where understanding varying perspectives and agendas was imperative. They also had to be sensitive to the repercussions of their recommendations. The case pivoted on this, and, as such, was a great experience for the students. The mere fact that this was event competitive was powerful as well.

For me, the most valuable part was seeing perhaps some perspective on what future graduates are thinking about bringing their design skills into the workplace. I believe that there are some extremely clever people who will be professionals in our field soon, but I think it's clear that we have some "broadening" to do... We need to insure that new designers and future decision-makers in our field are equipped with both the design skills and interpersonal skills to be true "change agents" in their careers.

Of the six officials who are not yet using ID cases in their classes, three commented that they are considering integrating cases into their courses as a result of this experience:

We have actually talked about restructuring the two-semester instructional design sequence to actually take advantage of the case study...because it contextualizes. I mean it is just good instructional design... It comes about as close to situated cognition as you can get over the web...

Discussion

Sixty-seven percent of the participating students and 82% of the officials responded to the follow-up survey and 43% of the participating students and 71% of the officials agreed to be interviewed. They shared their perspectives on the value of the Case Event as a tool, for the preparation of professional practice in instructional design. The students also described the processes in which they engaged to analyze the case and create a design solution, and several (8 of

the 14, or 57%) of the officials commented on their observations of this process. In the following section, we discuss the implications of our findings as they pertain to our primary question guiding this study and follow with discussion of our secondary questions.

- Is a Web-based case competition a worthwhile medium for expanding professional knowledge and exploring emerging issues in instructional design?

The potential to expand their preparation for professional practice in ID was noted by the majority of the students who commented (11 of 13, or 85%) on their reasons for participating in the Case Event. Students from two of the Teams that were constructed as a part of a course observed a lack of commitment from team members who remarked they had been required to participate. At the conclusion of the Case Event, however, all of the respondents noted the value of the case experience as a tool for developing ID expertise. This suggests that, although most participants value the ID experience gained during the case event, those who participate by choice are more likely to engage in the process and more fully benefit from the experience.

Consistent with our previous study, the participants were enthusiastic about the competition and their engagement in the process began prior to the event. All but one student read at least one of the previous IT cases and the majority of them read the accompanying case responses (85%) and expert (71%) critiques. Prior experience using ID cases as a learning tool had increased since our previous study from only one student to almost one third of the students (28%). In addition to reviewing the materials available on the Web site, other preparation included research of learning theory, review of instructional design literature, and procedures for collaboration. Just under one third of the students we interviewed indicated they had reviewed the recommended articles on EPSS as well.

The case analysis and response generation described in this paper reinforces the findings from our previous study. There were several common aspects of coordination exhibited by most of the Teams.

This included:

- reading the case prior to the first meeting;
- meeting two or three times;
- using the first meeting to share perspectives and develop a plan for the response and the second meeting to generate a solution;
- designation of one or two individuals to compile ideas into a single document; and circulation of the document among team members for review.

Some Teams divided the case response among team members according to the competition guidelines while others completed all of the sections together or in sub-groups. One Team was unique in its approach, completing individual analyses and conducting research before their first meeting.

Some significant new aspects that emerged from the analysis and response generation pertained to collaboration. All of the Teams perceived collaboration as important to productivity and there were various factors influencing team dynamics. Several participants felt prior experience (or lack thereof) working together contributed to their effectiveness as a team. Those with prior experience had few disagreements, while others felt that lack of experience working in large groups diminished the effectiveness of their meetings, in particular sharing multiple perspectives and coming to a consensus as a whole group. Some Teams addressed this challenge by splitting into sub-groups, which was seen by some participants as productive and others as a poor use of time due to the redundancy in the work produced in the sub-groups. Leadership was another factor that emerged as an important aspect of team collaboration. Some participants felt that shared responsibility was effective, while others felt it resulted in varying levels of commitment to the project. In spite of these challenges in collaboration, the majority of the respondents (79%) felt that the team process was one of the most valuable learning experiences in this activity. Slavin's (1995a, 1995b) research on group goals and individual accountability is reflected in the team that successfully collaborated due to a combination of factors. These included: small group size, a designated leader and action plan, individual generation of responses, and meetings reserved for the integration of ideas and decision making.

Students who volunteered to participate in the case event felt the competition was an important component in the case experience, increasing the sense of challenge and motivating them to participate. Most of these students also viewed the prospect of being judged as motivating. They were compelled to research beyond the given information in the case. One team who volunteered, however, described a negative influence on their performance. They reflected their efforts to "second-guess" the Judges throughout the generation of the case response and commented that it added stress to their learning experience. The majority of the officials who commented on the value of competition agreed that it enhances the learning experience by engaging students cognitively and emotionally. There were concerns however, that the challenge to compete with doctoral and experienced ID students could be intimidating for beginning master's level students. This sentiment was voiced by the team composed of novice ID students who felt they were not prepared to compete without a foundation in the ID process.

As in our previous study, the Teams performed well in their case responses. According to the ratings on the overall performance item, the Judges indicated agreement or strong agreement that team performance was excellent with the exception of one team that received a lower rating from two Judges. Ratings on the specific criteria suggest that, in general, the Judges felt positive about the Teams' application of ID theory and demonstration of insight into ID practice. Their weakest performance was in the identification of project risks and the development of project management plans.

The Judges related several observations on team performance and design expertise to the differences between novice and expert designers, similar to those identified by Rowland (1992). For instance, the case responses reflected the approach taken by novice designers who accept information at face value and move immediately to the generation of solutions. Most of the Teams pursued the solution requested by the client in the case and were observed to throw many solutions at the problem simultaneously. In contrast, experts will draw from previous experience and reflect on a wide range of factors as they interpret the design problem (Perez & Emery, 1995; Rowland, 1992). This was evident in two Teams who went beyond the case's general needs assessment and demonstrated an awareness of techniques they might use to obtain additional information. Students recognized the effects of prior experience on their performance as well, noting that their expertise applying the ID process and interacting with team members was evident in the quality of their case response. Some students commented that this expertise continued to develop during the case experience.

Embedding an emergent issue in ID practice, EPSS, into the case study was seen as one of the most challenging and valuable aspects of the case experience. Most of the participants remarked that the case study introduced them to EPSS and to the necessity of learning how to integrate emergent issues into the ID process. They learned that instructional design goes beyond the scope of training and CBT (computer based design). Some of the officials felt that, all of the Teams performed well as beginners; they were able to address the surface issues in their treatment of EPSS. Most of them neglected consideration of important components of EPSS design such as quality management issues, including risk management. This was considered to be another example of novice versus expert performers. Some of the students commented that they were encouraged to continue learning about the topic while others noted they had become aware of its prominence in the field of ID and were pleased they had been introduced to the topic.

All of the responding officials and students agreed or strongly agreed that the Case Event experience had been valuable for developing ID expertise and enhanced their preparation for professional practice. One official noted that the Case Event helped the students recognize their role as change agents by placing them in a situation where they were forced to consider multiple perspectives and the consequences of their recommendations. Officials and students alike felt that the case competition was one of the best experiences that had occurred in their ID education. Finally, one official noted the value of the case competition for IT programs, providing them a means to measure what design skills graduates are bringing into the workplace.

- Did this case experience alter student perceptions of skills they need for professional practice in ID?

When asked what they had learned relevant to actual practice, students noted that their awareness of what knowledge and skills they will need for actual practice goes beyond the theory and models of ID they practice in the classroom. The degree of knowledge and skills recognized correlated to the students' prior experience in the field of ID. Those with limited experience applying the ID process gained a deeper understanding of components within the needs such as the value of the environmental assessment and the necessity for obtaining multiple perspectives through multiple interviews. One of the Teams inquired into studying the instructional design issues they had identified in the case with their team sponsor. Students who entered the competition with some prior experience practicing ID drew a correlation between the case experience and the new challenges they would face in actual projects that might occur in environments similar to the case. Most notable was the necessity to support all assumptions and design solutions with evidence. Both beginning and advanced students recognized the need to continue developing interpersonal skills which are essential to successful practice in ID. Officials saw a valuable opportunity for the students to continue to expanding their professional knowledge, as well, by exploring the collection of IT cases, expert responses, and feedback from the Judges.

- Did the design of our Web-based case enhance the sense of realism and complexity necessary to compel exploration of ID issues and practice?

We focused the design of our case on character development and designed the interface to match its theme. Our results suggest our emphasis on character development and the supporting interface design helped enhance the sense of realism: All but one respondent felt the case was realistic and sufficiently compelling for exploration into the ID issues. The disagreeing student (who was from the beginning ID class) felt limited by her lack of knowledge about the animation industry and found it too complex for entry level students in ID. She did, however, find the characters to be believable and representative of personalities she has interacted with in other work environments. A

facilitator-guided analysis of the cases may be a better suited learning experience for beginning ID students who do not yet have the background knowledge of ID theory necessary to solve the case problems on their own. According to Vygotsky (1978), expert facilitators can build on the learners' existing knowledge by providing guidance and feedback, which will help them move beyond their current level of competence. As a result, they can begin to solve problems as does someone with expert experience.

Those who commented on the sense of realism reflected in the case study felt that character development and case format helped them to focus on the issues in the case. Some noted they had become immersed in the story, taking on the role of each character, and were able to imagine how the personalities might answer their questions. Most of the officials found the case extremely realistic as well, commenting that the key issues represented the types of problems one would find in any setting. Other aspects of the case contributing to the sense of realism included the context of the company, the design of the organization charts, and the presentation of the interviews in dialogue form. Several officials and students commented that these elements helped the reader experience the case through the eyes of the characters.

Limitations of these findings

It is possible that students who did not respond may have had different perceptions of the value of the case experience as a learning tool in instructional design. Participants received three email notices about the survey and their Team Sponsors were asked to announce it to the team as well. Survey respondents were sent individual e-mail requests for interviews. We feel that all who wanted to respond had the opportunity to do so.

This paper presents the experience of participants in a case competition. Therefore, we cannot assume the level of enthusiasm and motivation exhibited during this activity are representative of case methods employed during a regular ID class.

We know that the participants feel they gained skills for actual practice from this experience. We do not know however, whether the students will retain their enthusiasm and apply what they learned in other settings. As one official noted, with the wealth of feedback the participants get through the multiple responses from the participants, experts, and judges, we can assume this was a growth experience. We do not know, however, how the students will use this feedback. Research of long-term outcomes can help us identify whether students successfully integrate what they learned during this experience into instructional design projects, teamwork or project management design.

Future research and development directions

As the use of cases in instructional design classrooms increases, so will the number of students participating in the case competition who have prior experience analyzing ID cases. Future research of Case Event outcomes can help us identify whether these students are transferring what they learned in prior cases to the new environments represented in the competition cases. This may provide further insight into the effectiveness of case studies in narrowing the gap between novice and expert practice of instructional design.

While most of the respondents considered the competition and judging valuable aspects of the case event, some of the students were intimidated by the prospect of being judged. Some students tried to emulate what they thought the Judges would consider the "correct" response rather than using their own perceptions to design what they believed to be the best possible solution. This may have diminished the effectiveness of the learning experience and we would like to know what factors contribute to this reaction to the competition environment. Future research can also tell us whether the judging process diminishes the real world experience for these students.

Volunteers?

For the past three years, we have facilitated the IT Case Event, writing and producing Web-based case studies and coordinating the competition. To encourage collaboration between IT programs across the country, we would like to extend an invitation to other universities to take on this role or coordinate with some other institutions in facilitating the competition. Each university has unique perspectives on application and theory in ID and we feel facilitation of the event from multiple universities can enhance the case experience for all of the participants.

Implications for the training of instructional designers

We continue to find that the cases are a useful tool for encouraging students to explore ID issues. Students who participate out of choice will gain more from the experience than those who are required to participate. Limiting group size to a maximum of 4 or 5 persons can provide the best dynamics for discussion and consensus. Web-based case methods; students enthusiastically engage in the case analysis and feel that it helps prepare students for professional practice in instructional design. Cases cannot replace actual experience, yet they can expand the learners' depth of understanding applying the design process. The experience in solving problems in the multiple environments presented in the case studies can increase the novice designer's arsenal of design tools. The

competition is motivating and, when implemented in a collaboration environment, the case experience provides a valuable venue for expanding professional knowledge.

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THE INSTRUCTIONAL TECHNOLOGY CLINICAL EXPERIENCE: EXPECTATIONS AND REALITIES

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Virginia Tech

"To learn to use tools as practitioners use them, a student, like an apprentice must enter that community and its culture. Thus in a significant way learning is, we believe, a process of enculturation." (Brown, Collins, & Duguid, 1989, p. 33)

Graduate schools in Instructional Technology (IT) typically prepare students with the tools of instructional design and development. IT programs usually require classes in instructional design, learning and instructional theories, and technical production skills. However, studies of expert performance indicate that experts in a domain possess more than knowledge of subject matter specific facts, concepts and procedures. Experts also possess heuristic strategies which include general techniques and "tricks of the trade", control strategies which direct the process of carrying out a task, and learning strategies that guide the expert in learning new concepts, facts, and procedures. Research in the development of expertise suggest that these additional skills may develop in situations that involve solving complex ill-defined problems under the guidance of a more capable other (Brown, et. al., 1989). Thus, the skills of an expert may be developed through immersion in the culture of practice. Unfortunately, the only experience many graduate students have in the design and development of instructional materials is through small projects in courses; they may leave school with little experience in the design and development of complex projects for real clients, and with few opportunities for developing complex skills through enculturation.

Several methods have been suggested to involve graduate students more extensively in the entire design and development enterprise. Specific methods include; the preparation and examination of case studies; role playing and simulations; instructional design studios; class work on real projects; internships, apprenticeships, public presentations, competitions among graduate students; examination of design artifacts, and analysis of examples of expert work (Rowland, 1993; Rowland, Fixl, & Yung, 1992; Quinn, 1994; Tripp, 1994).

We developed the idea of an Instructional Technology "Clinical" to address the needs of our students for immersion in the practice of instructional design and development. We envisioned an experience based on an apprenticeship model of teaching and learning that included an instructional design studio experience (the "Clinic course"), public presentation of student work (as part of student evaluation), and the examination and development of case studies and design artifacts (as an orientation to projects and as part of student evaluation).

We explored the perceived need for a "Clinical experience" to facilitate learning through immersion in "real problems" that provide opportunities for participants to apply program ideas and techniques. During the fall 1997 semester, 27 students enrolled in our Instructional Technology Professional Seminar participated in a discussion of the Clinical concept. We followed the period of open discussion with a questionnaire asking students to identify the benefits of such an experience, their related concerns, and ideas for implementation. We developed a specific plan for an "IT Clinical" based on our examination of student's perceptions and review of literature. In this paper, we will provide an overview of the Clinical course and compare the perceived "reality" of the Clinical experience, in terms of benefits and concerns, with students' initial expectations of the Clinical experience.

The IT Clinical Plan

"Cognitive apprenticeship methods try to enculturate students into authentic practices through activity and social interaction in a way similar to that evident- and evidently successful- in craft apprenticeship." (Brown, et. al., 1989, p. 37)

Collins, Brown and Holum (1991) outline a framework for designing cognitive apprenticeship learning environments. Their framework suggests an appropriate *sociology* for effective cognitive apprenticeship learning environments, *methods* for developing expertise, types of *content* knowledge required for expertise, and how to *sequence* learning activities. Based on this model of cognitive apprenticeship, we have incorporated each of the proposed pedagogical features into the Clinical experience.

Sociology

The sociology of the learning environment includes the context and social environment in which the learning occurs. Collins, et. al. (1991) suggests that the learning environments should establish a social context where learning is situated, students participate in a community of practice, students are intrinsically motivated, and cooperation is encouraged.

Situated learning

Situated learning is defined as "learning knowledge and skills in contexts that reflect the way knowledge will be useful in real life" (Collins, 1991, p. 122). The purpose of the Clinical experience is to provide an experiential learning environment where students apply program ideas and techniques to develop instructional materials for the college, university community, and external organizations. Projects with actual clients with real instructional design problems provide opportunities to learn through immersion in the culture of practice.

Students enrolled in the IT Clinic are expected to spend considerable time on course activities on an ongoing basis. The course is offered for variable credit, and students are expected to spend approximately 3 hours per week working on the class for each hour of course credit. Specifically, students are expected to:

1. Contribute to an on-going design and development project.
2. Identify project and individual learning needs.
3. Meet project goals and individual learning needs in a timely manner.
4. Articulate design and development decisions.
5. Share expertise with other students.

In this way, the IT Clinical supports and facilitates situated learning.

Community of practice

In a community of practice, participants are expected to relate to one another with respect, participate in and take responsibility for the collective life of the project, and count on one another for meeting both individual and collective needs. In the Clinical, students further along in the program are expected to collaborate with beginning students and mentor them along with faculty. Individuals are "free to specialize in particular areas so that the community can capitalize on diversity" (Lin, et. al., 1995). Clinical students assume one or more possible roles, depending on the project. In this way, students learn about the design and development process by observing how others approach a problem.

Intrinsic motivation

Intrinsic motivation is encouraged as students set personal goals to perform specific activities and gain particular skills. Students' progress is assessed through an informal system in which students determine activities they will pursue to meet those goals and document their process. As faculty, we evaluate the reasonableness of those goals and the extent to which students are successful in meeting them.

Cooperation

Students work together to accomplish common goals. Each participating student and faculty member evaluates the degree to which their peers contributed to the project and shared their expertise with others. The willingness of participants to share their expertise through coaching and modeling techniques is considered in these evaluations.

Methods

Methods for developing expertise include modeling, coaching, scaffolding, articulation, reflection, and exploration. These methods are clustered into three groups of complementary activities (Collins, et. al., 1991). *Modeling, coaching, and scaffolding* by the teacher or more competent peer provide learners with guidance and support as they gain new skills through progressively more complex or independent activities. *Articulation and reflection* by both the teachers and students make reasoning explicit and allows learners to compare their developing understanding with the ideas of others. *Exploration* provides opportunities for learners to define their own goal problems and seek ways of solving them independently. We have incorporated each of these features in our Clinical experience.

Modeling, coaching, and scaffolding

Modeling refers to the demonstration of processes and strategies to perform real-world tasks by the expert. In a cognitive apprenticeship, many problem solving tasks take place mentally; thus, it is important for the experts to provide detailed explanations of what they are doing and why. Modeling introduces learners to the processes and strategies used to solve a complex problem; coaching supports students as they attempt a task on their own. Coaching involves providing hints, feedback, giving encouragement, and otherwise overseeing the learning process (Collins, et. al., 1991). Scaffolding refers to the process of providing, and gradually removing, support for learners, as they become increasingly more capable of performing tasks independently. Support can range from doing almost the entire task for the learners to giving occasional hints as to what to do next. Taken together, modeling, coaching, and scaffolding provide the foundation for cognitive apprenticeship (Collins, et. al., 1991)

Our Clinical students and faculty meet once a week to discuss project progress and plan the next steps. Some meetings involve the client as well as the project team. During these meetings, we scaffold student learning. Students are encouraged to perform as much of the task as possible independently. We constantly assess the students' performance, and when their performance is judged to be going astray or students appear to be floundering, we coach them through offering suggestions, providing hints, or asking guiding questions. If they still appear to be going astray in their reasoning or performance, we step in and model the way we would handle the situation.

These weekly design meetings provide opportunities for faculty to diagnose areas where the students are having problems. A variety of "just in time" instruction is provided to demonstrate skills needed by the design and development team beyond those possessed by the group members. Periodic "workshops" are scheduled throughout the term to respond to the learning needs of a particular semester. Faculty as needed, to respond to the information needs of the task at hand selects Reading materials. Students are encouraged to learn from others as much as possible. In fact, students are expected to model behaviors for their peers, coach others in obtaining new skills, and provide scaffolding for their peers.

Reflection and Articulation

Articulation refers to the process of verbalizing thoughts and reasoning in order to make design decisions explicit. Through reflection, individuals compare their ideas and skills with those of others. These methods encourage both students and faculty to think about what they are doing and to make their tacit knowledge explicit. "By engaging students and faculty in dialogues regarding the identification of problems and causal relationships, as well as requiring justification from participants regarding their use of certain strategies, cognitive apprenticeships are thought to encourage reflective thinking. Reflection is believed to help students learn how to think about their work and the work of others in order to understand it, to learn from it, and eventually to contribute to new conceptions of it" (Ertmer & Cennamo, 1995, p. 48).

During weekly Clinical meetings, faculty and students reflect on and articulate their design decisions. As a means of assessing student learning, students are expected to prepare design documents (a "case") based on their project. Through the preparation of design artifacts and cases, students are required to reflect on their current understanding of the issues of the project and identify what they have learned by participation in the Clinical experience. In addition, students who join the project in subsequent semesters are able to examine the materials in order to identify the current status of the design project. As such, the cases provide an orientation to the project for students who enroll in the Clinical in subsequent semesters.

In addition, each project team is expected to publicly present their project in forums such as our Instructional Technology Professional Seminar, presentations to client groups, and conference presentations. These presentations provide students with opportunities to reflect on their decisions and articulate their reasoning in order to justify the design decisions that contributed to their finished product.

Exploration

"Exploration, as a method of teaching, involves setting general goals for students and then encouraging them to focus on particular subgoals of interest to them or even to revise the general goal as they come upon something more interesting". (Collins, et. al., 1991, p. 44) Each week, Clinical participants identify specific tasks to be completed before the next class meeting. The task assigned to each student is based on a combination of the students' individual strengths as well as their interest in learning more about unfamiliar areas of instructional design and/or development. Students are responsible for identifying tasks of interest to them and setting sub-goals to accomplish those tasks. Depending on the nature of the task, students may work individually, in pairs, or as a group of the whole. Students generally understand, and are willing to accept their responsibilities in completing an assigned task

Content

Content knowledge necessary for expertise includes domain knowledge, heuristic knowledge, control strategies, and learning strategies. Although students are expected to enter our course with domain knowledge in the areas of instructional design, learning and instructional theories, and technical production skills, we anticipate that their heuristic strategies and control strategies may be relatively undeveloped. However, as the students have at least a bachelors degree before enrolling in the course, we assume they possess adequate knowledge of learning strategies; thus are able to direct and monitor their own learning. Collins, et. al (1991) acknowledge that heuristic knowledge and control strategies may be learned through observation of experts articulating their decisions, making their reasoning explicit, and reflecting on what they did and why. In our Clinical classes, faculty and students work together to solve instructional problems. The composition of the classes reflect a variety of expertise in instructional design and development, ranging from instructors with fifteen or more years of experience in the field, to beginning masters students in instructional technology. As we collaborate as a design and development team, we try to develop heuristic knowledge and control strategies through the sociology and methods of a cognitive apprenticeship.

Sequencing

Collins, Brown and Holum (1991) also suggest that learning activities should proceed in a certain order. Global activities that provide opportunities to understand the whole task should precede the development of specific skills. Task should increase in complexity and difficulty, and finally, activities should reflect increasing diversity as students develop their expertise in order to emphasize the broad application of skills across a variety of situations. Although this sequencing of skill development is not apparent within a semester-long Clinical course, students are encouraged to enroll in the Clinical experience for multiple semesters. Likewise, students are encouraged to enroll in the Clinical at multiple points in their academic experience. In this way, beginning students may develop a global understanding of the entire design and development experience as they participate in less complex tasks on the development team. As they increase their expertise, they are expected to assume increasingly complex responsibilities. As they participate in the course across multiple semesters, participating in multiple projects, they gain practice in applying skills across a variety of situations, with a variety of projects and clients.

Procedures

We piloted our Clinical idea with a group of 5 students during the spring 1998 semester. During this pilot semester, we tested and refined our preliminary ideas. During the fall 1998 semester, 11 students enrolled in two courses offering a Clinical experience. The intent of this paper is to compare students' expectations of the Clinical experience with students' perceptions of the actual experience (the reality). The data for this comparison was collected at two points in time.

Data Collection

Expectations

Data reflecting initial expectations of the Clinical experience was collected from 27 students enrolled in our Professional Development seminar during the fall 1997 semester. Although no demographic data was collected from these participants, the Professional Development seminar is intended for doctoral students. During any semester, typically no more than 5 of the approximately 30 students are master students. Following an open discussion of the Clinical concept of approximately 30 minutes in length, students completed an open-ended questionnaire which asked students to identify the benefits of such an experience, their related concerns, and ideas for implementation. We believed that this advanced group of students would be in an ideal position to reflect upon the potential benefits and problems of a Clinical experience. This data reflects students' expectations of the Clinical experience.

Reality

During the fall of 1998, the two Clinical courses enrolled six master students and four doctoral students majoring in Instructional Technology. One doctoral student from another academic area was enrolled in the course. As this student did not meet the characteristics of the target population of the Clinical, his responses were eliminated from the final analysis.

Different professors taught the two classes and each class worked on a different project. However, both projects were complex in nature. The students in one course were asked to create an online system to support scientific inquiry using museum objects. This task involved providing electronic access to the museum collection and developing an electronic support system for inquiry-based learning. Led by another instructor, students in the second class formed a single group that provided services for a small liberal arts university in North Carolina. This student group was charged with the responsibility of providing "electronic" solutions to instructional problems identified by the university's faculty and staff.

However, the intent of this paper is *not* to discuss the details of the individual projects but to discuss students' perceptions of the Clinical experience to determine commonalities between the two experiences. In the fall 1998 semester, we collected quantitative and qualitative data on the perceptions of students who were enrolled in the Clinical courses. At the time at which the data was collected, these students had participated in the Clinical experience for fourteen weeks. This data represents the reality of the Clinical experience. Students were asked to rate the degree to which they agreed or disagreed with 25 statements derived from a list of possible benefits and concerns generated by IT Professional Seminar students in response to the idea of having Instructional Technology students work on "real life" projects within a course setting. They rated their responses on a five-point scale that included "strongly agree", "agree", "don't know", "disagree" and "strongly disagree". Statements were similar to the following:

- I liked being part of a team working toward a common goal.
- I benefited from interacting with clients outside of IT.
- I felt that the faculty treated me like a colleague.

In addition, students responded to three open ended questions, which asked them to reflect on the situation, their own learning, and the Clinical experience. They submitted written responses to the following three questions:

1. Assessment of situation (For example: What have you observed when working on this project? What seemed to work well? What not so well? What would you have liked to go differently? What suggestions would you have for others who wanted to do similar projects?)
2. Self- assessment (For example: What have you learned? What were the benefits to you? Anything you wish you had done differently? What caused you frustration?)
3. Assessment of course/ Clinical (For example: What were the benefits of the way it was conducted? What caused you frustration? What suggestions would you have for others who wanted to conduct other instructional design and development Clinical courses?)

Results and Discussion

Expectations

Students' expectations were analyzed to determine trends and patterns in their responses. Perceived benefits included opportunities for peer, faculty, and client interactions; professional and personal development; opportunities to apply what they learned in their course work, and available resources. They were concerned about the nature of peer, faculty, and client interactions, scheduling the Clinical within the current curriculum, the scope of the task, and having enough resources.

Peer Interactions

Students perceived increased interactions with their peers to be a benefit of the Clinical experience. They indicated that they would benefit from interaction with other students on real projects and by being a part of a team working toward common goals. On the other hand, they were concerned about trust among group members.

Faculty Interactions

They viewed interactions with faculty members as both a benefit and possible concern. They perceived that mentoring and modeling of behaviors by faculty members would be beneficial; however, they were concerned that they may not get the mentoring they needed. They realized that increased interactions with IT faculty could be beneficial, yet, they were concerned that faculty may not be actively involved. They felt it would be beneficial to be treated like a colleague by the faculty, yet were concerned that they may not be.

Client Interactions

Students also viewed client interactions as beneficial and of possible concern. They thought it would be beneficial to work with different people in different settings. However, they were concerned that they may not have the opportunity to be a decision-maker.

Task Scope

They also were concerned about their roles and responsibilities. They were concerned that the projects may require them to provide technical support only, and hoped to have the opportunity to serve as instructional designers as well as developers. In addition, they were concerned that the task may be too broad or too simple.

Personal and Professional Resources

On a related note, they were concerned that the course may require more hours of work than a traditional course. They also were concerned that they may "get in over their head" in terms of technical skills. They recognized that "just in time" training was a benefit of the Clinical experiences, but were concerned that training may not be provided as needed or that they would not be given the time to learn new skills when needed. They felt that access to on-campus resources might be a benefit, yet were concerned that they may need resources that were not available.

Professional Development

However, they saw several benefits in terms of professional development. They perceived that the real world experience would provide an opportunity to apply program ideals and techniques. They saw the "hands-on" nature of the course as extremely practical. Students recognized that they would benefit from the multiple perspectives of the Clinical participants. They believed the Clinical experience would make them more marketable, provide satisfaction for the work done, and document their skills and competencies.

Personal Development

They also looked at the Clinical experience as an opportunity to determine their individual strengths and limitations. They believed they would learn to delegate responsibilities and accept delegated responsibilities. Students also thought they would learn to respect colleagues' capabilities and communicate with them about specific goals.

The Reality

Survey Results

Responses to the survey items were tabulated and percentages of students selecting each response option were calculated. For most of the survey questions, there were no noticeable differences in responses between the two Clinical courses. Where there were differences, these differences are noted. Responses are discussed in relation to students' initial expectations in each category of perceived benefits and concerns.

Peer Interactions

Ninety percent of the students felt they benefited from their interactions with other graduate students. All students agreed that they felt like part of a team. Ninety percent of the students liked being part of a team working toward a common goal. In addition, 80% felt they learned skills from other graduate students in the group. The perceptions of students who had completed the Clinical experience seemed consistent with students' expectations of the benefits of peer interactions.

Faculty Interactions

All students enjoyed working closely with IT faculty and believed that the faculty was actively involved in the project. Seventy percent of the students felt the faculty treated them like colleagues. The other 30% did not know. Ninety percent of the students felt they benefited from the mentoring and modeling of behaviors by faculty.

Students' perceptions of faculty interactions were consistent with expected benefits of the experience. Students initially expressed concern that the faculty may not be actively involved in the project, they may not provide mentoring as needed, and that they may not treat students like colleagues. The responses of students who participated in the Clinical experience indicates these concerns were unfounded.

Client Interaction

Students felt they benefited from interacting with clients outside of the field of Instructional Technology. Eighty percent of the students agreed that they learned to communicate with clients about specific goals. However, two students from one class disagreed with this statement. Students expected client interactions to be both a benefit and a concern; from the responses to the questionnaire, client interactions seem to be perceived as providing more benefits than limitations

Personal and Professional Resources

Students initially had many concerns related to personal and professional resources. They were concerned that the course many require more hours of work than a traditional course, that they may get in "over their head" in terms of technical skills, that training may not be provided as needed, and that they would not be given the time to learn new skills. In addition, they were concerned that they may not have access to the necessary resources. Student's responses to the survey indicated that these concerns were unfounded.

Seventy percent of the students felt they received training and instruction as needed. In one of the classes, one student did not know if training and instruction was provided as needed, and two students believed it was not provided as needed. However, all students felt they were given the time to learn skills needed on the projects; and only one student felt "over my head" in terms of technology. Eighty percent agreed that they were provided with adequate resources to complete the project, one student disagreed, and one didn't know. Seventy percent of the students felt the time demands of this course were no greater than for a traditional course; half of the students in one of the classes (30% of respondents) felt the time demands of this course were greater than in traditional courses.

Students were split in their feelings toward ending their involvement after one semester. Thirty percent were comfortable, 40% didn't know, and 30% were not comfortable ending their involvement.

Professional Development

Ninety percent of the students felt the class was extremely practical. All students agreed that they benefited from the different perspectives of the group members, faculty and clients. Ninety percent of the students agreed that they had the opportunity to apply what they learned in other classes. The survey responses confirm students' initial perceptions of the professional development benefits of the Clinical experience.

Personal Development

Ninety percent of the students felt they learned to trust their colleagues. Seventy percent of the students felt they learned to delegate responsibilities. However, two students in one class *did not agree* that they learned to delegate responsibilities. From their responses, we do not know whether they already knew how to delegate responsibilities or whether they lack the skill and simply did not learn it. However, 90% agreed that they learned to accept delegated responsibilities. All students agreed that they learned to communicate with colleagues about specific goals. Ninety percent agreed that they learned to recognize others skills and capabilities. Seventy percent of

the students agreed that they became aware of their own lack of abilities, one student didn't know, one disagreed with the statement, and one did not respond. From the responses to the questionnaire, it appears that the expected personal development opportunities were present.

Results of Open-ended Questions

The responses to the open-ended questions were analyzed to look for general patterns and themes across individuals. Although different professors taught the classes, students worked on different projects, and course activities differed slightly, analysis of the qualitative data indicated no differences in students' perceptions of the two experiences.

Student comments clustered into two main themes: Students primarily commented on the frustrations of working with a client and the benefits of the experience. In the discussion below, general themes are illustrated with student comments.

Client Relations

Even though the two courses worked on different projects with different client contacts, the majority of comments on the open-ended questions referred to client relations. Students commented on their difficulties in obtaining information from clients as quickly as they would like.

- "The experiences were trying at times. Clients have their own sense of time and time frame."
- "Communications with the client were difficult and frustrating. I learned patience."
- "Timing was the only frustration. Having to depend on someone you don't even know for information is difficult to handle."

Students were clearly frustrated with the difficulty of communicating with clients about their goals, expected products and vision.

- "I think the client caused the most frustration. I never got from our liaisons, what they wanted, nor did I really understand the view they were coming from."
- "In hindsight, it appears that there was little shared understanding of the issues we were trying to grasp, and there was a long drawn out period where these were slowly teased to the surface."
- "It would have been helpful to know specifically what the client wanted without having to go through some type of discovery process. However, this would be counter to the "real world" nature of the course."

Students wanted to share what they learned about communicating with clients with others. Advice and suggestions for future Clinical groups often centered on client relations.

- "I would suggest to others to, first keep it professional, don't just listen to the client, hear them, and hear what they are not saying, and don't get frustrated, it is all part of the process."
- "... do everything within your power to coerce a vision out of your client before proceeding, even if it means extra time up front."
- "Make sure that everyone's role is clearly articulated and agreed upon before proceeding. ... even though it seems overly formal at first, it can avoid problems further down the road."
- "Advice for such situations in the future: make sure all project participants are clear on what the goals and products of such a partnership will be."

Some students who did not interact with the client directly were frustrated by this lack of interaction.

- "I have enjoyed being in the Clinical. I do wish I had been more a part of the client process. I feel a lot of that interaction was done by others and at times I felt on the outside of what ever was going on. All did a great job of reporting, but it is hard to read faces and gestures from others reports."
- "I wished that I had more interaction with the group. I know that we met once a week, which was beneficial, but I feel like I was left out of some of the conversations that went on."

Benefits

However, students enjoyed the experience and felt they benefited from participating. Their positive comments reflect our success in developing a supportive apprenticeship environment. Students' perceptions will be discussed as they pertain to the characteristics of a cognitive apprenticeship learning environment.

Situated Learning

Students felt their learning was situated in a realistic context where they could learn skills in the context of their application.

- "For me this course was real world. The task was handed down, assignments were made, and I was responsible for doing my part. There was a team of people, including the client, depending on my participation. It forced me not to procrastinate and actively take a role in the goals and objectives of the program. I would gladly take more classes like this, than hand holding and "this is what could happen" kind of classes. I enjoyed the experience of it all."
- "I feel very good about watching and participating in the "real process" of designing. I think this experience has probably

- taught me more than if we had had a smooth liner process. If our project had gone according to the books, the learning curve for me would have been much lower."

Community of Practice

Students' responses to the open-ended reflections indicated that they felt they were part of a community of practice, where each team member was working toward common goals. Students commented:

- "The benefits of the Clinical in the way it was conducted was the "real" environment that was created. It was a work group coming together and delegating task to one another. It was each of us working separately toward a common goal and needing the work of others to be able to fit our part into the puzzle."
- "I appreciate all the learning I did from everyone. Each of the participants brought their own platter to the table and I feel very appreciative that I was able to glean some knowledge from everyone."

Intrinsic motivation

As the students' comments indicated, they felt satisfaction from achieving their goals. These responses indicate that the Clinical successfully created a social climate that encouraged intrinsic motivation.

- "It is an exceptional experience to see work done for class to have an immediate impact on a client or institution other than doing the work for a grade or to fulfill a requirement."
- "This class was a great benefit to me. I learned what it takes to be a team to achieve a common goal. What I really liked about this class was that it pertained to a "real" situation. It felt good once the goal was achieved."

Collaboration

Students also felt they worked in a collaborative environment, where they were part of a team.

- "That was the best thing about the experience... for everything that we needed to get done there was one of us that could do it without much difficulty."
- "I also learned the importance of doing what you do well whenever you can. It made it a lot easier to get the easy stuff done, let other people get their easy stuff done, and hopefully, there will be nothing left."

Students also recognized the value of the methods of instruction. They commented on the benefits of the *coaching, modeling, and scaffolding* that occurred.

- "The Clinical experience was good.... I really grew from the mentoring and discussions."
- "I learned a great deal from all of the people in the group. Working with others has given me a better understanding of the process and what to do and what not to do."

Student responses indicated active articulation and reflection on their skill development.

- "The benefits to me were the group interaction and being responsible not only for myself but also for a team of people, the interaction with the client and feeling like my skills were 'up there' and 'comparable to others'."

And finally, they rose to the challenge inherent in the exploration phase of a cognitive apprenticeship.

- "I had to learn new skills as I applied them. I would have preferred to have the skill going into the class. However, this is often the reality of the work place."

Conclusions

The results of our investigation indicate that we successfully established an environment conducive to apprenticeship learning in our Instructional Technology Clinical courses. We compared students' expectations of the Clinical experience in terms of perceived benefits and concerns with students' perceptions of the reality. The results indicated that the expected benefits from faculty and peer interactions, realistic experiences, client interactions, personal and professional development opportunities, and applied learning were achieved. In addition, the results indicated that students' concerns about inadequate training and mentoring by faculty, increased time demands above those of traditional courses, lack of trust among team members, and inadequate resources were unjustified. Analysis of students' reflections on the Clinical courses indicates that students perceived the sociology and methods of cognitive apprenticeships as beneficial to the Clinical experience. Their responses mentioned the beneficial effects of modeling, coaching, scaffolding, reflection, articulation, exploration, situated learning, cooperation, intrinsic motivation, and a community of practice.

However, Clinical students expressed frustrations at the nature of their interactions with clients. It must be noted that from our perspective as faculty members with extensive experience in design and development, our interactions with the clients were not atypical. In many ways, the students' concerns were justified: their concerns were the result of the situated nature of their learning. They were frustrated as they tried to apply skills in client interactions; skills that are not addressed by typical coursework in instructional technology, but are best developed through experience and immersion in the culture of practice. The prevalence of student comments on client relations emphasizes the need for experiential learning experiences in instructional technology graduate programs. By participating in real experiences with real clients prior to graduation, students can be mentored and discuss possible strategies with colleagues in a safe learning environment.

The results of these analyses suggest that we may need to prepare both clients and students for the collaborative experiences. Both clients and students need to realize that the client's environment and university classes represent different cultures, each with their own set of expectations, vocabulary, timelines, rewards, and consequences. As faculty coordinators, we should assess students' experience in interacting with clients to design and develop instructional materials and conversely, clients' experience in working with instructional designers and developers. Guidance can be provided to both clients and students in the form of readings, direct modeling, coaching behaviors, and discussions concerning issues of collaborating on a common project.

Despite occasional frustrations by students, both groups gained from their collaboration. The students working with the university in North Carolina successfully accomplished the following tasks:

- wrote and submitted a grant to request funding for the establishment and operation of an instructional systems development research group.
- designed and developed an on-line database to assist the university in procurement, security, and maintenance of instructional technology facilities and equipment
- negotiated an agreement to enroll participants of the university's cohort initiative into a nationally acclaimed professional development academy;
- reviewed and reported on a variety of software tools used to develop and deliver Web-based instruction
- arranged for the cohort's graphic-design work to be sub-contracted to an external group comprised of work-study students majoring in graphic arts.

Students working with the museum successfully:

- reviewed literature on inquiry based learning
- reviewed numerous museum web sites to identify those that included elements of inquiry based learning
- developed a plan for a museum web site that provided access to collection information for the purposes of conducting inquiry
- developed a prototype web site that included collection images and data, inquiry based lesson plans, and background information on scientific inquiry.

We envision this Clinical in product design and development as the first of several such experiences. Our graduates, like our faculty, often have responsibility for design and development of instructional materials, for the creation and publication of original research, and for teaching. Apprenticeship learning experiences can be developed in both research and teaching based on this model.

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A REVIEW OF COLOR CODING AND FIELD DEPENDENCE RESEARCH

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Abstract

The purpose of several studies was to examine the effects that differentially coded (black and white and color) illustrations had on students who were classified as field independent, field neutral and field dependent on tests measuring different educational objectives. The effects of visual and verbal formats were also examined. In general, results reveal an insignificant interaction between coding type and level of field dependence. However, field dependency was found to be an important instructional variable, and that for some types of learning objectives the process of color coding instructional materials may reduce achievement differences attributed to differences in cognitive style. Unexpectedly, students who received verbal tests across all field dependence levels achieved significant higher mean scores than did those who received the visual test formats.

With the response capabilities inherent in the new electronic technologies, educators are becoming increasingly interested in examining instructional effects of the learners' cognitive learning style. Cognitive learning style is generally considered to describe the manner in which an individual interacts with and processes information. Probably the most extensively researched cognitive style which has the widest application to educational problems is known as field dependence/independence (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). The field dependence/independence continuum, as it applies to learners, describes the degree to which learners will interact with a visual presentation, that is, whether the learner will merely interact with the visual as presented or will he/she analyze, reorganize and synthesize the instructional field to make the content more meaningful and memorable (Ausburn, & Ausburn, 1978). Field dependent individuals, when presented a visualized presentation tend to modify the structure but accept and interact with it as it is presented. They tend to fuse all segments within the visual field and do not view or interact with the visual components discretely. Field independents tend to act upon a visual stimulus, analyzing it when it is organized and providing their own structure when it lacks organization. The findings of most studies in the literature examining achievement indicate a superiority of FID students over FD student in terms of performance (Moore, 1985; Reardon, & Moore, 1988; Canelos, Taylor, & Gates, 1980; Witkin, Moore, Goodenough, & Cox, 1977). These results are explained by the fact that FID student utilize their competence in articulation or in analyses and structuring (Couch, & Moore, 1992).

Although many studies have examined the effects of visual attributes on learning (Dwyer, 1978; Dwyer, 1987) few have studied the effects of varied visual attributes on specific cognitive learning styles. Research has shown that color coding helps learners organize or categorize information into useful patterns which enables them to interpret and adjust more readily to their environment. It was hypothesized that color-coded visuals would be more effective than black and white-coded visuals in enhancing the solvent visual cues, thereby making them more identifiable and instructional to field dependent learners. The color coding would attempt to compensate for the restructuring skills absent in the field dependent learners and subsequently lead to deeper information processing and increased achievement. This hypothesis seemed plausible since field dependent learners tend to be global in perception and would be most inclined to take advantage of the increased structure provided by the color coding.

Previous research (Dwyer, 1978; Dwyer, 1987; Dwyer, 1968) has verified the superiority of color coded visuals over black and white illustrations in answering questions of a verbal nature, i.e., terminology and comprehension (Dwyer, 1978; Dwyer, 1987). However, there was no research available which investigated the role of color on verbal or visual type questions across the cognitive style known as field dependence/independence (FD/I). Additionally, it was not known whether coding (B&W and Color) and field dependence interact or whether color coding positively affects the deficiency of field dependent learners to organize and structure instructional content.

Statement of the Problem

Specifically, the purpose of these studies was to examine the effect that coding (B&W and color) has on the achievement of students categorized as FD/I learners and to determine if there was an interaction between field dependency and color across both visual and verbal oriented tests measuring different educational objectives.

Instructional Treatments

The subject content for the studies consisted of a 2,000 word instructional booklet on the anatomy and functions of the human heart. Each booklet contained nineteen illustrations which were designed to illustrate the content being presented verbally. Booklets received by the students in the black and white and color coded treatments were identical in verbal and visual content with the exception of the color code which was applied to one treatment.

The instructional material consisted of a 7" by 8-1/2" spiral bound booklet. The booklet included one page of directions and twenty pages of concepts and functions on the heart integrated by prose text with accompanying visualization. A simple line drawing was positioned (2-3/4" by 3-1/8") on each frame. All booklet pages were clearly numbered, with the prose text in the lower half of each page and the visualization in the upper half of the page. The arrows were employed to focus learner attention on relevant information in the visual.

Directions on the first page of the booklet indicated to the learner that the materials were part of an investigation to study the relative effectiveness of visual illustrations which accompanied printed instruction. Learners were directed to be attentive to both the written and visual information. They were further instructed that there was no time limit to the instructional sequence, and that a test with several parts would be administered when they felt they had mastered the presented concepts.

Given all of the above design elements found within the black/white instructional booklets, the color coded treatment differed only in the application of color to certain verbal and visual concepts illustrates the color coding application. Six color categories and black were used to code the heart concepts.

To facilitate replication printer's ink colors selected were from the Pantone Matching System, developed by Pantone Incorporated. The six colors were: red (Pantone--warm red), blue (Pantone--process blue), green (Pantone--green), purple (Pantone--No.227), brown (Pantone--No.471), and gold (Pantone--No.124). The black (Pantone--black) was used for all the non-color coded design elements within the color coded material and for all the design elements within the black/white material. The illustrations in the black and white version contained black and white coded line drawings which highlighted the information and process being presented. Students receiving the color coded treatment received the same visuals as did students receiving the black and white treatment; however, several different colors were used to highlight the information being discussed. The major independent variables in the studies were the effect that B&W and Color Coding of information had on the information processing strategies of students identified as processing different levels of field dependence (FI, FN, FD).

Criterion Measures

Each student in each treatment received the Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin, & Karp, 1971). The GEFT (11) is a group-administered, 25 item test administered in three timed sections (2,2 and 5 minutes each). Students must trace one of eight simple figures embedded in figures of greater complexity. Reported reliability is .82. Students participating in these studies were classified as field independent (FI), field neutral (FN) in field dependent (FD) based on their performance on the GEFT. The grand mean and standard deviations was calculated for each study. Students achieving one-half standard deviation above the grand mean were considered to be FI while students achieving one-half standard below the mean were considered to be FD. Field neutral students were those achieving one-half standard deviation on either side of the mean.

After receiving their respective coded treatments each student then received a battery of individual tests in either a verbal or visual format. These tests were designed to measure achievement of different types of educational objectives. The following description of the criterion tests, adapted from Dwyer (1978, pp.45-47) illustrated the types of instructional objectives assessed in this study.

Drawing Test

The objective of the drawing test was to evaluate student ability to construct and/or reproduce items in their appropriate context. The drawing test provided the students with a numbered list of terms corresponding to the parts of the heart discussed in the instructional presentation. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test the emphasis was on the correct positioning of the verbal symbols with respect to one another and in respect to their concrete referents.

Identification Test

The objective of the identification test was to evaluate student ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart which had been discussed in the presentation was numbered on a drawing. The objective of this test was to measure the ability of the student to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test. This test consisted of items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas which have an understanding of the basic elements as a prerequisite to the learning of concepts, rules, and principles.

Comprehension Test. Given the location of certain parts of the heart at a particular moment of its functioning, the student was asked to determine the position of other specified parts or positions of other specified parts of the heart at the same time. This test required that the students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding in which the individual can use the information being received to explain some other phenomenon.

Total Test Score. The items contained in the individual criterion tests were combined into a composite test score. The purpose was to measure total achievement of the objectives presented in the instructional unit.

The design of the visual form of each of the criterion tests utilized only one drawing with four or five letter labels in all items in which it was possible to do so while maintaining clarity and correspondence to the verbal test items. However, two items in the terminology test and all items in the comprehension test required four drawings. The item stems of both the verbal and visual test questions were verbal and asked the same question. In addition, the visual distracters in the visual tests corresponded to the verbal distracters in the verbal tests as closely as was reasonable. The description of the verbal tests given previously also describes the visual tests.

Summaries of Studies Investigating Color Coding and Cognitive Style

Study 1. Moore, D.M. & Dwyer, F.M. (1991). Effect of color coded information on students' level of field dependence. *Perceptual and Motor Skills*. 72, 611-616.

Number of subjects: N=119

Independent variables: black and white and color coded treatments; levels of field dependence (FI/FN/FD).

Dependent variables: terminology, comprehension and total test (combined terminology and comprehension).

Number of Students in each level of field dependence: FI=43, FN=45, FD=29.

Results: Insignificant interaction between coding strategy, (black and white and color coded) and levels of field dependence (FI, FN, FD).

Field independent students achieved significantly higher mean scores on both the terminology and comprehension tests when receiving the black and white coded treatments; however, when color coded treatments were used insignificant differences in achievement resulted between the FI and FD students.

On the terminology and comprehension tests insignificant differences in mean achievement resulted between students receiving the black and white and color coded treatments.

Study 2. Dwyer, F.M. & Moore, D.M. (1991). Effect of Color Coding on visually amended tests with students of different cognitive styles. *The Journal of Psychology*, 125, 677-680.

Number of subjects: N=117

Independent variables: black and white and color coded treatments; levels of field dependence (FI, FN, FD).

Dependent variables: scores on the two visual oriented tests--drawing and identification. Total test was a combination of both criterion measures.

Number of Students in each level of field dependence: FI=43, FN=29, FD=45.

Results: Across all levels of cognitive (FI, FN, FD) significant differences were found to exist for cognitive style and color coding on the drawing, identification and total tests. Students at all levels who received the color coded treatment achieved significantly higher scores than did students who received the black and white color coded treatments.

On the drawing test FI students scored significantly higher than did FD students on both the black and white and color coded treatments. On the identification test achievement differences between students receiving the black and white and color coded treatments were insignificant.

Study 3. Dwyer, F.M. & Moore, D.M. (1991-92). Effect of color coding on visually and verbally oriented tests with students of different field independence levels. *Journal of Educational Technology Systems*, 20, 311-20.

Number of subjects: N=119

Independent variables: black and white and color coded treatments, level of field dependence (FI, FN, FD).

Dependent variables: achievement scores on the drawing, identification, terminology, comprehension and total criterion test (combination of the instructional criterion measures)

Number of Students in each level of field dependence: FI=43, FN=45, FD=29:

Results: An insignificant interaction was found to exist between coding strategy and levels of field dependence. On all criterion measures for all levels of field dependence, students who received the color coded treatments achieved significantly higher scores than did students receiving the black and white coded treatment.

In analyzing individual performance on the drawing, identification and total criterion test, students receiving the color coded treatments achieved significantly higher mean scores than did students receiving the black and white coded treatments. However, on the terminology and comprehension tests there were insignificant differences in achievement between students receiving the black and white and color coded treatments.

Significant differences existed in favor of FI students on all criterion measures when they received the black and white coded treatments; however, when students received the color coded treatments insignificant differences were found to exist on the four individual criterion measures.

Study 4. Moore, D.M. & Dwyer, F.M. (1994). Effect of cognitive style in test type (visual or verbal) and color coding. *Perceptual and Motor Skills*, 79, 1532-1534.

Number of subjects: N=183

Independent variables: black and white and color coded treatments; levels of field dependence (FI, FN, FD), visual and verbal test formats.

Dependent variables: scores on both the verbal and visual test formats for the terminology, identification, drawing comprehension and total criterion measures.

Number of Students in each level of field dependence: FI=66, FN=74, FD=43.

Results: On all criterion measures significant achievement differences occurred in favor of FI students on color coding in favor of color coding. Students receiving the verbal test formats achieved significantly higher achievement scores on all criterion measures than did students receiving the visual test formats.

Results and Discussion

The results of these experimental studies support the contention that field independent and field dependent learners differ in the cognitive processes they use as in the effectiveness of these cognitive processes as measured on

tests measuring different educational objectives. The studies found that across all studies where FI and FD students reviewed black and white coded treatments, the field independent students scored significantly higher than did field dependent students on the terminology/drawing, terminology/comprehension and total criterion tests. These results support prior research (Moore, & Bedient, 1986) which found that independent learners tend to score higher on criterion measures which require the acquisition of information from visualized instruction and are used to assessing visually complemented instruction. This finding is also consistent with the previous reviews of the literature that have concluded that field independent learners exhibit an active, hypothesis testing strategy toward learning, whereas field dependent learners tend to employ a more tentative or spectator approval to learning (Witkin, Moore, Goodenough, & Cox, 1977). The results also indicated that across all studies on a number of criterion measures (e.g., drawing and identification tests) the use of color coding of visualization did not provide sufficient structuring of the critical information to alter the information processing level of field dependent learners.

It was expected that the color coded treatments would make the relevant cues more explicit to the field dependent learners, thereby improving their performance. When both FI and FD students both received the color coded treatments insignificant differences in mean achievement on all four individual criterion measures. Apparently, the color coded illustrations provided a sufficient structure for the FD learners to interact with and internalize at levels similar to that achieved by the FI learners. Another possible explanation may be presented to explain these results. Witkin, Moore, Goodenough, and Cox (1977). have indicated that it is possible to induce FD learners to use analytical techniques by providing specific directions as to how to proceed. Possibly the specific directions on the first page of the instructional treatments was sufficiently strong to instigate greater levels of information processing thereby enabling them to achieve at levels realized by the FD learners. Annis' study (1979) investigating cognitive style on study technique found that field dependent students did not score as well as field independent students in completing items of high structural importance even when the passage was well organized. The implication being that the field dependent students, in addition to receiving the well organized instructional module received specific directions alerting them to the fact that would be tested upon completion of the module. The combination of specific directions and the color coded illustrations enabled the field dependent students to achieve levels similar to those achieved by the field independent students.

It was hypothesized that the students who received the visual version of the criterion measures would achieve significant higher scores in the criterion measures. This was not the case, in fact, students who received the verbal version of the criterion measures achieved significantly higher scores than did students who received the visual versions. These results were unexpected and require further study before definitive conclusions can be proposed.

Note: Presentation based upon an article entitled: Dwyer, F.M., & Moore, D.M. (1997-1998). Field dependence and color coding; A review and summary of research evidence. *Journal of Educational Technology Systems*. 26 (3), 243-253.

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EFFECT OF VISUALIZATION (JOB AIDS) IN FACILITATING COGNITIVE DEVELOPMENT

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Abstract

Three hundred learners participated in this study which (a) examined the instructional effectiveness with which different job aid types facilitated learner achievement of different types of learning objectives and (b) identified the degree to which low and high prior knowledge individuals profit from different job aid types. The instructional content used in the study was an instructional module on the parts and functions of the human heart. Participants were randomly assigned to one of five treatments complemented with different job aid types. After interacting with the instructional module, participants received four post tests each measuring different educational objectives. Research findings indicated that when job aids are used following instruction (a) they are not equally effective in facilitating learner achievement of different types of educational objectives; (b) they do not reduce learning differences between low and high prior knowledge learners; and (c) there is an insignificant interaction between job aid type and prior knowledge level.

Introduction

The essence of appropriate instruction relies heavily on an instructional design practitioner's ability to balance instructional efficiency and effectiveness. Instructional efficiency takes into account finite resources such as time, money, and staff personnel allocated to the development of an instructional intervention while instructional effectiveness focuses on the desired performance or outcome of that intervention. To compound this situation in the corporate environment, performance demands change constantly because of the introduction of new products, services, process and technology; individuals are required to maintain current performance levels while acquiring new complex processes and skills; and management's expectations have employees performing more tasks at irregular intervals. In meeting some of these diverse demands, instructional design practitioners have relied on non-instructional interventions known as job aids (Silber, 1990). Job aids, also known as performance support tools, contain factual and procedural knowledge and are used during actual task completion (Grau, 1986; Rossett, 1991; Rothwell & Kazanas, 1994). They are effective especially when the consequence of error is high, performance is lengthy or complex, performance is changing frequently or limited budget or time exists for making an instructional intervention (Carlisle & Coulter, 1990; Finnegan, 1985).

Duncan (1985, p.1) indicates that job aids "...put more training into the programs of instruction without significantly increasing the course length, ...save time and money in training development without sacrificing student achievement, ...reduce the paperwork requirements in training development and multitude of training products...and...increase performance both initially and on a sustained basis." Finnegan (1985) proposes the following five reasons to use any job aid type: (1) to provide a performance focus, (2) to guide performance that would likely be forgotten, (3) to reduce cost and development time—as compared to training, (4) to provide flexibility of revision when task change, and (5) to be used in conjunction with training to decrease training time. Evolving rapidly, job aids have taken on a multitude of shapes, sizes and forms. Utilizing a more formal approach to the development of job aids, Rakow (1981) suggests the following job aid typology; example, cueing, association, proceduralized, and analog classification.

In recent years, the advancement of cognitive psychology has expanded the way individuals conceptualize job aids. Viewed in the past only as external mechanisms which store information and prompt memory to improve performance, job aids now have taken on additional rolls such as guiding perspectives, decisions and self evaluation (Rossett, 1991). Other individuals such as Tillman (1985) and Sleg (1988) suggest that job aids be incorporated as an instructional intervention to assist in the acquisition of skills and knowledge. Unfortunately, this paradigm shift has not occurred in the scientific community. Only a limited number of empirical research studies have been conducted using job aids. These studies have resulted in a contribution of valuable knowledge in the areas of: job aid and improved performance (Keefer, 1986; Lafleur, 1994); job aid development and implementation efforts (Ruyle, 1991; Ford, 1994); expertise transfer using knowledge based systems as job aids (Stevenson, 1990); and helpfulness of job aids in journal writing (Cole, 1993). Little research has been conducted to identify the potential educational value of job aids in the domain of knowledge acquisition. No research has been conducted to identify how prior knowledge interacts with job aids in the facilitation of knowledge acquisition. For this reason, an exploratory investigation was undertaken in this unknown area.

Statement of the Problem

Literature supports the use of job aids to decrease efficiency (finite resources) and improve effectiveness (performance). But most literature indicates that job aids are used to recall, guide knowledge and procedures previously acquired. Limited research has been conducted using job aids as an instructional intervention. It was hypothesized that the use of job aids as an instructional intervention administered directly after interacting with the instructional content would function to facilitate the acquisition and retention of the content material. The study focused on the following research questions:

- Are all types of job aids equally effective in facilitating learner achievement of different kinds of learning objectives?
- Are different types of job aids equally effective in facilitating learner achievement among learners identified as possessing high or low prior knowledge?
- Is there an interaction between learners' level of prior knowledge and type of job aid?
- Do learners identified as high and low prior knowledge levels learn equally well from identical types of job aids?

Procedure

The physiology pretest was administered to nine hundred and three participants. Participation quartiles were calculated. Participants in the first quartile were identified as the low prior knowledge group; whereas participants in the fourth quartile were identified as the high prior knowledge group. Participants in the second and third quartiles were eliminated from the study. Each participant of the prior knowledge groups was then randomly assigned to one of five treatment subgroups. Total pretest participation quartiles are displayed in Table 1.

Table 1. Total Pretest Participation Quartiles

Percentage	Quartile	Pretest Score (Number Correct)
100 %	Q4	32 - 23
75 %	Q3	22 - 21
50 %	Q2	20 - 19
25 %	Q1	18 - 03

The cut off score for the low prior knowledge group was 18. Participants in each of the treatments possessing this score or lower were classified as possessing low prior knowledge. Combining all five treatments together the low prior knowledge group had a total of 247 participants. The high prior knowledge group for each treatment contained all participants who scored 23 or above on the pretest. Combining all five treatments together the high prior knowledge group had a total of 241 participants. The descriptive statistics for the total participation group, total low prior knowledge group and total high prior knowledge group are displayed in Table 2.

Table 2. Total Participation Group, Total Low Prior Knowledge Group and Total High Prior Knowledge Group Descriptive Statistics

Statistical Computation	Total Participation Group	Total Low Prior Knowledge Group	Total High Prior Knowledge Group
N	903	247	241
Mean	20.05	15.83	25.25
Standard Deviation	4.80	2.27	2.06
Variation	23.00	5.17	4.25

After identifying the low and high prior knowledge groups of each treatment, participants with incomplete data element were eliminated. Every seventh participant was then eliminated until all treatments contained the same number of participants and the prior knowledge groups (low and high) were distributed equally. The study was conducted with a sample of N=300. The low prior knowledge group consisted of 150 participants; high prior knowledge group consisted of 150 participants. Each of the five treatments was comprised of 60 participants with 30 low prior knowledge and 30 high prior knowledge. Descriptive statistics for the sample based on low and high prior knowledge groups are shown in Table 3.

Table 3. Descriptive Statistics for the Study Sample Based on Low and High Prior Knowledge

Statistical Computation	Low Prior Knowledge	High Prior Knowledge
N	150	150
Mean	15.62	25.20
Standard Deviation	2.54	2.07
Minimum	3	23
Maximum	18	32

Treatments

The instructional content used in both studies was a self-paced 1,800-word instructional module describing the human heart, its parts and the internal processes which occur during the systolic and diastolic phases (Dwyer, 1972; Dwyer, 1978). This content was selected because of the high reliability associated with its dependent measures and because it offers the ability to investigate different intellectual skill learning objectives (facts, concepts, rules and problem solving) that are effective and efficient performance functions of a typical work environment. The job aid typology developed by Rakow (1981) provided the skeletal format for each job aid because each job aid type identified in his typology offers advantages when used correctly. In order words, specific job aid types must be developed for specific results. To improve learner performance, it is vital that the instructional design practitioner identifies the type of information required and how the information will be utilized (Gagne, Briggs & Wager; 1972). Keeping this in mind, each of the treatments developed for the study mirror a specific intellectual skills hierarchy level. The cueing job aid possessed facts; the association job aid possessed facts and concepts; the proceduralized job aid possessed facts, concepts, and rules/procedures; and the analog job aid possessed facts, concepts, rules/procedures and problem solving information.

The same self-paced instructional module was distributed to all treatment groups. In addition to this module, all but the control group received some type of job aid and in some cases two job aids that were developed by the researchers after conducting an extensive literary search, collaborating with a content expert and determining reliability of the job aids through a pilot study. Job aids are thought to be self-sustaining, independent from training and for this reason, the researchers did not incorporate the job aids into the instructional content but placed them at the end of the instructional material to facilitate synthesization, integration and recall of the designated information. The five treatments described in Table 4 were developed specifically for the research study.

Table 4. Treatment Descriptions

Treatment Number	Group Name	Description
1	Control	Participants received the instructional module containing no job aids.
2	Cueing Job Aid	Participants received the instructional module containing two job aids designed to direct attention to the facts but did not provide step-by-step directions. The first job aid contained a heart graphic with structural parts labeled and the second job aid contained a heart graphic with labeled processes associated with blood circulation in the heart. The information in the cueing job aids provided participants with specific information they needed to discriminate between presented stimuli.
3	Association Job Aid	Participants received the instructional module containing one job aid which related unknown information to already known information in the typical format of a reference document. The job aid contained facts using a heart graphic with labeled parts numbered and concepts in the form of a definition. The numbers identified the heart parts and their respective definitions. This job aid enabled the participant to identify a stimulus as a member of a group possessing some common characteristics, even though the stimuli would differ from each other.
4	Proceduralized Job Aid	Participants received the instructional module containing one job aid describing the twelve step-by-step process of how the blood circulates through the heart. Each step had an explanation and a heart graphic. The job aid used facts, concepts and a procedure associated with the third intellectual skill level.
5	Analog Job Aid	Participants received the instructional module containing two job aids that assisted participants to conceptualize knowledge of organization, structure and relationships to solve problems and/or generate higher level concepts and values necessary to solve problems. One analog job aid presented knowledge of heart valve relationship; the other job aid provided knowledge of the circulation of blood through the heart.

Criterion Measures

Four individual criterion measures, each measuring different learning objectives, were used as the cognitive dependent variables. The criterion measures were administered immediately after the participants completed interacting with their respective self-paced instructional treatments. Table 5 summarizes the criterion measures. The listed descriptions are adapted from a description provided by Dwyer (1978, pp. 45-47) and illustrates the types of learning objectives that were assessed in this study. KR reliability coefficients are provided for each measure.

Table 5. Description of Criterion Measures

Criterion Measures	Description
Drawing Test	Participants recalled information found in the instructional module to construct a simple line drawing of the heart. This 20-item test evaluated the participants' ability to construct and/or reproduce content related items in their appropriate context (KR-20, 0.90).
Identification Test	Participants recalled information presented in the instructional module to identify parts and positions of an object. The test contained 20 multiple-choice questions (KR-20, 0.84).
Terminology Test	The objective of this 20-item, multiple-choice test was to evaluate the participants' understanding of facts, terms and definitions printed in the instructional module (KR-20, 0.77).
Comprehension Test	Consisting of 20 multiple-choice items, this test measured the participants' deep understanding of concepts related to the functioning of the heart (KR-20, 0.77).
Total Criterion Score	The score is the sum of adding the correct number of responses of the four criterion measures. This score provided total understanding of the instructional module (KR-20, 0.94).
Physiology Pretest	This 36-item, multiple-choice test was developed to measure the participants' prior knowledge level of human anatomy and physiology (KR-20, 0.92).

Design

The research design was a randomized post-test only design (Campbell & Stanley, 1966). Participant scores on the criterion measures (drawing, identification, terminology and comprehension tests) were identified as the dependent variable. The independent variable was job aid types (cueing, association, proceduralized and analog) and prior knowledge (low and high). The study design, a 5 X 2 crossed design, may be represented as RSIU (5 levels of job aids and 2 levels of prior knowledge). Alpha was set at the .05 level. A MANOVA was conducted to determine the overall effects where significant F ratios were obtained. Table 6 provides a summary of pretest and dependent variable descriptive statistics.

Table 6. Pretest and Dependent Variable Post Test Descriptive Statistics Correlation, Means and Standard Deviation (N=300)

	Pretest	Drawing Test	Identification Test	Terminology Test	Comprehension Test
Pretest	1.00	0.40	0.38	0.48	0.37
Drawing Test		1.00	0.80	0.63	0.61
Identification Test			1.00	0.64	0.67
Terminology Test				1.00	0.74
Comprehension Test					1.00
Mean	20.41	8.86	12.62	9.91	9.76
Stan Dev	5.33	5.31	4.61	3.68	4.18
Minimum	3	0	2	2	1
Maximum	32	20	20	20	20

Table 7 presents the mean achievement and standard deviation scores achieved by participants in each job aid by criterion measure. Where as Table 8 depicts mean achievement and standard deviation scores achieved by participants for low and high prior knowledge levels.

Table 7. Mean Achievement and Standard Deviation Scores for Treatment

Treatment Test Mean	Drawing Test Mean	Identification Test Mean	Terminology Test Mean	Comprehension Test Mean
Control	4.333	10.083	8.900	8.650
Cueing	9.916	13.483	9.666	9.616
Association	10.433	13.300	10.550	9.866
Proceduralized	10.033	13.516	10.933	11.150
Analog	9.066	12.716	9.516	9.533

Table 8. Mean Achievement and Standard Deviation Scores for Prior Knowledge Level

Prior Knowledge Test Mean	Drawing Test Mean	Identification Test Mean	Terminology Test Mean	Comprehension Test Mean
High	10.920	14.253	11.546	11.266
Low	6.793	10.986	8.280	8.260

The multivariate analyses (MANOVA) indicated that for all variables an insignificant interaction existed between job aid type and prior knowledge level. However, for all variables assessed simultaneously, a main effect existed among the different job aid treatments and between the prior knowledge levels. The results of the MANOVA are displayed in Table 9.

Table 9. MANOVA Test Criteria and F Approximations for Overall Effect Using Wilks' Lambda Statistic

Variable	Value	F	Num DF	Den DF	Pr > F
Job Aid	0.767878466	4.95215	16	877.437	0.0001
Prior Knowledge	0.762896938	22.2994	4	287.000	0.0001
Job Aid*Prior Knowledge	0.931476308	1.28913	16	877.437	0.1965

Follow up analyses indicated that all four job aid treatments were significantly more effective than was the control treatment on all four of the criterion measures. However, all job aids were found to be equally effective in facilitating learner achievement on each of the criterion measures. Follow up analyses also indicated that learners in the high prior knowledge level achieved significantly higher mean achievement scores on each criterion measure than did learners in the low prior knowledge level.

Results

The multivariate analyses (MANOVA) yielded an insignificant interaction between job aid type and level of prior knowledge (Table 9). As shown in Table 9 for all variables simultaneously, a main effect existed for job aids ($F=4.95$) and prior knowledge ($F=22.23$).

Simultaneous confidence intervals using the .05 alpha level were calculated for each criterion measure to determine job aid treatment effects. On the drawing and identification measures all four job aid treatments (cueing, association, proceduralized, and analog) were found to be significantly more effective than the control in facilitating student achievement. Insignificant differences in achievement were found to exist among participant mean achievement scores on both criterion measures. On the terminology test measure, only treatments three (association) and four (proceduralized) were more effective than the control treatment in facilitating student achievement however, all job aid treatments were again found to be equally effective. On the comprehension test measure, only treatment four (proceduralized) was found to be significantly more effective than the control treatment in facilitating achievement. Insignificant differences in achievement were found to exist among the four job aid treatments.

To identify the prior knowledge treatment effects, simultaneous confidence intervals were computed using the .05 alpha level. Results indicated that low prior knowledge learners achieved significantly lower mean achievement scores on all criterion tests (drawing, identification, terminology, and comprehension) than did high prior knowledge learners.

Discussion

The findings of this study indicated that job aid treatments (T2, T3, T4, T5) were all significantly more effective in facilitating learner achievement on the drawing and identification measures than was the control

treatment (T1) which contained only the instructional module. A possible explanation for these results may be that all job aid treatments contained a graphical picture highlighting or identifying the structural and organizational components of the heart. These graphics helped the learners organize information to facilitate acquisition, retention and subsequent retrieval of the information. Research supports the fact that long term memory visualization increases performance (Kolars & Ostry, 1974; Light, Berger & Bardales, 1975). Gagne, Walker Yekovich and Yekovich (1993) suggest that declarative knowledge (knowing that something is the case) is stored in knowledge structures in the form of a schema. Schemas are characterized as having variables, being organized hierarchically (embedded within another), and facilitating inferences. Within schemas, declarative knowledge is represented in the form of a proposition, image or linear ordering. A proposition is a basic information unit such as one idea and expresses the relationships among concepts. According to Wanner (1968) individuals do not store knowledge in words, phrases or sentences but proposition form. The control group (T1) participants receiving the instructional module containing only a narrative may have developed propositions without the assistance of job aids. However, participants who received the instructional module containing job aids may have developed propositions from the instructional narrative but also enriched the schema by adding additional declarative knowledge in the visual form of a heart graphic and linear ordering (step 1, step 2, step 3, etc.).

On the terminology measure, only treatment three (association) and four (proceduralized) were more effective than the control treatment. The explanation for this finding may be that the association job aid required additional participant interactivity with the instructional modules containing job aids. Participants looked at the graphic, identified a number related to a specific heart part, identified the heart part, located the definition of the heart part listed at the bottom of the job aid below the graphic, read the definition and related the definition back to the heart part located on the graphic. Used as an elaboration learning strategy this activity influenced the construction and integration aspects of the encoding process. Internal connections are constructed in working memory between new information and knowledge stored in long term memory. The proceduralized job aid used an organizational strategy which not only identified and related major and minor information but also assisted in selection or the paying attention to incoming information which was then transferred into working memory and construction or the building of connections between ideas contained in working memory. Both the association and proceduralized job aids provided relationship information and required additional interaction with the instructional content. Braune and Forshay (1983) and Craik and Tulving (1975) both suggest that it is only through many interactions with the task that individuals seem to develop an understanding of functional relationships contained in concepts. The cueing job aids contained factual information and required very little interaction. The complexity of the analog job aids may have produced confusion or affected the ability of the participants to discriminate relevant information for non-relevant information. Non-processed information is not locatable and retrievable during the assessment phase and therefore, negatively impacts achievement.

All job aids provided additional declarative knowledge in image form and may be the reason that all job aids did not differ significantly from one another. However, the additional interactivity of the association and proceduralized job aids was not enough to result in a significant difference between the job aid types.

High and low prior knowledge participants did not profit equally from the different job aid treatments. Participants classified as low prior knowledge had significantly lower mean identification, drawing, terminology and comprehension scores than did high prior knowledge participants. This finding is consistent with the premise that successful integration of new information occurs when it is related to existing long term information (Bransford & Franks, 1976; Clifton & Slowiaczek, 1981; Davey & Kapinus, 1985). High prior knowledge participants who received the same treatments consistently scored higher on all four criterion post tests. According to Weinstein and Mayer (1986), if an individual already possess prior knowledge of a subject, it is easier to add information, connect a new schema to make inferences and access the schema information.

All treatments contained in the study were developed as self-contained instructional books containing directions and instructional narrative and in some cases job aids. No additional assistance was rendered to the study participants. Therefore, the findings of the study may support Jonassen and Grabowski (1993) who found that high prior knowledge learners require less instructional assistance than do low prior knowledge learners and Willoughby and Wood (1994) who found that restriction of prior knowledge impacts the learners ability to integrate new information and makes instruction more difficult and increase the probability that achievement will be affected in a negative manner.

Finally, the significant lower scores for low prior knowledge participants may be the result of their inability to make inferences (Gagne, Walker Yekovich & Yekovich, 1993). Experts possess more declarative knowledge and rich domain specific relevant information than do novices and possess the ability to make correct inferences during the spread of activation in long term memory when they are unable to retrieve exact information (Weinstein & Mayer, 1986). Novices, on the other hand, are less likely to make correct inferences because of limited knowledge representation in the cognitive domain.

Conclusion

The research findings indicate that the type of paper-based job aid used with a self-paced instructional module would be based on the desired education objective. Also, if learners possess a high degree of prior knowledge, then paper-based job aids may be used with self-paced instructional content to positively effect the types of cognitive development evaluated in this study. The findings also indicate that to improve job aid effectiveness some form of interactivity such as rehearsal, elaboration, organizational or comprehension monitoring strategies be incorporated into the design of the job aids.

The study was an attempt to venture into an uncharted area of using paper-based job aids as an instructional intervention to improve learner achievement. However, the findings do not provide enough evidence to alter the current practice of using job aids as non-instructional interventions. It is vital that additional research be conducted to substantiate the findings of this study and investigate additional variables which may impact on the use of job aids as instructional interventions. Future research may include but is not limited to the following list of potential empirical research:

- Replicate the current study to substantiate findings and increase credibility.
- Replicate the study substituting Factor B, prior knowledge, with time-on-task classifications to determine if the amount of time devoted to the instructional content and job aid alters the current achievement outcomes.
- Replicate the study using a different instructional delivery medium. Use of a computer-based instructional module containing job aids may significantly impact the current achievement outcomes.
- Replicate the study using job aids containing additional forms of learning strategies.
- Replicate the study comparing the self-paced instruction with instructor-led instruction.
- Conduct a longitudinal study to assess the effect of knowledge retention when paper-based job aids are administered after a self-paced instructional module.

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EFFECTS OF LEARNING STRUCTURE AND SUMMARIZATION DURING COMPUTER-BASED INSTRUCTION

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Abstract

The purpose of this study was to investigate the effects of learning strategy and summarization within a computer-based chemistry and physics program. Students worked individually or in cooperative dyads to complete science instruction; half of them completed summaries over the instructional content when directed to do so. The study examined the effects of learning strategy and summarization on posttest and enroute performance, attitude, time-on-task, and cooperative interaction behaviors.

Introduction

Cooperative learning is an instructional strategy often used by teachers for classroom application. While some teachers implement cooperative learning because they believe it is effective in terms of student achievement, many teachers use cooperative learning to solve problems of classroom logistics. Teachers often group students around a computer to work together, a practice usually driven by the scarcity of computers in the schools. While this practice may be driven by necessity, teachers using limited resources must find ways for students to learn effectively while using computers in group situations.

A number of research studies have been conducted to investigate the effectiveness of cooperative learning. The effects of cooperative learning have often been studied in comparison to individual or competitive learning in situations ranging from kindergarten classrooms to courses offered on college campuses (Carrier & Sales, 1987; Cohen, 1990; Hooper, 1992a; Sharan, 1980; Slavin, 1980, 1988). Learner performance on cooperative tasks has been measured using text-based, television-based and computer-based instruction (Dalton, Hannafin & Hooper, 1989; Klein & Pridemore, 1992; Slavin, Stevens & Madden, 1988). Many studies have yielded positive results for achievement and attitudes when cooperative learning was implemented in classroom settings (Johnson & Johnson, 1989; Sharan, 1980; Slavin, 1990). However, the overall results of implementing cooperative learning with media such as computer-based instruction have been mixed at best.

Reviews of cooperative learning research are generally positive for achievement when cooperative learning is used in classroom settings. Slavin (1987) reviewed 35 studies which met the four conditions of cooperative learning and which used group rewards based on the sum of group members' individual learning; he reported that in 30 of those studies, researchers found significantly greater achievement for cooperative groups than control conditions. In a later review, Slavin (1990) noted that most cooperative learning studies measure achievement, and that more than half of those found significantly greater achievement for cooperative learning groups than for control conditions.

While the literature includes fewer studies on cooperative learning combined with computer-based instruction (CBI), some studies have reported significant achievement results when cooperative learning was used with CBI. Dalton, Hannafin & Hooper (1989) found that eighth-grade students who cooperated to complete a computer-based lesson on health significantly outperformed individuals completing the same lesson. Johnson, Johnson and Stanne (1985) reported that eighth-grade students who worked cooperatively to complete computer-assisted instruction performed better than those who worked individually or competitively. Other researchers found significant results for achievement when fourth, fifth, and sixth graders used cooperative CBI to learn math content (Hooper, 1992b; Hooper, Temiyakarn, & Williams, 1993).

However, not all researchers have found significant achievement effects for cooperative CBI when it was compared to individual CBI. Carrier & Sales (1987) found no significant achievement differences between college students who worked cooperatively and those who worked alone on either an immediate or delayed posttest. Webb (1987) reviewed 19 cooperative computer-based learning studies, and found that there were no significant achievement differences between cooperative groups and individuals for nine of them and that cooperative groups outperformed individuals in only five of those reviewed.

Another area of research focus has been the effect of cooperative computer-based instruction on affective variables. Many studies have reported mixed results for attitudes and affective variables in cooperative computer-based instruction. Dalton, Hannafin, & Hooper (1989) found that attitudes differ between high ability and low-ability students, and also between male and female students in cooperative groups versus the individual condition. Doran (1994) found that overall attitudes toward CBI were positive, but that attitudes toward learning structure for college students in cooperative, collaborative and individual conditions were mixed. However, Jones (1995) found that high school students working cooperatively to complete a CBI lesson on math content liked cooperative learning

significantly more than those working as individuals liked working alone. Crooks (1995) found that college students in cooperative learning structures preferred to return to CBI significantly more than those in the individual conditions. Johnson, Johnson, & Stanne (1985) found that attitudes toward computer-based instruction did not vary, but that attitudes were significantly less positive for the competitive condition than for the cooperative and individual conditions.

In addition to affective measures, several studies have examined how students interact in a cooperative learning setting. To ensure appropriate interaction, students are usually trained to cooperate by behaving in specific ways in relation to their partner(s) and within the instructional environment. In a discussion of the conditions under which cooperative dyads become productive, Cohen (1994) notes that in CBI tasks, students often divide the labor into roles such as thinkist and typist rather than interacting, and that this can be avoided by preparing and instructing students regarding the appropriate levels of interaction during cooperation. In some studies, more specific instructions on how and when to interact resulted in higher achievement than did less specific directions or no directions (King, 1991; Meloth & Deering, 1992; O'Donnell, Dansereau, Hall, & Rocklin 1987).

Research into the types of interaction which yield the best achievement results has shown that behaviors such as asking and answering questions, giving and receiving help, and giving elaborated explanations have tended to improve achievement for students of all ability levels (King, 1990; Repman, 1993; Webb, 1982a, 1982b, 1983). Results showing that students who interact well tend to achieve more have prompted researchers to examine techniques for increasing or directing cooperative interaction. Some studies have used very elaborate strategies for directing and influencing student interactions during cooperative learning situations. Other researchers have required that learners follow a specific script and assume roles, or required learners to review or summarize key concepts (Dansereau, 1987; Larson, et. al, 1985). O'Donnell and Dansereau (1993) found that students who did not take notes over the content, but who reviewed cooperatively performed as well as those who took notes; additionally, students who expected to review individually but instead reviewed cooperatively with another student performed better than those who reviewed individually. Skaggs and her colleagues (1990) found that directing interaction to require oral summarization, elaboration, and other types of processing of technical content have impacted retention and recall of information.

Researchers have studied summarization as one form of interaction during cooperative learning. Findings generally show that achievement is enhanced when cooperative subjects are cued to summarize content and listen closely to detect errors or omissions in summaries (O'Donnell, Dansereau, Hall, & Rocklin, 1987; Lambiotte, et. al, 1987). Spurlin, Dansereau, O'Donnell, & Brooks (1986) found that cooperative subjects who take turns performing the roles of summarizer and listener score better on posttests than those who maintain static roles. These researchers also reported that distributed summary cues have a positive effect on achievement, recall, and transfer. Others who have studied learner interactions based on assigned roles during summarization found no overall performance differences for role assignments or summary type (O'Donnell, et. al, 1987). In addition, Sherman and Klein (1995) found that eighth graders who completed a cooperative, computer-based science lesson with distributed cueing performed significantly better than those in dyads who were not cued to summarize and explain the material to their partners.

The purpose of the current study was to investigate the effects of learning structure and summarization on achievement, enroute performance, and attitudes. High-school students worked either cooperatively or individually to learn science content from a computer-based lesson. Half of the students in both learning structures were required to write summaries according to instructions embedded throughout the instructional program which directed them to summarize the main points of the section just covered. These directions were similar to those used in other cooperative learning studies (Dansereau, 1987; O'Donnell & Dansereau, 1993; Sherman & Klein, 1995).

The instruction, practice, and feedback were provided by a computer-based program designed to provide an interactive learning environment, including an on-line periodic table of elements, an animation program illustrating internal atomic structure, and animations of specific chemical compounds.

The major research questions addressed in this study were:

1. What is the effect of cooperative versus individual learning structure on the posttest performance, enroute performance, attitudes, and time-on-task for subjects completing an interactive CBI science program?
2. What is the effect of summarization versus no summarization on the posttest performance, enroute performance, attitudes, and time-on-task for subjects completing an interactive science CBI program?
3. Does requiring dyads to write summaries during CBI influence cooperative interaction behaviors?

Method

Subjects

The subjects for this study were 78 ninth-grade students from a large, public high school in the southwest. All students were enrolled in a freshman ChemPhysics science class and had access to a computer lab during the

hour of their science class. All students had been taught how to work together in cooperative situations by their teachers.

Materials

The materials for this study comprised a computer-based lesson on the periodic table of elements and the chemical and physical properties of elements. The lesson included a tutorial, an on-line periodic table of elements, and animated atomic models. The content of the materials was based on objectives and materials currently taught in the ChemPhysics course. The on-line tutorial included an introduction, a review of prerequisite knowledge, information on the development, structure and practical use of the table, practice questions, and feedback. There were also several sets of interactive exercises, which required that students access the table to complete the exercises correctly.

The introduction to the tutorial provided directions on how students should use the instruction, general navigation, how to interact with the on-line periodic table and animated atomic models, and how to get on-line help when necessary. Another section of the introduction covered the impact of this program on the students' course grade. The instructional segment of the program was divided into three sections. Students completed two sections on Days 1-3 of the study and one section on the last day. The first section introduced students to the program and navigation, and included screens explaining that the students' performance at the computer and on the posttest would count toward their course grade. Those in the summarization condition also saw two screens relating to the summaries; the first screen contained a description of the summaries to be written and the other contained an explanation of the summary directions they would see throughout the lessons. This introductory section consisted of 20 screens, five of which are interactive pages which taught students how access and use both the on-line periodic table and on-line help.

The actual ChemPhysics course content was presented in three lessons. Each lesson began with the objectives and an overview for the lesson. For the summarization condition, students saw two direction screens and two input screens in each section; there were 24 summarization screens in all. There were 81 instructional screens in the program and 19 selected-response practice questions. Lesson One consisted of two sections of information on the development and revision of the periodic table of elements. Lesson Two included two sections, which covered chemical and physical properties of elements and the Periodic Law that is the basis for the organization of the table. Lesson Three included two sections on the element key and the practical use of the key and table by chemists. Each lesson included two sets of practice questions, and provided the students with the number correct and points earned at the end of each section in the lesson.

Three types of interactive exercises were embedded within the program. The first type of constructed-response item required subjects to use the on-line periodic table to find specific properties of given elements; there were four sets of element characteristics exercises, which included four items each. The information was available from the Periodic Table, and the computer did not accept incorrect responses; feedback was provided for each item within each set of exercises. The second type of interactive exercise required students to fill in the three missing components in an element key. Six items requiring students to construct element keys from information available in the periodic table were included; the computer did not accept incorrect answers. The last type of interactive exercise dealt with atomic composition. In addition, there were six atomic composition items, which required the students to build atoms of the specified elements by placing protons, electrons and neutrons on a graphic of an atom shell. Students were allowed three attempts for each item. A total of 16 interactive practice items were distributed throughout the program.

Subjects had navigational control throughout the program, with a few exceptions. Subjects could not jump ahead in the program, but could return to previously-viewed screens within a section until they encountered a summary direction screen (summary version). Review was not permitted once students reached the selected-response practice questions at the end of each section.

The computer tutorial was supplemented by an on-line, interactive periodic table of elements, which provided the information normally available in any standard periodic table. In response to the subjects' input, the table also provided more specific information about each element and group of elements. From the table, subjects had access to the atomic animations, which displayed the atomic composition of each element (protons, neutrons, and electrons).

The on-line periodic table of elements looked just like a typical periodic table, except that the square for each atom displayed only the symbol for the atom. When a subject clicked on a particular atom's location, more detailed information appeared in a text section just to the right of the actual table. This information included the full name of the element, the atomic number and atomic weight, as well as typical properties of the element itself. Different groups were highlighted when the subject clicked a specific button regarding that group or type of element. The subject could also bring up detailed information about the different types of elements (such as noble gases, or alkali metals) by clicking on specific, labeled buttons. The table was accessible by the subjects when they were completing the tutorial, the practice exercises, and interactive exercises.

The table also featured a search engine that located elements when the name of an element, or partial name, was typed in to the search engine dialog box. Subjects could locate information about an element even if they did not know the chemical symbol for the element. Once the element was found, the square for that element was highlighted and the detailed information for that element was displayed. If an entry could not be located within the table, a message came back stating that a match could not be found and suggesting that the subject check the spelling of the element name.

The periodic table of elements was linked to an [atomic animator](#). Based on the selection made by the student, the animator displayed the atomic structure of any element, which was selected, or active at the time the Show Atom button was clicked. The atoms were accurately represented by up to 18 protons, neutrons, or electrons. Atoms with an atomic number greater than 18 were represented by the same atom display as 18, but the actual numbers of protons, neutrons, and electrons were accurately stated within the diagram. Up to the atomic number of 18, the elements were represented with accurate numbers of protons and neutrons in the nucleus of the atom, orbited by the correct number of electrons displayed in the correct levels. For example, the atomic animation for carbon (atomic number = 6) showed six yellow protons and six red neutrons in the nucleus, with two blue electrons in the first level and four more blue ones in the second level. The electrons circled the nucleus continuously at a constant distance when the animator was running. The subject could stop the animation at any time by clicking the Hide Atom button. The animator could only be launched from the table, and not directly from the tutorial screens.

The atomic animator was also accessed directly from several instructional screens on atomic composition. The students could view an animation by clicking on the buttons provided on related instructional screens, and were then returned to that same screen from which the Hide Atom button was clicked.

From instructional screens containing information about or references to compound composition, students were directed to access another animator, which displayed a specific set of compounds as the combination of atoms graphically represented. Subjects saw the selected compound, which was accompanied by a brief descriptive text message. Each compound animation displayed the actual atomic composition of the compound. For example, water displayed one oxygen atom and two hydrogen atoms, which were all linked at their outer electron levels and shared the electrons necessary to fill the all outer levels of all three. For each animation, a descriptive compound-specific message was displayed, and the message was visible until the subjects dismissed it with a mouse-click.

A summarization and a no summary (control) version of the computer lesson were developed. Both versions included all of the instructional elements described above. The summarization version also included 24 summary screens, 12 that directed students to list the main points covered on the information in the preceding instructional segment and 12 where the summaries were typed into text fields. Each section included two summary screens.

The summarization version for the cooperative treatment directed students to work together to summarize the main points of the information and directed students by name to type in the summary. Students in cooperative dyads were directed by name to take turns typing in the summaries. The summarization version for the individual treatment directed students to summarize the main points and type in the summary each time. Subjects in the no summary (control) conditions received exactly the same ChemPhysics instruction, practice exercises, and interactive exercises, but they did not see the summarization screens directing them to recall and type in summaries of the information presented in the computer-based tutorial.

Procedures

This study included four different treatment groups: cooperative-summary, cooperative-no summary, individual-summary and individual-no summary. Twenty individuals were assigned to each summarization condition; in the cooperative conditions, 20 students were assigned to summarization condition and 18 to the no-summary condition. Subjects in the cooperative-summary group worked in dyads to complete the computer lesson and were provided with directions to summarize main points during the instruction. Those subjects in the cooperative-no summary group worked in dyads to complete the lesson but did not receive summary directions. In the individual-summary group, subjects worked alone to complete the lessons and were provided with summary directions while those in the individual-no summary group completed the lessons but did not receive these directions. All subjects implemented their treatment-specific computer lesson over four consecutive school days.

Students in three ChemPhysics classes were randomly assigned to either a cooperative or individual treatment condition. Subjects assigned to cooperative treatments were randomly assigned a partner in the same class. Approximately half the subjects in each class were randomly assigned to the summarization treatment and half were randomly assigned to the no summary treatment.

Subjects in the cooperative-summary condition worked in assigned pairs to complete the computer lesson. These dyads were told to work together to complete the exercises, and that each would be assigned the score achieved by the pair for correct completion of the exercises. At specific points during the lessons, pairs were directed to work together to summarize the main points of the section. They were also directed to take turns typing summaries into the computer, and that their grades on the exercises and the posttest were part of their semester grade for the

course. All subjects were informed that they would take the posttest individually. Finally, each subject completed an attitude survey immediately before taking the posttest.

Subjects in the cooperative-no summary condition worked in assigned pairs to complete the lessons. These dyads were told to work together to complete the exercises and that each would be assigned the score achieved by the pair for correct completion of the exercises; they were told that their grades on the exercises and the posttest would be part of their semester grade for the course. All subjects were informed that they would take the posttest individually. Each subject completed an attitude survey immediately before taking the posttest.

Subjects in the individual-summary condition worked alone at the computer to complete the lessons. At specific points in the instruction, they were directed by name to summarize the main points of the section. Individuals were told to complete all the exercises and that they would be assigned a score for correct completion of the exercises; they were told that their grades on the exercises and the posttest would be part of their semester course grade. All subjects were informed that they would take the posttest individually. Each subject completed an attitude survey immediately before taking the posttest.

Subjects in the individual-no summary condition worked alone at the computer to complete the lessons. They were told that they would be assigned a score based on correct completion of the exercises and that their grades on the exercises and the posttest would be part of their semester grade for the course. All subjects were informed that they would take the posttest individually. Finally, each subject completed an attitude survey immediately before taking the posttest.

Criterion Measures

The criterion measures for this study were a posttest and an attitude survey. Interaction behavior, time-on-task, and enroute performance were also examined. Achievement was measured by a 25-item, paper and pencil posttest. All subjects completed the posttest individually; they were informed at the outset that their posttest grade would be part of their ChemPhysics course grade. The posttest covered all of the objectives taught and practiced within the computer lesson, as well as all the objectives typically covered by the ChemPhysics tests over this segment of material for the course. The posttest consisted of 17 selected response items and eight constructed response items. The Kuder-Richardson reliability estimate for the posttest was .65. The experimenter scored all posttests using an answer key that included correct answers and possible points per item.

Attitude was measured by a pencil and paper survey administered just before the posttest. The survey consisted of 10 items which subjects responded to using a five-point Likert-type scale. Items measured the three attitude components of confidence, satisfaction, and continuing motivation. The Cronbach's Alpha reliability for the attitude survey was .74.

Subjects' behaviors during the study were recorded by trained observers using checklists for consistent tracking and recording; the checklist and instructions were adapted from Klein & Pridemore (1994). Subjects in cooperative conditions were observed for 30-second intervals to determine the type and frequency of interactive behaviors. Each observer recorded interactions for all cooperating dyads, watching each dyad for 30 seconds before moving to the next dyad. Observers noted how often a dyad discussed the material presented, how often members of a dyad discussed navigation, program requirements or task parameters, and how often students in a dyad worked individually. Off-task behaviors and conversation were also tracked. Observers also noted whether subjects shared keyboarding and summarizing responsibilities. Prior to recording observations during the study, the observers met to watch a videotape of a pair of ninth graders working together to complete the instructional program and discuss the categories of behavior. There was a discussion about the types of interaction behaviors and the observers practiced recording interactions as they watched several segments of the videotape. Inter-rater reliability was measured after training; observers were shown a different segment of video and were directed to record all interaction behaviors on the checklist. Each observer's record sheet was compared to the record sheet completed by the researcher. Inter-rater reliability exceeded 90 percent.

Enroute performance was measured using scores on the 19 selected-response practice questions. Subjects in the cooperative condition worked together to complete the items, and each received the score achieved by the pair working together. Individuals completed the same questions and received credit for the number completed correctly.

Design and Data Analysis

This study was a posttest-only, control group design. It was a 2 learning strategy (cooperative versus individual) x 2 summarization (summary versus no summary) factorial study. Both learning strategy and level of summarization were between-subjects variables. Analysis of variance (ANOVA) was conducted on posttest and enroute performance scores. Attitude scores were analyzed using MANOVA. Univariate analyses were performed on individual survey items. Time data were also analyzed using MANOVA with instructional and practice time as the dependent variables. Univariate analyses were conducted on the time spent on different sections of the program. Observation data gathered on interaction behaviors for dyads were analyzed using T-tests of significance.

Results

Posttest Performance

The overall mean for the posttest was 27.95 ($SD = 3.59$), or 74 percent. The mean posttest score for subjects in the cooperative condition was 26.95 ($SD = 2.88$) and was 28.58 ($SD = 3.10$) for those in the individual condition. Posttest mean score was 27.73 ($SD = 4.15$) for students in the summary condition and 28.38 ($SD = 3.14$) in the no summary condition. Analysis of variance (ANOVA) conducted on posttest scores revealed no significant effects for any condition.

Enroute Performance

Enroute performance scores were reported as the number of practice questions completed correctly for all conditions. The overall mean score for enroute performance was 14.22 ($SD = 2.79$), or 75 percent. The mean enroute score for subjects in the cooperative condition was 13.53 ($SD = 1.98$) and was 14.55 ($SD = 2.84$) for those in the individual condition. The enroute mean score was 13.30 ($SD = 2.87$) for students in the summary condition and 15.17 ($SD = 2.06$) in the no summary condition. Analysis of variance for enroute scores (practice questions) showed a significant difference between students who wrote summaries and those who did not, $F(1,55) = 7.15$, $p = .01$. Examination of the mean scores revealed that students in the no-summary condition ($M = 15.17$) performed better on enroute practice items than those who summarized ($M = 13.30$).

Attitude

Results indicated that subjects enjoyed using the computer program ($M = 2.01$) and would like to use computer programs more often ($M = 1.86$). Students generally reported a positive attitude toward the effectiveness of the exercises ($M = 2.22$), the atomic animations ($M = 2.08$), and the on-line periodic table ($M = 1.89$). Student attitudes toward the learning condition showed that those who worked cooperatively liked working with a partner ($M = 2.08$), and those who worked individually liked working alone ($M = 2.28$). MANOVA conducted on the attitude data showed no significance for any attitude items ($\alpha = .05$).

Time-on-Task

Time-on-task was broken out as instruction time and practice time. The overall mean for instructional time was 55.59 ($SD = 16.37$) minutes. The mean instructional time for the cooperative condition was 50.73 ($SD = 13.95$) minutes and was 57.89 ($SD = 17.07$) minutes for those in the individual condition. Instructional time means were 55.17 ($SD = 16.48$) minutes for those in the summary condition and 56.02 ($SD = 16.53$) minutes in the no summary condition. The overall mean for practice time was 32.69 ($SD = 8.91$) minutes. The mean practice time for the cooperative condition was 31.50 ($SD = 9.55$) minutes and was 33.25 ($SD = 8.65$) minutes for those in the individual condition. Practice time means were 29.85 ($SD = 7.49$) minutes for those in the summary condition and 35.62 ($SD = 9.41$) minutes in the no summary condition. MANOVA was conducted on time data using instructional and practice time as the dependent variables. MANOVA revealed that summary condition had a significant effect on time-on-task, $F(2,54) = 6.04$, $p < .01$. Univariate analysis revealed that students who summarized spent less time on practice items than those who did not summarize, $F(1,55) = 11.95$, $p < .01$ (see Table 7). Univariate analyses also revealed a significant interaction between learning strategy and summary condition $F(1,55) = 6.76$, $p < .01$. Follow-up Scheffé multiple comparison tests indicated that the practice time mean for those in the individual-no summary group ($M = 34.22$) was significantly different from the means for those in the cooperative-summary ($M = 24.99$) group. The Scheffé test also indicated that the practice time mean for the cooperative-no summary ($M = 38.72$) group was significantly different from the cooperative-summary ($M = 24.99$) group.

Interaction Behaviors

Observational data were gathered during the course of the study for cooperating pairs only. The mean for observed helping behaviors was 8.39 ($SD = 4.54$) for no-summary and was 15.10 ($SD = 3.90$) for summary condition pairs. The mean for task-related behavior was 2.09 ($SD = 1.57$) for no-summary and was 3.00 ($SD = 1.66$) for summary dyads. The mean for on-task individual behaviors was 2.82 ($SD = 2.97$) for pairs in the no summary condition and was 2.93 ($SD = 2.50$) for pairs in the summary condition. Finally, the mean for off-task behavior was 1.45 ($SD = 2.02$) for no-summary pairs and was 3.53 ($SD = 4.93$) for summary pairs. T-tests run on interaction behaviors revealed that subjects in the cooperative-summary condition exhibited significantly more helping behaviors than those in the cooperative no-summary condition, $t(30) = 5.59$, $p < .01$. Subjects in the cooperative-summary group also exhibited significantly more task-related behaviors than those in the cooperative no-summary condition, $t(30) = 2.55$, $p = .016$. Differences were not significant for the two remaining interaction behaviors.

Discussion

The purpose of this study was to investigate the effects of learning strategy and summarization within a computer-based chemistry and physics program. Students worked individually or in cooperative dyads to complete science instruction; half of them completed summaries of the instructional content when directed to do so. The study examined the effects of learning strategy and summarization on posttest and enroute performance, attitude, time-on-task, and interaction behaviors.

Results indicated no significant differences for posttest performance. One possible explanation for this result lies in the power of aligned and well-designed instructional materials. Subjects in this study used a competency-based instructional package developed to address each of Gagne's nine events of instruction. The computer program introduced material in prerequisite order and provided appropriate practice and feedback (Gagne, 1985; Sullivan and Higgins, 1983). It is possible that the design of the materials overrode the effects of the potential differences, which were investigated via the experimental conditions. The design of the ChemPhysics materials supplemented by the on-line Periodic Table and atom animation supports the theory of Anderson, Reder, and Simon, (1996) that "combining abstract instruction with specific concrete examples is better than either one alone" (pg. 8). In fact, Anderson, Reder, and Simon, (1996) cite a number of studies that support the contention that the combination of abstract and concrete concepts is a powerful method of instruction.

Other researchers have suggested that the performance of individuals and cooperative groups is often equal when well-designed instruction is used by all students. Bossert (1989) indicated that studies often compare cooperative learning conditions to whole-class methods, or compare well-designed cooperative learning structures to poorly-designed individual situations. In studies utilizing well-designed instruction across all conditions, posttest results do not consistently show significant differences for cooperative learning (Cavalier 1996; Klein & Doran, 1997; Slavin & Karweit, 1984; Slavin, Madden, & Leavey, 1984; Snyder & Sullivan, 1995).

Results also indicated no significant enroute performance difference between those working in cooperative dyads and those working alone. Enroute items consisted of selected-response items, which were aligned to the instructional content sections, presented. These items measured the acquisition of factual knowledge, not complex skills. Cooperative learning researchers have found that complex skills such as higher order reasoning provide the best opportunity for cooperative structures to impact performance (Bossert, 1989; Hooper & Hannafin, 1988). It is likely that the level of processing or performance required for students to answer the selected response items was not sufficiently demanding for those in the cooperative structure to benefit from collaboration.

Another factor in the lack of differences for enroute performance may be due to the consistency of the computer-based instruction. Bossert (1989) notes that in many cooperative learning studies, teachers often give specific instructions, explanations, encouragement, and feedback to students in the cooperative situation but do not give them to individual students. Computer-based instruction provides consistency for students in both cooperative and individual conditions.

Results for enroute performance indicated that practice scores for students who did not write summaries were significantly higher than for those who wrote summaries. It is likely that the difference in scores resulting from summary conditions was caused by the amount of time spent on practice. Results for time-on-task showed that students who summarized the material spent significantly less time on the practice items than students who did not write summaries. Students who wrote summaries may have felt pressured to spend less time on the practice questions, and therefore may have been more prone to answer incorrectly. The lower enroute performance scores for those in the summary condition seem to indicate that those students had insufficient time to complete the practice items.

Results for time-on-task also indicated a significant interaction between learning strategy and summary condition. Generally, it might be expected that students working in cooperative dyads would take more time to complete practice items than those working individually because they had to interact regarding the material and agree on an answer. However, this was only the case for those in the cooperative no-summary condition. Cooperative pairs in the summary condition spent less time on practice items than the individuals. Again, it is possible that the time limitation of class periods accounts for this result. Students who had spent time cooperating throughout the instruction and who then wrote summaries likely had the least time remaining for the practice items. Cooperative students who did not write summaries had more time remaining for practice.

Results for time on instruction showed no significant differences for students in any of the conditions. Knowledge that summaries would be required apparently did not impact time-on-task for students in either learning strategy condition. Although it is generally expected that students who cooperate require more time to complete instruction (Slavin, 1990), there are some researchers who indicate that computer-based instruction can be as efficient for those who cooperate as for those who work individually (Klein & Doran, 1997). While it was expected that students in cooperative dyads would expend more time than those who worked individually, the results of this study suggest that under some conditions, students can learn as efficiently when cooperating if the instruction is specifically written for cooperative interaction to take place.

Attitude results regarding the actual computer-based program were generally positive. The results of the study indicate that students enjoyed learning about ChemPhysics by using the computer program and would like to learn more by using other computer programs. This could be reflective of the instructional quality and interactive level of the program itself, which encourages active involvement (Bright, 1983; Caldwell, 1980; Hannafin & Peck, 1988). The attitude results also show positive student reactions to the effectiveness of the interactive exercises, the atomic animations and the on-line, interactive periodic table. However, these positive results may be as much a response to the actual interactivity of those program features as to their effectiveness as learning tools. It is also possible that these attitude results could instead be attributed to a novelty effect that students experienced because class was held in the computer lab where they used computers instead of in the typical lecture and lab format (Bright, 1983; Hannafin & Peck, 1988).

Attitude results regarding the learning structure from the study were mostly consistent with positive attitude results reported in other cooperative learning studies. Attitude scores show that students expressed positive feelings about the particular learning strategy to which they were assigned. Positive attitudes for cooperative learning structures have been reported by a number of researchers (Crooks, 1995; Jones, 1995; Sherman & Klein, 1995; Slavin, 1980).

Results from the study also indicated that students in the two cooperative conditions interacted together in somewhat different ways. Student pairs in the summary condition exhibited more helping behaviors than those in the no-summary condition. Dyads in the summary condition also interacted more regarding the instructional content of the program. It is likely that these differences were the result of the additional interaction required of the summary condition, as the students who wrote summaries had more opportunities during which they could work together. While the observed interaction differences were statistically significant, further consideration of the actual means for observed behavior indicate that the differences were quite small because the number of observed behaviors overall was quite small. Since differences in observed interactions were small and did not impact posttest performance, it is important not to over-interpret the results for interactions.

This study has some implications for the application and design of computer-based instruction. It is possible that educators can compensate for the realities of limited resources in schools by implementing well-designed computer-based instruction with cooperative learning. This study indicates that computer-based instruction designed and developed following a systems approach may enable students working together to perform almost as well as students working alone. Since technology to deliver computer-based instruction to individuals may not be consistently available in public schools, the availability of resources is a legitimate concern for teachers and administrators.

The current study also suggests that CBI developers must consider practical time constraints prior to including strategies such as cooperative learning or summarization in their programs. The inclusion of these strategies may have unintended consequences such as a decrease in practice time especially if students are not provided enough time to complete other portions of the lesson. Additional research should explore the variables used in this study for a longer duration of time. It might also be worthwhile to investigate the performance effects of summarization during CBI in the absence of other forms of practice.

Future cooperative learning research should also continue to use well-designed instruction that teaches school-age children existing curricular objectives (Anderson, Reder, and Simon, 1997). While teacher-directed and whole-class activities still dominate schoolroom practices, there is considerable pressure to change to other forms of instruction. Therefore, there is value in the continued investigation of how to employ well-designed CBI to support learning in small group situations.

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USING COOPERATIVE LEARNING AND OBJECTIVES WITH COMPUTER-BASED INSTRUCTION

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Abstract

The purpose of this study was to investigate the effect of implementing cooperative learning and objectives with computer-based instruction (CBI). Cooperative dyads and individuals worked through a CBI earth science program that contained either instructional objectives, advance organizers, or no orienting activities. Results indicated that students who received instructional objectives performed significantly better on intentional posttest items than students who received either advance organizers or no orienting activities. Results also revealed that dyads who received objectives exhibited significantly more on-task group behaviors, more helping behaviors, and fewer off-task behaviors than dyads in the other orienting activity conditions. Furthermore, learning strategy influenced time on task; individuals spent significantly more time on instruction and practice than cooperative dyads. Implications for CBI developers are explored.

Introduction

Computer-based instruction (CBI) is becoming a more widely accepted instructional delivery medium in schools. However, access to computer resources is limited in most classrooms. Teachers who do have computers available usually have one or two in their classrooms or have access to computer labs with fewer than 15 workstations (Becker, 1991). Working with these restrictions, teachers have limited options. They may assign computer time to individual students on some type of rotation basis or assign groups of students to work at the computer. Grouping students may be a practical solution to equipment shortage. However, it is not clear how groups perform using computer programs traditionally designed for individual students.

While teachers frequently group students to work together on CBI, software developers have normally presumed that their programs would be used by individual students (Cosden, 1989). Recently, a search of 14 educational software catalogs revealed that only 40 out of 5,964 CBI programs were designed with the option of implementing the program with more than one student at a time (Cavalier, 1996).

Since teachers often group students together to use computers, it is important to determine the factors that influence learning and motivation in these settings. Several researchers have examined the effect of implementing cooperative learning with CBI. Some have found positive effects for achievement and attitude when small group strategies were used with CBI (Dalton, Hannafin, & Hooper, 1989; Hooper, Temiyakarn, & Williams, 1993; Johnson, Johnson, & Stanne, 1985; Mevarech, Silber, & Fine, 1991; Trowbridge & Durnin, 1984). Others have reported that individual and cooperative methods were equally effective when used with CBI (Carrier & Sales, 1987; Cavalier, 1996; Crooks, Klein, Jones, & Dwyer, 1997; Doran, 1994; Klein & Doran, 1997; Orr & Davidson, 1993).

According to Klein and Pridemore (1994), the mixed results for studies that have examined cooperative learning with media may be due to the orienting activities employed within mediated lessons. An orienting activity is a mediator through which new information is presented (Hannafin & Hughes, 1986). Orienting stimuli evoke inspection behaviors in learners, which help to influence what is learned from textual material (Rothkopf, 1970). An example of an orienting activity is when learners are provided with the objectives of a lesson. According to Gagne (1985), objectives help to activate a mental set that focuses student attention and directs selective perception of specific lesson content.

Reviews of research have generally supported the prescription of providing objectives to learners. However, inconsistencies in the results of these studies have suggested that objectives as orienting activities may not be effective in every learning setting (Duchastel & Merrill, 1973; Hamilton, 1985; Hannafin & Hughes, 1986; Melton, 1978). Researchers have indicated that objectives increase the attainment of factual information, but do little to help students process higher level skills (Clark, 1984; Hannafin, 1985; Ho, Savenye, & Haas, 1986; Mayer, 1984). Others have reported that objectives enhance learning of intentional or test-relevant content, but provide little assistance for learning incidental material (Duchastel, 1972, 1977; Duchastel & Brown, 1974; Kaplan & Simmons, 1974; Morse & Tillman, 1972; Rothkopf & Kaplan, 1972, 1974).

In addition to objectives, another orienting activity is supplying learners with advance organizers. Ausubel (1968) defined an advance organizer as "relevant and inclusive introductory materials . . . introduced in advance of learning . . . at a higher level of abstraction, generality, and inclusiveness" (p. 148). Advance organizers relate potentially meaningful information to be learned to existing structures that exist within a learner's memory; they

serve as a vehicle to assist learners to incorporate new information into existing schema (Ausubel, 1960, 1968). Advance organizers remind students of something they already know and assist in organizing information to be learned (Gagne & Driscoll, 1988). According to Mayer (1979), advance organizers provide the learner with a framework that allows for integrative relationships to be formed between new and existing knowledge; knowledge that is acquired goes beyond an isolated fact or concept and is integrated into a larger schema. Furthermore, an advance organizer promotes learning when new content is not well organized; as the structure of to be learned material decreases, the greater the advantage of using an advance organizer as an orienting activity (Mayer, 1977, 1979).

Researchers have found that advance organizers increase both retention and comprehension of instructional content (Ausubel, 1968; Mayer, 1984; Stone, 1983). But advance organizers have not facilitated performance in every learning setting. Some researchers have indicated that advance organizers provide students with more support of incidental information rather than recall of specific or intended learning (Ausubel, 1978; Hannafin, 1987; Mayer, 1979). Others have reported that subjects given advance organizers outperformed those who were not given this orienting activity on material that required broad assimilation and better understanding; both groups performed similarly on factual test items (Krahn & Blanchaer, 1986). Finally, the benefits of advanced organizers have been reduced when more powerful instructional elements such as practice were included in CBI lessons (Hannafin, 1987; Hannafin, Phillips, Rieber, & Garhart, 1987; Phillips, Hannafin, & Tripp, 1988).

The purpose of the current study was to investigate the effect of implementing cooperative versus individual learning and orienting activities during a CBI program. Cooperative dyads and individuals worked through a CBI earth science program that contained either instructional objectives, advance organizers, or no orienting activities. While a number of studies have been conducted to examine the separate effects of cooperative learning and orienting activities during CBI, no research has investigated the effects of both cooperative learning and orienting activities during CBI. A study by Klein and Pridemore (1994) indicated that orienting activities influenced student interactions and knowledge acquisition when students implemented cooperative learning with instructional television. The current study was conducted to determine if those results could be extended to computer-based instruction.

Method

Design and Subjects

A 2 X 3 factorial design was used for this study, with learning strategy (cooperative versus individual learning) and orienting activity (objectives, advance organizers, none) as the independent variables. The dependent variables were performance and attitude. Time on task and student interaction behaviors were also examined.

Subjects were 125 fifth and sixth graders enrolled at an elementary school located in a lower socioeconomic neighborhood in metropolitan Phoenix. The school was organized in pods where grade levels were combined to allow for group and individual learning in various subjects and special projects. The fifth and sixth grade students who were subjects in this study were members of the same pod. Each class of fifth and sixth graders was comprised of approximately 30 students. Subjects attended a weekly 45-minute class session in a computer lab of 28 networked Apple Macintosh LC computers. Prior to this study, subjects had been taught basic computer skills such as word processing and presentation graphics. Subjects were also experienced in using cooperative learning strategies. They regularly had participated in small group projects in science, math, and social science in the classroom. However, subjects usually worked individually at the computer during the weekly lab session.

Materials

An original computer-based instruction (CBI) program entitled Prospecting for Arizona's Treasures was developed for this study. The program was a Hypercard tutorial that presented information about the tools, equipment, people, and methods used in modern prospecting. The content was written at a fifth grade reading level. Six versions of the CBI were developed with all possible combinations of learning strategy and orienting activity used.

The tutorial contained the same content for all versions. The program consisted of a total of 140 screens. There were 20 introductory screens, 78 information screens, 34 practice screens with feedback, 5 practice/feedback score screens, and 3 exit screens at the end of each lesson. All subjects progressed through all screens sequentially while controlling the pace of the lesson. The tutorial consisted of an introductory section and three lessons.

The introductory section consisted of five parts: identification information solicited from subjects, motivational information, navigation information, cooperative or individual instructions, and the appropriate orienting activity. Subjects were prompted to enter an assigned identification number and their first name. These data were used by the program to address each student by name and assign tasks throughout the program. Motivational screens presented reasons for studying prospecting in Arizona. The content of these screens focused on the impact of the mining industry in Arizona. Information and practice on button operation, function, and navigation was also presented in the introduction. As subjects practiced navigation, they were informed that a posttest would be

administered at the conclusion of the CBI and extra credit points would be earned by those who attained a posttest score of 80% or more. These screens also instructed subjects in the cooperative groups to discuss all information and practice exercises, and assigned roles and responsibilities to each dyad member. The final screen in the introduction displayed the appropriate orienting activity for Lesson 1, Unit 1.

Lessons 1 and 2 consisted of two units each. Lesson 3 consisted of one unit. Each unit had an orienting activity, information, practice, and feedback. Two versions of the program contained instructional objectives, two versions contained advance organizers, and two versions contained no orienting activities.

Objectives were presented as verbal information outcomes that students were expected to possess after instruction (Gagne, 1985). Each unit included 3 - 5 objectives. Each objective was listed on a separate line preceded by a bullet to draw attention to them. Advance organizers were structured using the approach described by Ausubel (1968, p. 148) as "materials presented at a high level of abstraction, generality, and inclusiveness that can serve as anchoring ideas for the information to be learned. Each unit included an advance organizer. Each advance organizer was presented in paragraph format and included 55 – 65 words.

Information was presented in a story format for all three lessons. A narrator character acted as guide by introducing students to members of a modern prospecting team. Subjects were told that they would accompany the team on a search for gold, silver, and copper simulating a prospecting trip. Characters acted out the storyline, with the narrator character interrupting the story with comments, instructions, and assignment of tasks. The units of each lesson served as a scene change for the storyline and the narrator presented the appropriate orienting activity at the start of each unit. Lesson 1, Unit 1 is described below as an example of the structure of each lesson.

Unit 1 introduced three members of a modern prospecting team and the equipment that each takes on a preliminary search for metallic mineral deposits. The search strategy had been predetermined by various methods that are discussed by the prospectors as the story unfolded. At the end of the unit, the narrator presented a series of five, short-answer practice items. Practice items were directly aligned with the objectives for each unit and required subjects to provide information about the tools, equipment, people, and methods used in prospecting. The tutorial was programmed to allow for a variety of spellings and variations in subject responses.

The CBI was field tested prior to the study with a small group of fifth and sixth graders of average ability. Revisions were made as needed to ensure transparent program navigation and clarity for subjects. For example, navigation instructions were added at the beginning of each lesson rather than placing them in the overall introduction. Furthermore, several practice items were reworded to improve clarity.

The cooperative version of the CBI incorporated the elements of positive interdependence, face-to-face interaction, and individual accountability (Johnson & Johnson, 1989; Slavin, 1991). Positive interdependence was established by assigning tasks and responsibilities to dyad members, by cueing students to switch these roles, and by providing extra credit points when both members of a dyad achieved 80% or better on the posttest. Eighty percent was considered mastery level at the subjects' elementary school. Face-to-face interaction was promoted by instructing dyads to discuss key information and their responses to practice items. Individual accountability was established by having each member of dyad independently complete the posttest.

The individual version of Prospecting for Arizona's Treasures differed from the cooperative version only on those screens which provided directions and cues for the dyads to cooperate. Individuals were provided the same incentive to perform well on the posttest; those subjects who achieved 80% or more on the posttest received extra credit points.

In addition to the CBI lesson, a script of oral instructions to subjects was designed by the researchers. Oral instructions prior to each computer session were the same for all subjects. The script informed all subjects how to respond if they needed assistance with the program and how to enter their ID number and name. Instructions pertaining to the program differed for subjects in the cooperative and individual groups. The script for cooperative groups provided instructions on how to cooperate. These instructions informed subjects that they would be working with a partner at the computer, that the program was designed so that they could help each other perform well on the practice items, and that both had specific tasks that they were to perform. Oral instructions also prepared subjects for switching tasks at the beginning of each unit. For example, the oral instructions for Lesson 1, Unit 1 were as follows: "You will be working with a partner at the computer. This program was designed for you to help each other. Both of you will have jobs to do while you go through the program. You should talk about what is happening in the story and work together to get the answers to the practice questions. Lesson 1 has two units. At the beginning of the second unit, you will switch jobs. The program will tell you when to do this." These instructions were similar for each of the three computer sessions.

Procedures

There were six treatment groups in this study. The treatment groups were cooperative learning-objectives, cooperative learning-advance organizers, cooperative learning-no orienting activity, individual learning-objectives, individual learning-advance organizers, and individual learning-no orienting activity.

Prior to assigning subjects to treatment conditions, reading ability scores from the Iowa Test of Basic Skills (ITBS) were obtained. The mean score and standard deviations for each of the four intact classes were 45.37 (SD = 25.33), 47.56 (SD = 24.85), 49.26 (SD = 24.43), and 53.22 (SD = 24.64). In order to achieve a balance between treatments, the classes with the highest and lowest means were combined to make one group, while the two remaining classes were combined to make another group. Both of these groups were then randomly assigned to either the cooperative or individual condition. The mean score for the cooperative treatment group was 49.30 and was the mean score for the individual treatment group was 48.41.

Reading scores were also used to assign partners to subjects in the cooperative treatment. Using an overall median score of 45, subjects were identified as either high ability or low ability. One high and one low ability student was randomly assigned to each cooperative dyad. Teachers reviewed these pairings to verify that each dyad included a high and low ability learner. After subjects in the cooperative treatment were paired, each dyad was randomly assigned to one of the orienting activity conditions. Subjects in the individual treatment were also randomly assigned to an orienting activity.

The study consisted of three 45-minute computer sessions conducted on three consecutive days. Each group was given two 45-minute class periods to complete Lessons 1 and 2, and 30 minutes of the third class period to complete Lesson 3. The remainder of the third class period (15 minutes) was spent completing a student attitude survey.

When subjects arrived at the computer lab, they were instructed to sit at their assigned computer but not to type at the keyboard. When all subjects were seated, instructions were read to them. Subjects were told that they would be working at the computer to complete a lesson and were instructed to raise their hand if they had a question. Cooperative dyads were instructed to decide who would keyboard first and informed that the computer would prompt them to change roles at the beginning of each unit. Subjects were then instructed to launch the appropriate version of the CBI. Subjects in all treatments worked through each lesson at their own pace. While cooperative subjects worked through each lesson, a trained observer recorded instances of interaction behaviors. All cooperative dyads were observed during all three lessons. Upon conclusion of Lesson 3, all subjects individually completed an attitude survey in the computer lab. Upon returning to the classroom, teachers distributed a posttest and all students individually completed it.

Criterion Measures

The two criterion measures in this study were a posttest and an attitude survey. In addition, time-on-task and student interaction behaviors were measured.

A 30-item, short-answer, paper-and-pencil posttest was used to measure acquisition of the information presented throughout the CBI lesson. The posttest was divided into two sections; 15 items addressed intentional learning and 15 items addressed incidental learning. Intentional learning items were directly aligned to the outcomes of each lesson and were similar to the practice items found in the CBI program. Two examples of intentional items are "Name three members of a modern prospecting team" and "What tool would you use to break off a piece from an outcropping?" Incidental learning items tested information that was provided throughout the program, but not directly practiced or aligned with the outcomes of each lesson. Two examples of incidental items are "Name two reasons that a laptop computer is a good tool to take into the field" and "Why do minerals fall to the bottom of a stream?" Each section of the posttest was worth 20 points. Individual answers to an item were checked against a scoring key and points were assigned for each response. An item was worth one point unless it required a multiple response. One person scored all of the items on this test. The Kuder-Richardson internal-consistency reliability was .88 for the entire posttest.

A 10-item Likert-type survey was administered prior to the posttest to determine student attitudes. It measured a subjects preference for cooperative or individual learning, confidence level toward knowing what was to be learned at the beginning of each lesson through the orienting activity, perceived value of practice as test preparation, degree of difficulty in understanding the content, enjoyment of working on a computer, use of a storyline to convey content, and interest in prospecting as a topic. The Cronbach Alpha internal reliability of this attitude survey was .67.

Interaction behaviors for a sample of 34 cooperative dyads (14 received objectives, 11 received advance organizers, 9 received none) were observed and recorded by two trained observers. The classification of interaction behaviors was based on research by Webb (1982, 1987) and Klein and Pridemore (1994). These interaction classifications were divided into four sets of behaviors: helping, on-task group, on-task individual, and off-task behaviors. Helping behaviors included asking for help, giving help when asked, and unsolicited help. On-task group behaviors were taking turns and group discussion. On-task individual behaviors were assuming control and working alone. Off-task behavior included talking about something unrelated to the lesson and nonverbal actions such as reading or working on other assignments. Inter-rater reliability was conducted to ensure consistency of interaction observations. Reliability estimates were .92 for helping behaviors, .95 for on-task group behaviors, .91 for on-task individual behaviors, and .96 for off-task behaviors.

Each observer was centrally located among the computer stations. At two-minute intervals, the observers recorded the interaction behaviors of a dyad and then rotated to the next cooperative dyad. Observations continued throughout each of the three class periods while dyads worked at the computer. Each dyad was observed five times during the study. Interactions were documented on the interaction criteria scoring sheet for type and amount. As each behavior was observed, a tick was recorded on the score sheet.

Embedded in the CBI was a tracking routine that provided raw data on time spent on each screen as subjects progressed through the tutorial. Time spent on orienting activities screens, instructional screens, and practice and feedback screens was captured for tabulation. The time spent on each lesson and the overall time for the CBI was also collected.

Data Analysis

A separate 3 X 2 multivariate analysis of variance (MANOVA) was conducted on data for performance, attitude, and time on task. The dependent variables for the MANOVA on performance were scores on intentional and incidental posttest items. The MANOVA for attitude used each survey item as a dependent measure. The dependent measures for the MANOVA on time on task were time spent on orienting activities, time spent on instruction, time spent on practice, and total time in the program. A one-way MANOVA was conducted on interaction behaviors to determine the effect of orienting activities on the interactions of subjects in the cooperative treatments. Interaction behaviors were considered as a group-based measure, since a combined score was obtained for subjects in each cooperative dyad. Each MANOVA was followed by univariate analyses if a significant multivariate result was found. Scheffe multiple comparison tests were also conducted when a univariate test indicated a significant main effect for orienting activities. Alpha was set at .05 for all statistical tests.

Results

Performance

A 3 X 2 MANOVA conducted on posttest scores revealed a significant main effect for type of orienting activity, $F(4,218) = 3.11$, $p < .05$. MANOVA did not reveal an effect for learning strategy or an interaction between orienting activity and learning strategy. Follow-up univariate analyses indicated that type of orienting activity had a significant effect on intentional posttest scores, $F(2,110) = 6.35$, $p < .01$, $ES = .74$, but not on incidental scores. Scheffe multiple comparison tests revealed that subjects who received instructional objectives ($M = 12.30$) performed significantly better on the intentional portion of the posttest than those subjects who received advance organizers ($M = 10.16$) and those who received no orienting activities ($M = 9.39$).

Time on Task

A 3 X 2 MANOVA conducted on time data revealed a significant main effect for learning strategy, $F(4,76) = 6.22$, $p < .001$. MANOVA did not reveal a significant effect for orienting activity or an interaction between learning strategy and orienting activity. Follow-up univariate analysis showed that individuals spent significantly more time on instruction, $F(1,79) = 14.35$, $p < .001$, $ES = .80$, and practice, $F(1,79) = 20.36$, $p < .001$, $ES = .92$, than subjects working in cooperative dyads.

Attitudes

Mean scores for the attitude survey suggested that most subjects liked using the computer program ($M = 1.94$) and thought the story made it fun to learn ($M = 2.24$). Subjects indicated that the information was easy to understand ($M = 2.08$) and that the practice was helpful ($M = 1.82$). Subjects who worked cooperatively reported that they liked working with a partner ($M = 2.00$) while those who worked individually indicated that they liked working alone ($M = 2.36$). Furthermore, subjects in all orienting activity conditions felt that they knew what they were supposed to learn from the program ($M = 1.99$). A 3 X 2 MANOVA conducted on the attitude data did not reveal a significant main effect for orienting activity, learning strategy, or an interaction between these variables.

Interaction Behaviors

A one-way MANOVA conducted on interaction behaviors revealed a significant main effect for type of orienting activity, $F(2,13) = 5.92$, $p < .001$. Follow-up univariate analyses indicated that orienting activity had a significant effect on helping behaviors, $F(2,31) = 5.55$, $p < .01$, on-task group behaviors, $F(2,31) = 6.09$, $p < .01$, on-task individual behaviors, $F(2,31) = 4.58$, $p < .05$, and off-task behaviors, $F(2,31) = 8.83$, $p < .001$. Scheffe tests indicated that cooperative dyads who received objectives exhibited significantly more helping behaviors and more on-task group behaviors than those who did not receive orienting activities. Scheffe tests also revealed that dyads who did not get orienting activities exhibited significantly more on-task individual behaviors and more off-task behaviors than those who received either objectives or advance organizers.

Discussion

The purpose of this study was to investigate the effect of implementing cooperative learning and objectives with a CBI program. Cooperative dyads and individuals worked through a CBI earth science program that contained either instructional objectives, advance organizers, or no orienting activities. The study examined the effects of learning strategy and orienting activities on intentional and incidental posttest performance, time on task, student attitudes, and cooperative interaction behaviors.

Results indicated that students who received instructional objectives throughout the program performed significantly better on intentional posttest items than students who received either advance organizers or no orienting activities. Providing objectives at the beginning of each computer unit most likely directed student attention and selective perception of relevant content (Gagne, 1985). The objectives may have helped students focus on the learning task.

It is also likely that objectives enhanced performance on intentional scores because the objectives provided a clear link between expectancies for learning and incentive for learning. In this study, all versions of the CBI program informed students that (1) they would take a test at the end of the program, (2) it was important to learn all they could about prospecting, and (3) they would receive extra credit for achieving 80% or better on the test. This information was immediately followed with the appropriate orienting activity for Unit 1. Students who received the objectives may have seen a more direct relationship between incentives and expectancies than other students.

The results of this study support the work of other researchers who have reported that objectives enhance learning of intentional or test-relevant content (Duchastel, 1972, 1977; Duchastel & Brown, 1974, Kaplan & Simmons, 1974; Morse & Tillman, 1972; Rothkopf & Kaplan, 1972, 1974). However, the current study does not corroborate the findings of those who have suggested that advance organizers provide students with support of incidental information (Ausubel, 1978; Hannafin, 1987; Mayer, 1979).

Advance organizers did not influence incidental learning in the present study. This result was likely due to the CBI program used by students. It was designed following a systems approach and included most of the elements of effective instruction proposed by instructional design theorists (Dick & Carey, 1996; Gagne, 1985; Sullivan & Higgins, 1983). Mayer (1977, 1979) suggested that an advance organizer promotes learning when new content is not well organized. Furthermore, others have found that the benefits of advance organizers are reduced when more powerful instructional elements such as practice are included in mediated instruction (Bertou, Clasen, & Lambert, 1972; Hannafin, 1987; Hannafin, Phillips, Rieber, & Garhart, 1987; Klein & Pridemore, 1994; Phillips, Hannafin, & Tripp, 1988).

It is also possible that advance organizers did not influence learning in the current study because of the nature of the items used to test for intentional and incidental learning. All posttest items measured student acquisition of factual information presented in the CBI lesson. Other researchers have reported that advance organizers do not always increase the attainment of facts (Krahn & Blanchaer, 1986). In addition, Mayer (1979) theorized that advance organizers help learners acquire knowledge beyond an isolated fact or concept. Furthermore, the lack of effect for advance organizers in the present study may be due to the design of the organizers themselves. While the advance organizers were designed to include "relevant introductory materials at a high level of abstraction, generality, and inclusiveness" (Ausubel, 1968, p. 148), little attempt was made to relate information to be learned about prospecting for minerals to students' existing mental structures and schema.

In addition to performance, results of the current study revealed that orienting activities had a significant influence on the interaction behaviors of dyads. Dyads who received objectives exhibited significantly more on-task group behaviors and helping behaviors than those who did not receive orienting activities. In addition, dyads who received either objectives or advance organizers exhibited significantly fewer off-task behaviors than students who did not receive orienting activities. These results support Klein and Pridemore (1994) who indicated that providing objectives to cooperative groups may be an effective method for increasing student interactions.

It is possible that the objectives version of the program provided dyads with a clear goal to accomplish. Most successful cooperative learning methods include some type of group goal (Johnson & Johnson, 1989; Slavin, 1990). Dyads who received objectives probably had a better understanding than other dyads of the goals and expectations of the CBI lesson. According to Gagne (1985) informing the learner of objectives activates expectancies which "represent the specific motivation of learners to reach the goals of learning that have been set for them" (p. 78).

While orienting activities influenced cooperative behaviors in this study, the performance and attitudes of students in both the cooperative and individual treatments was about the same. Again, these results likely occurred because the CBI was designed following a systematic approach. Students may have found the presentation of the content engaging and the structure of the instruction straightforward enough to overcome any preference for a particular learning strategy. Other researchers have suggested that cooperative learning studies which include well-designed instructional materials do not consistently show differences in favor of cooperative strategies (Bossert, 1988-89; Klein & Doran, 1997; Snyder, 1993). It is also possible that performance and attitude were similar for

individuals and dyads because the lesson focused on the acquisition of verbal information instead of skills or problem solving.

While learning strategy did not influence performance or attitude, results revealed that individuals spent significantly more time on the CBI than dyads. This is somewhat surprising, in light of Slavin's (1990) review that indicated, "most studies that have measured time on task have found higher proportions of engaged time for cooperative learning students than for control students" (p. 47). However, the increased time for individuals may be explained through direct observation of students. Observers noted that individuals appeared less focused than dyads and were easily distracted. Individuals seemed to exhibit more off-task behavior and thus spent more time on the program. In contrast, cooperative dyads seemed to be more attentive to task. Dyads appeared to have little difficulty working cooperatively at the computer and demonstrated an efficiency of task. Thus, dyads spent less time than individuals on each screen. These findings suggest that cooperative dyads who have experience working in groups are likely to be more efficient with their learning than students working alone at the computer. However, the fact that dyads were formally observed and individuals were only informally observed, could account for dyads being more attentive to task than individuals.

The present study has some implications for practitioners who develop and implement CBI. Results strengthen the prescription of providing students with instructional objectives during CBI to increase learning of relevant information. Furthermore, findings support the use of objectives for increasing the interactions of students who work together during CBI lessons. Providing objectives to students may reinforce the structure and goals of a CBI lesson even when it is well-organized and includes other elements of effective instruction. Results also suggest that teachers faced with limited resources can assign students to work together at a computer. While cooperative learning may not always increase student achievement or improve attitude, this study illustrates that cooperative learning may be as effective as individual learning when students use well-designed CBI.

Since teachers often group students together to use computers, it is important for educational technologists to determine the factors that influence outcomes in these settings. Future research should continue to investigate the design elements that influence learning and motivation when students work together to implement computer-based instruction. Future research should also continue to explore the use of well-designed computer instruction in classroom environments. As computer resources become more available in schools, educational technologists must continue to find ways to maximize the effect that computer-based instruction has on learning.

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INDIVIDUALLY-GUIDED EDUCATION AND PROBLEM-BASED LEARNING: A COMPARISON OF PEDAGOGICAL APPROACHES FROM DIFFERENT EPISTEMOLOGICAL VIEWS

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Abstract

Behaviorism was the dominant epistemology in education approximately 20 years ago, while Constructivism has most recently been the dominant epistemology in the field. In this paper, differences between the assumptions of behaviorism and constructivism are briefly identified, and subsequently, the behaviorist pedagogy of Individually-Guided Education and the constructivist pedagogy of Problem-Based Learning are analyzed across six core elements of the instructional environment, including learning goals, instructional approaches, teacher's role, students' roles, resource utilization and evaluation strategies. In conclusion, the authors discuss the similarities in pedagogy resulting from two very different epistemologies.

Introduction

Behaviorism was the dominant epistemology in education during the 1970s and '80s, while constructivism is currently the dominant epistemology in the field. Although they are different epistemologies, some of resulting pedagogical approaches have points in common and are worth further discussion. Under the underpinning of behaviorism, individualized instruction was developed in the 1960s and gradually reached its peak in the end of 1970s. Individually-Guided Education (IGE) is one represented approach to individualized instruction. On the other hand, the most common approach that reflects the constructivist epistemology is Problem-Based Learning (PBL), which was originally applied in medical schools in 1970s and was further developed by constructivists in the 1990's.

In this paper, the assumptions underlying behaviorism and constructivism will be briefly outlined in respect to their particular views related to reality, knowledge, the nature of learning and the purpose of instruction. Secondly, IGE and PBL approaches will be discussed as they relate to six key elements of instruction.

Assumptions of Behaviorism

The behaviorist epistemology is grounded in objectivism, which assumes that there is a single reality external to individuals. Based on this objectivist worldview, behaviorists argue that learners "acquire" knowledge from outside resources by engaging in learning activities (Ertmer & Newby, 1993). Ertmer and Newby describe the behaviorist position as one in which knowledge results when a learner "finds" it somewhere outside himself, and therefore, learning must be seen from the behaviorist view as a process of actively setting about to acquire knowledge. In order to help learners acquire knowledge, the behaviorist assumes that teachers will engage in instruction, which from this view is seen as the process of providing knowledge to learners.

Assumptions of Constructivism

Constructivists argue that there are multiple realities constructed by individuals. The human mind does not copy reality from outside directly, rather, it constructs reality (Driscoll, 1994). In other words, there is no shared reality. Constructivists believe that learners actively construct their own knowledge as they try to make sense of their experience (Driscoll, 1994). Knowledge is constructed when an individual creates meaning from his own experience through social negotiation and through his evaluation of the viability of individual understandings (Savery and Duffy, 1996). Constructivists view learning as a construction process that is context dependent. Learners engage in active knowledge construction and interpretation in order to develop understandings of relationships and phenomena in the world (Brooks and Brooks, 1993; Bender, Cunningham, Duffy, and Perry, 1995, Duffy and Cunningham, 1996). In constructivist learning environments, learners should be provided with opportunities to experience cognitive conflict. This is also called "puzzlement," which will help them to develop new schema or understanding through the interpreting process. Duffy and Cunningham (1996) describe learning as "an active process of constructing rather than acquiring knowledge, and instruction as a process of supporting that construction rather than communicating knowledge."

Differences between Behaviorism and Constructivism

Based on the assumptions stated above, one may draw several conclusions about the differences between behaviorist and constructivist epistemologies. Where behaviorism views knowledge as resulting from a finding process, constructivism views knowledge as the natural consequence of a constructive process. Where behaviorism views learning as an active process of acquiring knowledge, constructivism views learning as an active process of

constructing knowledge. Finally, where behaviorism views instruction as the process of providing knowledge, constructivism views instruction as the process of supporting construction of knowledge.

Both behaviorism and constructivism have spawned particular pedagogical approaches. Individually Guided Education was one of the preeminent approaches to grow out of behaviorism, while Problem-Based Learning has been one of the most popular approaches to grow out of the Constructivist movement. Each pedagogical approach has imbedded within it recommendations regarding six core elements of the instructional environment, including 1) learning goals, 2) instructional approaches, 3) teacher's role, 4) students' roles, 5) the role of resources and technology to support learning, and 6) use of evaluation strategies. In this section, IGE and PBL will be compared across these six core elements.

Behaviorist Pedagogy: Individually-Guided Education

In Individually Guided Education (IGE), like other approaches to individualized instruction, teachers diagnose students' entry skills, identify behavioral objectives, and plan a unique and appropriate instructional program to facilitate a student's achievement of the objectives. Team teaching, non-graded classes, and cross-age tutoring are used in the IGE model.

According to Saettler (1990), the IGE system was originally developed by Herbert Klausmeier. The U.S. Office of Education provided funds for large scale implementation of IGE in 1971, and by 1976 there were approximately 3,000 elementary and middle schools using some form of IGE.

Learning Goals

The IGE environment is structured to support three fundamental goals regarding the individual learner: 1) to foster self-determinism, encouraging the individual to take charge of his own destiny, 2) to encourage self-actualization by allowing the individual to act on his own personal needs and desires, and 3) to support self-direction – one should be free from inappropriate mechanisms of control (Romberg, 1985).

The basic assumption of IGE is that the learning of each individual child in these regards must be the focal point of the school (Romberg, 1985). In order to ensure that each individual child learns, it is necessary to provide curricula that are relevant to each student, and to identify behavioral goals for each student so that diagnosis and prescription can be used to measure achievement of goals. In the IGE system, teacher teams ensure that appropriate goals for each student are set, and students are encouraged to achieve these goals, in order to get feedback regarding progress toward goals (Klausmeier, 1975).

Instructional Approaches

Implementation of the IGE system requires that instructional time be spent with teachers and students collectively engaged in a cycle of exploration of individual students' learning styles, motivation levels, and appropriate objectives, engagement in suitable learning activities, and evaluation of the attainment of objectives. In the IGE system, heavy emphasis is placed on allowing variation in instructional approaches, specifically, varying the amount of attention and guidance provided by the teacher, varying the amount of time spent in interaction among students, and varying the amount of time spent by each student in one-to-one interactions with the teacher, independent study, small-group activities, and adult-led large group activities (Klausmeier, 1975).

Teacher Role

In IGE, teachers work as cooperative instructional teams in a multi-unit school organization, in order to plan, implement, and evaluate instructional programs for individual students in the instructional unit (which replaces the traditional age-graded classroom (Jeter, 1981; Romberg, 1985).

Teachers' work involves the organization of learning materials so that students can make effective progress through their learning activities; arrangement of the learning space to allow for students to work alone or together to achieve particular learning goals; keeping efficient records in order to trace each student's individual progress; and helping each student through his unique learning process. Additionally, teachers are responsible for providing resources and removing obstacles so students can learn efficiently (Dell, 1972).

Student Role

The IGE environment is built upon the assumption of individual differences: no two learners achieve at the same rate; achieve using the same study techniques; solve problems in exactly the same way; possess the same repertoire of behaviors; possess the same pattern of interests; are motivated to achieve to the same degree; are motivated to achieve the same goals; are ready to learn at the same time, or have exactly the same capacity to learn (Duane, 1973).

Building on these assumptions, students in IGE programs have some involvement in planning and carrying out their own organized program. In this regard, the student is not a passive learner, but works actively through many

activities such as manipulating learning resources, communicating with peers, and engaging in learning activities (Dell, 1972).

Use of resources

Resources play a critical role in IGE environments because they facilitate the variation of instructional approaches that is critical in order to meet each individual students' learning needs. In the instructional programming model for IGE, Klausmeier specifically states variation of instructional approach may be addressed through the use of resources and technologies including printed materials, audiovisual materials, direct experiencing of phenomena, and the use of space and equipment, (Jeter, 1981).

IGE environments are structured so that media are handled directly by learners and are an integral part of the curriculum. A wide variety of media are provided because they are the tools that address individual differences and various learning styles by providing alternative means of achieving objectives (Duane, 1973).

Strategies for Evaluation

IGE is just one of the many individualized instruction approaches that brought popularity and legitimacy to the concept of criterion-referenced evaluation (as opposed to norm-referenced evaluation). The primary purpose of criterion-referenced evaluation in IGE systems is to ascertain the individual learner's status in relation to stated learning goals and performance objectives, rather than to compare the individual to the group. Types of criterion-referenced measures that may be used in IGE environments range from paper-and-pencil tests, performance tests which require the learner to demonstrate capability on a particular task, work samples that demonstrate a student's mastery of an objective, and formal observation by the teacher when achievement of an objective is best measured in a natural setting (Bechtol, 1973).

Constructivist Pedagogy: Problem-Based Learning

Traditional classroom instruction has been criticized because, in this situation, students are passive learners and fail to transfer what they learned in school to daily life outside of the learning environment. Since students passively receive information from teachers, their motivation of learning and retention of knowledge are low. Based on the constructivist view, the problem-based learning approach was begun in medical schools in the mid-1970s to solve the problems of low learning motivation, knowledge retention, and rate of knowledge transfer. In this section, the PBL approach will be outlined as it relates to six elements of instruction.

Goal of Learning

The PBL approach is intended to help students develop learning skills. In order to learn, students must have metacognitive skills, self-directed learning skills, and thinking- and problem solving skills.

PBL educators are concerned about metacognition because they assume that expert problem solvers monitor and control their thinking process in order to be most effective. Metacognition may be defined as thinking about thinking. It's the "executive function in thinking: pondering, deliberating, or reflecting on the problem or situation; reviewing what is known and remembered about the kind of problem confronted; creating hypotheses, making decisions about what observations, questions or probes need to be made; questioning the meaning of new information obtained from inquiry; reviewing what has been learned, what it all may mean and what needs to be done next, etc." (Barrow, 1988, p3).

PBL is also concerned with fostering students' self-directed learning skills so that they will automatically continue their own learning for the rest of their lives (Barrow, 1988). PBL allows students to determine what and how to learn on their own in order to ensure their lifelong learning skills and the ability to be effective and independent learners.

In a PBL approach, students also learn to identify learning issues, develop strategies, locate information relevant to the issue, and evaluate their solution. This entire learning process helps to develop problem solving and thinking skills (Savery and Duffy, 1996).

Instructional approaches

Constructivists rarely use the term "instructional strategy," rather, they talk about principles of learning that can be applied across content areas. The instructional principles which constructivists consider ideal for facilitating the student's knowledge construction process are apprenticeship, situated cognition and authentic learning, as well as cooperative learning and social negotiation.

In an apprenticeship learning environment learners are faced with a real world situation that allows them to learn from doing. The apprenticeship environments "enculturate students into authentic practices through activities and social interaction" (Brown et al., 1989). Because learning is a construction of meaning in context and is context-dependent, students learn best in an authentic and cooperative learning environment. The goal of cooperative learning is to share alternative viewpoints and to challenge alternative points of view (Duffy and Cunningham,

1996). In social negotiation learning situations, students share their experience with others and expose themselves to multiple perspectives which help them to "judge the quality of their own solutions and to learn perhaps more effective strategies for problem solving" (Driscoll, 1994).

Role of the teacher

The teacher's role in a PBL approach has changed from the traditional information disseminator to an active curriculum designer and learning facilitator (Barrows and Myers, 1993). As a curriculum designer, the teacher selects learning problems to reflect curriculum objectives and real-world issues. As a learning facilitator, he uses instructional strategies such as reflecting, coaching, questioning, and modeling to perturbate student's thinking and help them to see the conflict in their thought, in order to accomplish negotiated meaning and solutions.

The facilitation skills required of the teacher are reflecting, posing problems, questioning, modeling, choosing appropriate strategies and assessing learning (Hawley, Hsu, McCall, and Schuh, 1997). According to Savery and Duffy (1996), the teacher is a facilitator rather than a subject matter expert. He needs to develop student's thinking and reasoning skills and help them to become self-directed learners. During the metacognitive learning process, the facilitator challenges students' level of understanding and relevance of student-generated issues, rather than leading them to the correct answer. Kalishman and Mennin (1993) describe the relationship of student and facilitator as one in which student and tutor work collaboratively together, and where the student demonstrates level of mastery while the tutor provides supportive and corrective guidance specific to the task undertaken.

Role of the student

In a PBL environment, students are active learners. Students work in small groups on a problem presented by the teacher. Students need to internalize and reason through the problem to identify the learning issues and define the objectives. As tasks and work schedule are assigned to each group member, they start to identify resources to gather information related to the learning issues. Each member brings back and reports his findings for the whole group to analyze the data or to shape their learning issues in order to identify the solutions. Once students synthesize and summarize findings into solutions, they need to conduct an assessment to see if all the objectives have been satisfied and to evaluate their performance. Finally, they receive feedback from the teacher/facilitator (Gallagher, 1997; Savery and Duffy, 1996; West, 1992).

Use of resources

Resources play a crucial role in the learning process, because students are responsible for using data in order to solve problems. Having access to multiple resources helps students to shape their learning issues and to more clearly see the problems they face from different perspectives. The problem situation is pre-designed by the teaching team and problem information is distributed to students as needed through the learning process (Stepien, Gallagher, and Workman, 1993). In some cases students are provided with a list of resources from the teacher, while in other situations students need to identify possible resources by their own (West, 1992). PBL requires students to use real-world resources including books and databases, local resources and experts, journals, and internet consultations (Boyce, VanTassel-Baska, Burruss, Sher, & Johnson, 1997). The local resource or experts may be mentors in the surrounding communities who agree to talk with students. Regarding the use of computers, De Corte (1994) describes the role of the computer as a supportive system that allows more student-control and induces effective forms of interaction and cooperation.

Strategies for evaluation

According to Barrow and Tamblyn (1980), evaluation should be an integral part of the learning process so that students will be aware of the learning needs and continuously receive feedback. Their idea corresponds to Duffy and Cunningham's (1996) claim that assessment should be "ongoing, rather than just being an end of the semester rating."

In respect to what should be assessed, Norman (1991) claims that the central role of PBL is the acquisition of problem solving skills. Therefore, it is important to evaluate students' problem solving skills independent of knowledge. Duffy and Cunningham (1996) suggest the use of peer and self-assessment to assess students' skills as problem solver, self-directed learner, and as team member. Norman suggests that essay exams and problem-based oral exams are good tools to assess students' problem-solving and self-directed learning skills. Additionally, Norman suggests that students should be evaluated in the context of problem solving, so that contextual clues to the situation are available.

Comparison of IGE and PBL approaches

Table 1 identifies some similarities, as well as some differences, between the IGE and PBL pedagogical approaches, as they relate to six key elements of the instructional environment. It is important to note that it is not possible to make exact comparisons between IGE and PBL for each of these elements. Despite this, it would seem

appropriate to conclude that, though there is a time span of 20 years between these approaches, they do encourage similar emphases related to learning and instruction. The conclusion section of the paper specifically identifies the commonalities in these two pedagogical approaches.

Table 1: Summary comparison of instructional elements as prescribed by IGE and PBL approaches

	IGE	PBL
<i>Learning Goals</i>	Develop students' capabilities in: <ul style="list-style-type: none"> • Self-determinism • Self-actualization • Self-direction 	Develop students' capabilities in: <ul style="list-style-type: none"> • Metacognition skills • Self-directed learning skills • Thinking skills and problem-solving skills
<i>Instructional Approaches</i>	Instruction as: <ul style="list-style-type: none"> • Cooperative Instructional Teams • Multi-unit school organization • Variations in pace, structure • Cycle of objectives and evaluation 	Instructional principles regarding: <ul style="list-style-type: none"> • Cooperative learning & social negotiation • Apprenticeship • Situated cognition • Authentic learning
<i>Role of the teacher</i>	Teachers facilitate learning through: <ul style="list-style-type: none"> • Meaningful learning activities • Removing obstacles to learning Teaching activities include: <ul style="list-style-type: none"> • Assessment of learning • Exploration • Providing resources • Helping students through unique learning situations 	As a facilitator to: <ul style="list-style-type: none"> • Show student how to construct knowledge • Create an instructional environment where learner's processes of situational sense making are enhanced. Facilitation skills include: <ul style="list-style-type: none"> • Assessing learning • Reflecting • Posing problem • Questioning • Modeling • Choosing appropriate strategies
<i>Role of students</i>	<ul style="list-style-type: none"> ▪ Plan learning program ▪ Organize learning activities ▪ Engage in learning activities ▪ Manipulate resources ▪ Communicate with peers 	<ul style="list-style-type: none"> ▪ Define problem and identify issues ▪ Frame learning objectives ▪ Determine work schedule ▪ Gather and analyze data ▪ Present and discuss learning findings ▪ Synthesize findings into solutions ▪ Justify solution and evaluate performance ▪
<i>Use of Resources</i>	Types of resources include: <ul style="list-style-type: none"> • Print materials • Audiovisual materials • Technological equipment • Direct experience 	Types of resources include: <ul style="list-style-type: none"> • Books and databases • Journals • Computers and Internet • Local resources and experts
<i>Evaluation Strategies</i>	Evaluation should include: <ul style="list-style-type: none"> • Criterion-referenced measures • Observation in natural settings • Work samples 	Evaluation should include: <ul style="list-style-type: none"> • Problem solving skills • Self-directed learning skills • Skills as a group member

Conclusion

It may seem counter-intuitive to report that the very different epistemologies of behaviorism and constructivism lead to some important similarities between IGE and PBL pedagogical approaches. Yet, the conclusion of this study is that, regardless of differences related to historical context and to terminology, there appear to be common pedagogical prescriptions between IGE and PBL as they relate to six core elements of instruction.

With regard to learning goals, both IGE and PBL prescribe that curricula should in some way be relevant to individual learners, that learners should have some reason to buy-in to the learning experience, and finally, that building self-directed learning skills is a crucial outcome of learning.

Regarding instructional approach, IGE and PBL both acknowledge the importance of students' active involvement in the activities of the classroom.

With regard to teacher role, both IGE and PBL emphasize the teacher's role as guide for students, and not as a source of knowledge. The teacher's responsibility is to create an environment where students can do their own learning.

With regard to students' roles, both IGE and PBL emphasize respect of individual differences, and therefore students' right to have a say in their own educational experience.

Regarding resource and technology utilization, IGE and PBL both value the creation of resource-rich environments in order to address individual differences and to foster richer and more complex learning.

Finally, with regard to evaluation strategies, both IGE and PBL approaches appear to be united in the view that norm-referenced evaluation is at best, an inappropriate evaluation strategy.

Perhaps the findings of this study indicate that good pedagogical principles stand above or apart from epistemological differences. It seems, then, that the challenge for all educators, regardless of avowed epistemological views, should be to work toward the creation of educational environments that are based upon sound pedagogy, as modeled by both IGE and PBL approaches.

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WEB-BASED MENUS: FONT SIZE AND LINE SPACING PREFERENCES

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Abstract

An abundance of books, articles, and Web sites are available to support novice designers in the creation of effective Web pages. Unfortunately, a review of these materials reflects an absence of research to support many of these design guidelines. While some of the suggestions offered are based on empirical research, all too often this research was conducted in simulated, print-based environments (Grabinger & Amedeo, 1985). In addition, conclusions are frequently based on investigations of older technologies, such as monochrome and low resolution monitors, that are non-representative of current learning environments (Hannafin & Hooper, 1989).

Increasing emphasis on Web-based delivery systems makes it imperative that research be conducted to establish (or confirm) guidelines that are appropriate for current media and that support end users. While the content of Web delivery is critical to the learning outcomes, visual appeal can be equally important as a factor in learner motivation (Keller & Burkman, 1993). This study is a first attempt to describe user preferences in font size and line spacing of Web-based menus. This study investigated the following two research questions.

- Given a non scrolled menu list, does font size or line spacing affect user preference in a CRT displayed Web menu?
- Given a scrolled menu list, does font size or line spacing affect user preference in a CRT displayed Web menu?

Literature Review

Many principles of Web page design have been transferred directly from previous research in print or television. Grabinger (1989) notes that recommendations concerning typographic screen design elements such as line spacing, line length, leading, size of letters, font characteristics, and case of letters are frequently based on folklore and practice in the visual arts. Citing Lynch, Rimer (1996) points out that current graphic design schemes for CRT displays often “emulate many aspects of the style and organizational conventions of paper documents” (p. 6). In a summary of an analysis of the literature on the use of color in screen design, Misanchuk and Schwier (1995) caution instructional designers against generalizing from research that was (a) conducted on older and/or obsolete equipment, (b) based on results from different display media and transferred to video display terminals, (c) not sufficiently similar to tasks performed during teaching or learning, and (d) did not specify intended use of the screen display. This study was predicated on the assumption that the same advice applies equally well to other screen design considerations such as type, font size, and line spacing for Web pages.

Winn (1993) offers the instructional message designer extensive guidelines which are based on the typography research of Miles Tinker (carried out between 1922 and 1967). Principles of type size recommended by Winn include using 10 point type in 19 pica lines set with two to four point leading for optimal legibility. These suggestions have been taken directly from print-based media for application in computer screen design. While these may turn out to be appropriate guidelines (Hartley, 1987), there is currently little empirical research to support the recommendations.

Chen and colleagues (1996) conducted a review of the literature and determined that most of the research on type size pertains to print and television screen presentation, with very little research on computer screens in general or font size in particular. Their research examined the effects of font size on readability (measured by comprehension) and user preference in a hypertext computer-based instruction (CBI) environment. Results of the study indicated that readers lacked satisfaction with font sizes of 10 and 12 points and clearly preferred text of size 14 and 16 points.

In reviewing the literature for this study, few studies were found concerning differentiation of textual purpose in Web screen design; however, Steinberg (1992) discusses the various functions of menus in computer-based instruction, ultimately noting that “the purpose of a menu is to provide information and to make retrieval as simple and efficient as possible for the intended users” (p. 7), by taking into account user characteristics and the nature of the task(s). Some researchers (Coll, Coll & Nandavar, 1993; Grabinger, 1989) have begun to look to the Gestalt psychologists for guidance in understanding how a learner’s perceptions of screen organization and design

affect his/her preferences and ability to complete learning tasks. Grabinger (1989) points out that it is the examination of combinations of textual elements that will help us develop design guidelines that will positively affect learner cognitive processes. An example of such research is the 1993 study by Coll et al. which found that the physical layout of screen menus, while still an important design consideration, was less crucial to the learning task than the conceptual layout (e.g., categorical or alphabetical).

Welsh, Murphy, Duffy and Goodrum (1994), in an investigation of link display strategy and link density within a hypermedia learning environment, found that users reported increased favorable ratings on ease of use when submenus were incorporated in the page design (in white area[s] outside the body of text) compared to iconic and textual link indicators placed within the text. "This finding may be attributable to the added information provided in each submenu which described the source and tone of each elaboration. Perhaps textual as opposed to iconic cues to elaboration type allow the learner to more easily discern the link destination, thus reducing cognitive effort" (pp. 32-33).

Leader and Klein (1996) investigated the effects of search tools and learner cognitive styles on performance in searches for information within a hypermedia database. Results indicated that field-independent learners performed significantly better than field-dependent learners using an index/find search tool. This finding led to a recommendation that designers of multimedia materials consider learner preferences. They also suggest further study of cognitive style factors in the use of hypermedia as they may relate to the formulation of criteria for interface tool design.

There may be a difference in user preference for font sizes in Web-based environments depending on the specific purpose or placement of the text. It is possible that preferences may differ for a body of text as opposed to menu text on a Web page. This study investigated the combined elements of font size and line spacing in Web menus for both a scrolled and not scrolled condition with a sample of undergraduate university students.

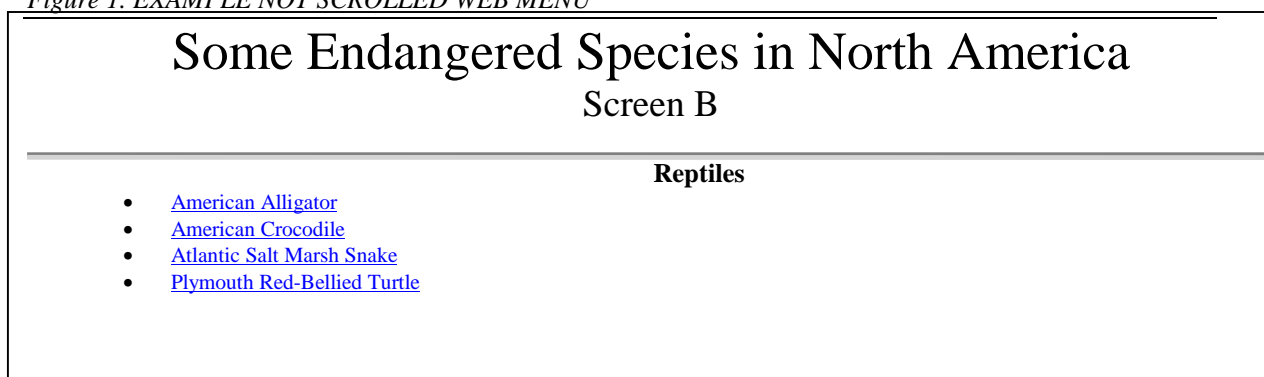
Sample and Methodology

The subjects were 185 university students enrolled in 13 intact sections of ET201, Technology in Education, and ET301, Educational Technology Applications. These are required, undergraduate preservice teacher technology courses at the University of Northern Colorado. Participants included 140 females and 45 males. All but two participants were native English speakers. The average age was 23, with a range from 18 to 51. Sixty percent of the subjects rated their Internet use as at least six hours or more per week; only five subjects responded that they spent no time using the Internet. A large majority of the subjects (82%) reported that they were comfortable using a computer.

Course instructors (graduate students in the Educational Technology program) were asked to volunteer their classes for this study. A total of 13 classes participated. Four different researchers administered the scripted treatment over a consecutive five-day period. Students were asked to rank their preferences of four distinct Web menu screens. The four screens included these combinations: (a) default font, double-spaced, (b) large font, double spaced, (c) default font, single spaced, and (d) large font, single spaced. Large font is defined as HTML "font=5." These screens were adapted for two additional conditions: long menus (scrolled) and short menus (not scrolled). The short menus were designed to be fully viewed on one screen without scrolling.

The content of the menus was selected to represent a fairly typical, but non-controversial, subject found on the Web; lists of endangered species (see Figure 1). Every screen had a title section in large type that said, "Some Endangered Species in North America." Under the title was a screen identification in a slightly smaller font which simply read "Screen A" or "Screen B," etc. A single line separated the title area from the menu itself. The short menu consisted of only four items (e.g., American Alligator, Atlantic Salt Marsh Snake) under the heading, "Reptiles." The longer (scrolled) menus had no headings. They listed a variety of endangered species in no particular order, neither alphabetical nor categorical. The 32 items in the scrolled menus were of varying length, from single words (e.g., Ocelot) to longer names (e.g., Carolina Northern Flying Squirrel). All screen backgrounds were white. The menu items appeared in the default blue color of the browser. All Web page borders were the default (gray) color.

Figure 1. EXAMPLE NOT SCROLLED WEB MENU



Data were collected in a computer laboratory setting that housed twenty 7000 series Power Macintosh computers with monitors set to standard resolution (640 x 480) and fifteen-inch viewing screens.

The ranking task was given to each class during the first 10 minutes of the class session. A script of instructions was read aloud to the subjects; then the ranking sheet and demographic data collection instrument were distributed. Due to concern regarding order of presentation of the menu combinations potentially influencing user ranking, four URLs were created. Each URL contained four screens presenting all combinations of font size and line spacing in either the scrolled or not scrolled condition. Order of screen presentation varied in each URL for both conditions scrolled and not scrolled. Students were randomly assigned a URL by distributing color-coded ranking instruments that designated a specific URL (set of four menu screens) to view. The students were instructed to open Netscape Navigator and enter the URL noted on their ranking sheet. Subjects were given five minutes to view the screens and rank their preferences on the ranking sheet. At the end of five minutes, the researcher collected the sheets and the subjects were thanked for their participation.

Results

Student preferences and frequency data were compiled for first, second, third, and least preferred menu styles for each condition (scrolled and not scrolled). The results reported here are descriptive in nature and reflect the characteristics of the preservice teacher research sample.

The first research question asked whether font size or line spacing would affect user preference in a not scrolled menu list displayed as a Web menu. Of the 80 students who viewed the not scrolled menus, 60% selected the menu with a large font and double line spacing as their favorite, 33% selected a large font with a single spaced menu, only 8% preferred the default font size whether part of a single spaced menu (5%) or a double spaced menu (3%). Second favorites (ranked number two) continued the preference for a large font size with 28% preferring the large font size, double spaced and 56% preferring the large font size, single spaced. Conversely, the least preferred (ranked number four) not scrolled menu display was the single spaced, default font size. Eighty-five percent selected this as their least preferred choice. These results indicate a strong preference for a large font size over the default font size for Web menus. The results of viewer preferences for single or double spacing are less conclusive. Refer to Table 1 for a summary of frequencies and percentages of student rankings of the not scrolled menu options.

The second research question investigated whether font size or line spacing would affect user preference in a scrolled menu list displayed as a Web menu. First choice preferences of the 105 students who viewed the scrolled menus resulted in 50% who selected a menu with a large font and double line spacing; 28% selected a large font with single line spacing; only 12% preferred the default font double spaced and 10% preferred the default font single spaced. For students who ranked the scrolled menus, large font continued to be the most preferred choice regardless of spacing. Forty-four percent of the students selected the large font single spaced as their second favorite menu; 21% selected the large font double spaced; 25% selected default font double spaced; and only 10% selected the default font single spaced. The fourth preference clearly indicated the default font single spaced menu was the least favorite with 64% ranking this choice as their least favorite. Although the overall preferences identified for scrolled menus reflected the same patterns of choice found in the not scrolled menus, the preferences were less pronounced than for the not scrolled menus. Refer to Table 2 for a summary of frequencies and percentages of the student rankings for the scrolled menu options.

*Table 1**FREQUENCIES AND PERCENTS OF PREFERENCES IN FONT SIZE AND LINE SPACING IN A NON SCROLLED CRT DISPLAYED WEB MENU*

	Most Favorite		Second Favorite		Third Favorite		Fourth Favorite	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Default Font Double Spaced	4	5%	12	15%	56	70%	8	10%
Large Font Double Spaced	48	60%	22	28%	7	9%	3	4%
Default Font Single Spaced	2	3%	1	1%	9	11%	68	85%
Large Font Single Spaced	26	33%	45	56%	8	10%	1	1%
Totals	80	101%*	80	100%	80	100%	80	100%

*Rounding error

*Table 2**FREQUENCIES AND PERCENTS OF PREFERENCES IN FONT SIZE AND LINE SPACING IN A SCROLLED CRT DISPLAYED WEB MENU*

	Most Favorite		Second Favorite		Third Favorite		Fourth Favorite	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Default Font Double Spaced	13	12%	26	25%	56	53%	10	10%
Large Font Double Spaced	52	50%	22	21%	14	13%	17	16%
Default Font Single Spaced	11	10%	11	10%	16	15%	67	64%
Large Font Single Spaced	29	28%	46	44%	19	18%	11	10%
Totals	105	100%	105	100%	105	99%*	105	100%

*Due to rounding

Discussion

This study investigated font size and line spacing for Web menus. Results clearly indicate that users prefer large fonts whether presented in a scrolled or not scrolled Web menu. Double line spacing was preferred over single line spacing in both scrolled and not scrolled treatments. The combination of default font and single line spacing was overwhelmingly ranked as least preferred in both the scrolled and not scrolled conditions.

A limitation of this study is its generalizability to alternative settings. The subjects of this study were a homogenous group of undergraduate students with the shared computer experience of educational technology classes. Replication of this study with subjects outside of the university environment is recommended.

Additionally, the reader is cautioned to note that these data reflect user preferences and may or may not affect the users' ability to learn from Web-based environments or increase their Web searching efficiency. Additional research is recommended to investigate the variables of font size and line spacing in Web environments designed for instructional purposes.

Another aspect of this study that deserves further exploration is the potential connection between user preference and user motivation. Keller and Burkman (1993) state, "The rapidity of change in both technical knowledge and cultural perspectives leads to increasing demand for ongoing education. The motivation to learn impacts on both the effectiveness and the efficiency of instruction" (p. 49). With the increasing emphasis on Web-based systems to deliver that instruction, it is imperative that instructional designers and Web developers understand the relationships between preferences, motivation, and learning. This study provides a foundation for further exploration of these relationships.

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CBT DESIGN: A FEEDBACK APTITUDE TREATMENT INTERACTION

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Abstract

A review by Clariana (1993) reported an aptitude-treatment interaction (ATI) relating instructional feedback and prior knowledge. For low prior knowledge learners, single-try feedback (STF) was slightly superior to multiple-try feedback (MTF), while for high prior knowledge learners, MTF was superior to STF. In this present report, raw score data from existing studies that examined STF and MTF, but that had not considered the possibility of an ATI were combined and reanalyzed by ANOVA. The results of this analysis are presented along with a tentative explanation of the observed effect. Prescriptive application of the ATI and suggestions for future study are provided.

Relevance

Frequently in corporate settings and occasionally in general education settings, mastery of lower level skills are often critical to safety or performance. For example, consider the multitude of alarm sounds that can occur in a nuclear power plant and the correct employee reactions to these alarms. This message includes verbal information, lower level intellectual skills, and possibly some attitudinal objectives, and it would be hard to dispute that this particular message is not important to the employees safety and also their feelings of well-being. In this case, computer-based training (CBT) can accurately produce the correct sounds and can require the employee to describe the nature of the emergency and the correct responses to each category of emergency (believe it or not, it's not always run away as fast as you can). This type of CBT module would be easy and relatively inexpensive to develop and deliver (especially compared to instructor led training), and allows for new employee training just-in-time and refresher training for existing employees as needed due to the infrequency of such alarms. Decades of educational research support the use of practice with feedback for learning this type of information. This presentation argues that learners' prior knowledge should be considered when deciding which type of feedback to use in the lesson design. This information has immediate practical application for CBT designers.

Note that this is not new data, but is a reanalysis of four previous experimental studies and an expansion of an earlier review by Clariana (1993). Richey (1998) has described these two processes as an accepted form of replicability, though caution must be taken that this present report is not seen as new data. This reanalysis and expansion seem acceptable because of the limited circulation of that earlier review due to the demise of the Journal of Computer-based Instruction at that time and the lack of information regarding this possible ATI when the four experimental studies were originally conducted. Further, the audience for this presentation are the most potent group for utilizing this information.

Introduction

Advances in voice recognition technology will soon allow relatively accurate evaluation of spoken words, and neural network software technology may eventually allow evaluation of sentences and paragraphs. However, currently computers are limited in the types of learner responses that can be evaluated in order to give corrective feedback. Computers can evaluate learner recognition tasks like clicking on an image or a word, and some free recall tasks, such as typing in words and short phrases.

Feedback in these circumstances has consistently been shown to be better than no feedback (for example, see Clariana, Ross, & Morrison, 1991). But is one type of feedback superior to another? A meta-analysis by Bangert-Drowns, Kulik, Kulik, and Morgan (1991) reported effect sizes (ES) that compared no feedback to (a) right/wrong feedback, usually referred to as knowledge of response feedback (KR), (b) knowledge of correct response feedback (KCR), (c) try-again feedback (requires multiple tries), and (d) elaborative feedback. Compared to no feedback, KR was negatively effective (ES = -0.08), followed next by KCR feedback, ES = 0.22. Repeat until correct and elaborative feedback were equally most effective (ES = 0.53). The performance results for feedback may be summarized as: KR < no feedback < KCR < Repeat until correct = Elaborative. Prescriptively, elaborative feedback and multiple-try feedback were equally most effective, however elaborative feedback typically is more difficult and costly to design.

A review of 30 studies by Clariana (1993) took this a step further by comparing forms of multiple-try feedback (MTF) to no feedback, KR feedback, KCR feedback, and delayed feedback. The median effect size for MTF compared to no feedback based on 16 effect size measures from 12 studies was ES = 0.56. This finding is nearly identical to the results of Bangert-Drowns et. al. (1991) above. However, unlike that meta-analysis, the

results for MTF compared to KR, KCR, and delayed feedback were all mixed, with median effect sizes close to no difference.

To explain these mixed findings, Clariana (1993) suggested that low-prior knowledge learners benefited slightly from single-try feedback forms relative to multiple-try feedback forms, while high-prior knowledge learners benefited greatly from multiple-try feedback forms relative to single-try feedback forms. If supported, this provides CBT designers with clear guidelines for selecting number of feedback tries based on audience analysis data and/or ongoing lesson performance.

The current presentation considers this feedback by prior knowledge aptitude treatment interaction (ATI) by combining and reanalyzing data from the existing studies described in Clariana (1993). This study addresses the following questions: (a) Is there an interaction between learner prior knowledge and number of feedback tries provided by CBT lessons? (b) If so, how large is this effect?

Approach

A review of the literature was conducted to identify all available studies that compared MTF and STF while also providing raw score data. It was necessary that besides posttest measures, the data set must also contain some measure of prior knowledge of the content, so that individual subjects could be classified as "low" or "high" in terms of prior knowledge. In all cases, lesson data ultimately was used to form low and high prior knowledge groupings based on median split of lesson scores.

- Three dissertations and one published report were obtained that met these criteria. All four utilized computer-based delivery of the instructional materials. The studies included: Noonan (1984) $n = 60$, Clariana and Smith (1989) $n = 48$, Nielson (1990) $n = 173$, and Clariana (1990) $n = 40$.
- Posttest raw scores were converted to standard scores within each study, then these standard scores were combined into one data set and analyzed by 2x2x4 analysis of variance (ANOVA) with the factors feedback (MTF and STF), prior knowledge (low and high), and study (the four studies listed above). The final sample contained $n = 321$ subjects.

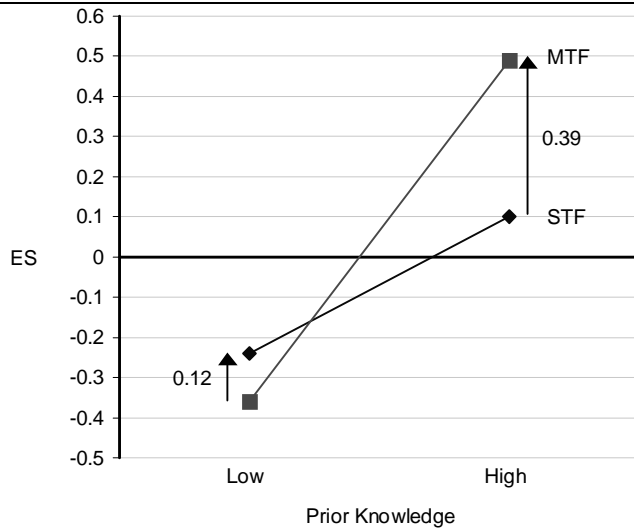
The main effect for number of feedback was not significant (see Table 1). The main effect for prior knowledge was highly significant $F(1, 305) = 24.21, p = .0001$. As would be expected, those students that performed well on the CBT lesson also performed better on the posttest. This finding is interesting in that in experimental studies using grouping by lesson performance, there is typically a regression to the mean. The "low" group tends to gain quite a bit since their lesson scores are low, while the "high" group gains less and may even decline. If the experimental treatment is not strong enough, this regression to the mean causes a leveling effect that can wash-out low and high group differences.

Table 1. Posttest scores Analysis of Variance

<u>Source</u>	<u>df</u>	<u>SS</u>	<u>MS</u>	<u>F</u>	<u>p</u>
Feedback tries (T)	1	0.14	0.14	0.16	0.69
Prior knowledge (K)	1	22.02	22.02	24.21	0.00 *
F x T	1	5.05	5.05	5.55	0.02 *
Study (S)	3	0.06	0.02	0.02	0.99
T x S	3	2.15	0.72	0.79	0.50
K x S	3	0.45	0.15	0.16	0.92
T x K x S	3	1.96	0.65	0.72	0.54
Error	305	277.34	0.91		

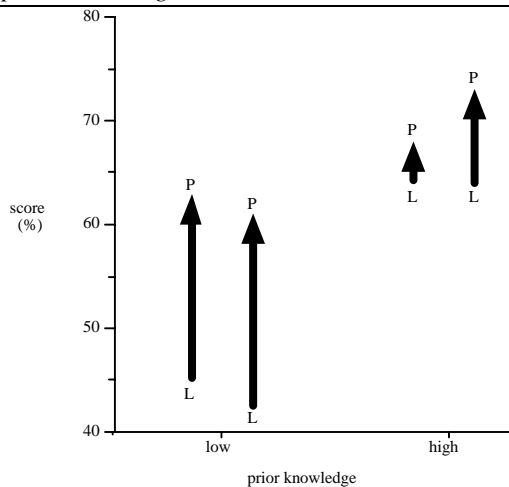
A significant interaction of feedback and prior knowledge was observed $F(1, 305) = 5.55, p = .02$. For low prior knowledge students, single-try feedback was more effective than multiple-try feedback, $ES = 0.11$ (see Figure 1). For high prior knowledge learners, multiple-try feedback was better, $ES = 0.39$.

Figure 1. Interaction of prior-knowledge and type of feedback.



The low-prior knowledge students made large lesson (L) to posttest (P) gains with both single-try and multiple-try feedback (see Figure 2). The high-prior knowledge students, since they had already scored high on the lesson measure of content knowledge, did not make gains as great as the low-prior knowledge students. In addition, the high prior-knowledge students receiving multiple-try feedback (the right vector of the “high” pair of vectors) made larger gains on the posttest relative to the high-prior students receiving single-try feedback (the left vector of the “high” pair of vectors) even though both groups already had good content knowledge.

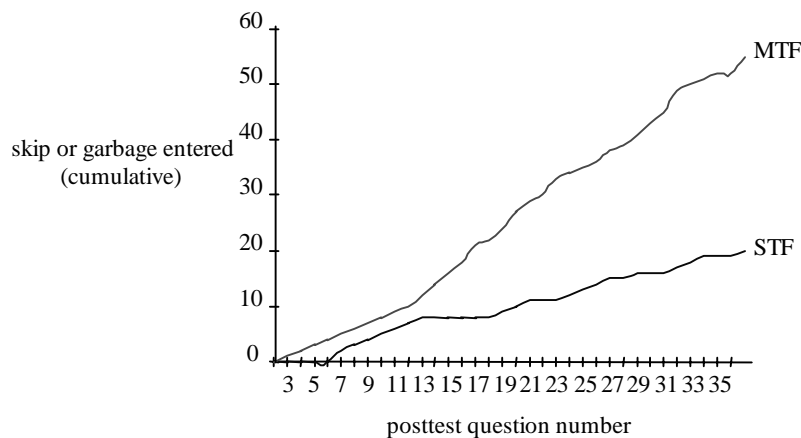
Figure 2. Lesson score (L) to Posttest (P) gains as vectors for single-try (left) and multiple-try (right) at low and high prior-knowledge levels.



Discussion

To summarize, this reanalysis supports an ATI for prior knowledge and number of feedback tries. Our *tentative explanation* of this effect involves an attitudinal impact on learning. Note that for these four studies, and for most if not all MTF studies so far, there is no difference in presentation form between STF and MTF when the learner's response is correct. The difference in presentation form between STF and MTF occurs only with lesson errors, in that the learner must respond again with MTF but is usually provided the correct answer without additional responses with STF. Dick and Latta (1970) reported that low ability students became frustrated with repeat until correct (MTF) recall lessons relative to high able students and also the STF treatment. To examine possible frustration with MTF, we recently collected item-by-item posttest responses for twenty of our students who were taking a computer-based module as an assignment in an instructional design class. In that module, it was possible to intentionally skip posttest questions (recall level) by entering either nothing or else entering nonsense letters (“garbage”) and pressing Enter. Figure 3 below shows the total number of intentionally skipped posttest items for the STF group (n=10) and MTF group (n=10). Note that the posttest was identical for each treatment, thus the pattern observed relates to attitude carried over from the preceding lesson activity.

Figure 3. Cumulative posttest “skip” or “garbage” responses.



This data leads us to feel that, as in the Dick and Latta (1970) study, students may experience some frustration with MTF, and this will likely negatively impact learning.

At the same time, in a survey of the same class, 71% of the students said that they would prefer to try-again (MTF) if given the choice. Some specific comments included: "I learn more when I get it on my own" and "Trying a second time makes me think more about the question and what it is really asking". This suggests that these learners and maybe learners in general have a bias towards "getting it right on their own", and so if they don't miss so many items that it becomes punishing, then they actively engage the items and learn more (relative), thus accounting for the higher performance for MTF with high prior knowledge learners. But if the learner misses a number of items, they begin to become frustrated and may eventually stop trying to learn, thus the lower performance for MTF (relative) for the low prior knowledge learners. Providing the correct answer after one try (STF) tends to reduce frustration for the students who miss a lot of items, but it seems to come at the cost of reduced engagement for the students who are doing well. Thus, the type of feedback given can influence the learners approach to the lesson, and on-going lesson performance serves as advisement allowing the student to decide to engage in or disengage from the lesson.

Requiring high-prior knowledge learners to try again in CBT has intuitive appeal, and can be implemented by tracking lesson performance and basing feedback prescription of STF or MTF on that performance. A lesson may start out with MTF, if a students on-going lesson performance drops below some designated value, say 80%, then the lesson changes to STF.

Does this finding generalize to other, and non-CBT settings? For example, in a constructivist-based classroom, what are the ramifications of asking questions to high-prior knowledge students versus the low-prior knowledge students. Asking a difficult question and requiring a student to develop the answer parallels the MTF condition with low prior knowledge students. This approach may be frustrating to the student, and could result in disengagement and reduced learning. Of course, teachers in class have additional options to mitigate frustration, but the question remains about what is the best approach in terms of questioning level and which students should be asked to respond. If this ATI holds for classroom instruction, in-class questions should be carefully crafted and targeted to the individual student, along the lines of Vygotsky's zone of proximal development (Vygotsky, 1986), and maybe asking some "easy" questions is a good idea.

Though this ATI is only supported by four experimental studies, there is enough evidence to warrant future studies to confirm or deny it, and possibly to expand on these findings to other settings. Though it is not currently fashionable to investigate "lower level" domains such as verbal learning using simple (or not so simple) recognition tasks like answering multiple-choice tests, nevertheless, these domains are an important and foundational to learning; and multiple-choice items, especially with feedback, are one tool among many that any instruction designer may use.

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INSTRUCTIONAL PRINCIPLES FOR SELF REGULATION

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Abstract

While there have been studies investigating the effect of instructional interventions, few systematic principles have been identified for providing support for learners who are poor self regulators. We analyzed the growing body of research on self regulation and the distinctive self regulation differences between higher and lower achieving adult learners to identify four instructional principles to infuse compensatory support for weak self regulation. A rationale based on research supports each principle and instructional application examples are included.

Introduction

A plethora of research describes how learner individual differences influence the effectiveness of instruction although only recently have instructional designers proposed seminal instructional guidelines for addressing learner differences to improve learning outcomes (Jonassen & Grabowski, 1993). Even more recently instructional designers began investigating the role of self regulation (SR), an important individual difference, in instruction (Young, 1996). Self-regulation determines how students personally activate, alter, and sustain their learning (Zimmerman & Martinez-Pons, 1986). Students are self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process (Zimmerman & Martinez-Pons, 1986). Students who engage in self-regulation take responsibility for and initiate their own efforts to acquire skill and knowledge instead of depending upon external sources (Zimmerman & Martinez-Pons, 1988). Students who self regulate learning have accessed metacognitive strategies, were more aware of their limitations, and have taken steps to correct deficiencies (Zimmerman & Martinez-Pons, 1995). Self regulated learners continually plan, organize, monitor, and evaluate their learning processes (Corno, 1989; Hagen & Weinstein, 1995; Zimmerman & Paulsen, 1995).

SR has been consistently related to achievement in learners across age groups. Ninety-three percent of 80 high school participants were correctly classified into preassigned high/low achievement tracks based on strategy use indicators (Zimmerman & Martinez-Pons, 1986). In a subsequent study with participants from fifth, eighth, and eleventh grades, students who were classified as gifted reported significantly greater use of self-regulated learning strategies than did students classified as regular achieving (Zimmerman & Martinez-Pons, 1990). Six SR strategies correlated positively with college statistics student's exam scores: self evaluation, seeking information, rehearsal and memorization, reviewing texts, and reviewing tests (Lan, 1998).

Fortunately, SR is not inherent but is a learned response that can be taught and controlled by the student (Iran-Nejad, 1990). Furthermore, even though a student is already exhibiting self-regulation, these processes can be enhanced to better support learning, motivation, and performance (Pintrich, 1995). Preservice teachers enrolled in education courses have benefited from instruction that supported self-regulated learning strategies such as cognitive skill instruction, effort reinforcement, and metacognitive skill use (Schutz, Lanehart, & White, 1995). Metacognitive strategy instruction when embedded in content instruction has improved student achievement (Nist, Simpson, Olejnik, & Mealey, 1991). Structuring regulatory strategies within instruction has improved achievement in college statistics students (Lan, 1998). The evidence from intervention studies on one or more of the SR processes suggests that instruction that supports regulation improves learning outcomes.

Better learners probably employ some of the strategies associated with SR to compensate for cognitive deficiencies (Di Vesta & Moreno, 1993). Given that SR activities may be increased through instruction, poor SR is a set of learner activities for which instruction may be able to compensate. Compensating regulatory instruction may moderate the negative impact of poor SR on achievement. For learners who are less self regulated, the instructional environment may compensate for poor SR skills with external regulatory instructional interventions. Instruction that includes lower achieving learners in the target population may be able to improve learning outcomes if the design promotes compensatory SR strategies.

While there have been studies investigating the effect of SR instructional interventions (Hattie, Biggs, & Purdie, 1996; Lan, 1998; Young, 1996), and SR models for instruction (Schunk & Zimmerman, 1998) and cognitive models of SR based upon the expert, highly self regulating learner (c.f., Winne, 1995), few systematic principles have been identified for providing support for poor self regulators based upon their SR weaknesses. Some SR interventions have been content specific, such as writing (Graham, Harris, & Troia, 1998), reading comprehension (Pressley, El-Dinary, Wharton-McDonald, & Brown, 1998), or mathematics (Schunk, 1998). Others have included

effective college learning to learn courses (Hofer, Yu, & Pintrich, 1998) or have described “computer supported tools” to guide learner SR (Winne & Stockley, 1998, p.133). Other approaches are directed toward specific populations such as adolescents (Belfiore & Hornyak, 1998), learning disabled (Butler, 1998), and children (Biemiller, Shany, Inglis, & Michenbaum, 1998; c.f., Corno, 1995). Some SR instructional models have approached the problem from the teacher’s but not the designer’s perspective (c.f., Schunk & Zimmerman, 1998); in fact, “most existing applied research on SRL has identified ways teachers can improve or promote SRL (Corno, 1995, p. 201).”

Few SR principles or models have been based upon empirically supported SR needs, that is, discrepant SR activities associated with achievement. Evidence suggests that the closer the match between learner SR needs and the instructional environment, the more positive the learning results (Young, 1996; Ertmer, Newby, & MacDougall, 1996). A meta-analysis with study participants across K-16 indicated that learning has resulted from learning skill interventions although improved outcomes were less likely when the intervention targeted a selected deficit rather than multiple deficits (Hattie, Biggs, & Purdie, 1996). Furthermore, because SR may be a developmental process which takes years and aging and even then may not transfer well (Pressley, 1995), the more that instruction can prompt or foment regulation, the more the poorly self regulated learner may learn. Instruction that follows principles for SR may bridge the gap between unacceptable and sufficient learning outcomes. Indeed design principles may be indispensable to instructional environments for the learner without SR expertise.

Instructional principles that guide the coordination between learner needs and the instructional environment might result in more effective instruction although the instructional design literature lacks general instructional design principles to facilitate the match between SR needs and instruction. We propose four instructional design principles, independent of content or a delivery media, to address discrepant SR activities associated with achievement. We have drawn upon two bodies of literature to derive the four SR principles. The first source is the a large body of research encompassing SR and the many individual factors that affect or comprise SR, e.g., achievement levels, metacognition, academic time management. The second source, research on SR characteristics associated with achievement, included three empirical studies: the first validated an SR interview measure that classified learners as higher or lower achieving (Zimmerman & Martinez-Pons, 1995); the second classified adult learners into normal and lower achieving with the same SR interview measure (Ley & Young, 1998); and a third analyzed SR differences between adult learners who used a SR instructional protocol and those who did not (Lan, 1998). We first analyzed research on learner behaviors associated with SR. We then analyzed the significant SR differences between higher and lower achieving learners. Finally we generated principles derived from the research on SR influences to address the significant SR differences associated with achievement.

Salient SR Activities

Two studies (Lan, 1998; Ley & Young, 1998) have classified discrepant SR activities among college learners according to categories and measures developed through the research of Zimmerman and Martinez-Pons (1986) (See Table 1). Each study measures SR in the same categories although one was a Likert scale and one was an interview. Since SR data collected with Likert scales lack validity that interview measures overcome with lower achieving adults the interview was used to collect data (Ley & Young, 1998; Young & Ley, 1997). Based upon structured interviews, five categories of strategy use were significantly different between normal and lower achieving adults (Ley & Young, 1998). The five categories were, in order from the strongest relationship, self evaluation, environmental structuring, organizing and transforming, reviewing tests, and keeping records and monitoring.

Three of the SR strategies that differentiated between normal and lower achieving adults (Ley & Young, 1998) were also significantly different between adult learners who did and did not use an instructional self monitoring protocol (Lan, 1996): environmental structuring, reviewing tests, and self evaluation. The significant SR differences between learners who were required to use an instructional self monitoring protocol and those who did not, in order from the strongest relationship, were environmental structuring, reviewing tests, self evaluation, and rehearsing and memorizing. Using the self monitoring protocol was also associated with significantly higher exam scores. In both studies, seeking assistance with peers significantly differed but the relationship was negative; peer assistance seekers were more likely to be either the lower achieving learners (Ley & Young) or not to have used the self monitoring protocol (Lan).

Table 1. Self Regulation Categories (from Zimmerman & Pons, 1986)

1. Self evaluation (1,3)- student initiated evaluations on the quality of completed work.
2. Organizing and transforming (3,0)- overt or covert rearrangement of instructional materials to improve learning, e. g., outlining before writing a paper
3. Goal-setting and planning – student-identified desirable educational outcomes or subgoals and planning for sequencing, timing, and completing activities related to goals
4. Seeking information – student-initiated efforts to secure further task information from nonsocial sources when undertaking an assignment, e. g., searching the internet
5. Keeping records & monitoring (5, 0)- student-initiated efforts to record events or results.
6. Environmental structuring (2, 1) – student-initiated efforts to select or arrange the physical setting to make learning easier
7. Self consequences – student arrangement of rewards or punishment for success or failure
8. Rehearsing & memorization (0, 4) – student-initiated efforts to memorize material to overt or covert practice
9. Seeking assistance from experts/teachers – student-initiated efforts to solicit help from experts or faculty
10. Seeking assistance from peers¹ – student-initiated efforts to solicit help from other learners.
11. Reviewing tests (4, 2) – student-initiated efforts to reread tests to prepare for class or further testing
12. Reviewing notes – student-initiated efforts to reread notes to prepare for class or further testing
13. Reviewing texts – student-initiated efforts to reread textbooks to prepare for class or further testing

Note. The first and second number in parentheses represent the rank by strength of significant relationships, respectively, between lower and normal achieving adults (Ley & Young, 1998) and adult users and nonusers of a self monitoring instructional protocol the (Lan, 1996).

¹ This was the only significant negative relationship between lower and normal achieving adults (Ley & Young, 1998) and adult users and nonusers of a self monitoring instructional protocol (Lan, 1996)

Compensatory SR Principles

We propose four instructional design principles to infuse compensatory instructional support for adult SR deficiencies. Instruction that accounts for SR may be essential for effective instruction with low achieving, under prepared, or ineffective learners. Both more and less self regulated learners should benefit from the regulatory support the principles prescribe by embedding SR strategies in instruction to compensate for SR deficiencies. For the less self regulated learner, the instruction would embed information and activities to compensate for SR weaknesses; the same information and activities should further encourage SR among more skillful learners.

More self regulating adult learners may benefit from a reduction of the cognitive load SR imposes thereby allowing the learner to spend less effort on SR activities. Many adult students often have job and family responsibilities that compete with educational commitments for their time and energy; course-embedded SR guidance gives the learner SR tools and strategies that he or she may otherwise have to take time to construct or identify. Learner may spend time deploying the SR strategies instead of creating them.

We present four principles, each with a rationale, and one for each of four broad categories of SR activities: preparing, organizing, monitoring, and evaluating. The definitions for each of the processes were adapted from the work of Zimmerman and Martinez-Pons (1986) (See Table 1). The instructional principles are adaptable across media so that, for example, an instructor, CAI, or web site could be the instructional media for providing compensatory SR activities.

Principle 1: Prepare

The instruction should encourage and guide learners to prepare appropriate learning environments.

Rationale

Environmental structuring, that is selecting and arranging the physical setting to make learning easier, has been strongly associated with SR. Arranging the physical setting was the second strongest predictor achievement levels between normal achieving and lower achieving, under prepared college students (Ley & Young, 1998); it was the strongest difference between college students who used an instructional self monitoring protocol and those who did not (Lan, 1996). The learners who recorded their study behaviors with the protocol reported significantly greater environmental structuring and earned significantly higher exam scores than those who recorded instructor behaviors or did no recording. Structuring the environment includes the learner's ability to cope effectively with disturbances, a crucial part of self regulation and volition (Corno, 1994).

Preparing Strategies

Include as part of the instruction techniques and exercises for establishing a study area that is quiet, comfortable, without distractions; encourage learners to analyze how and when to effectively control distractions (c. f., Corno, 1994). Suggest that students find a quiet place to work and eliminate distractions such as phone calls and noise. Suggestions to eliminate explicitly identified distractions could be included with a first assignment. For example, in a distance course, students who do poorly on the first assignment could receive counseling on structuring their study environment (c. f., Corno).

Instruction should require students to establish a study environment with the characteristics that facilitate concentration and attention. For example, the instruction could include a checklist that would require students to confirm they have established an appropriate study environment that is free from distractions such as television and noise. Instruction could require learners to record the amount of time spent studying in this environment and submit the record as a learning requirement. This strategy encourages the student to reflect upon how prepared he or she is to study and encourages the learner to prepare the environment in which he or she will be able to study most effectively.

Principle 2: Organize

The instruction should include different arrangements of the learning materials that will facilitate learning and the learner's cognitive and metacognitive strategy use.

Rationale

Organizing and transforming activities were the third strongest predictor of achievement level between normal and lower achieving college students (Ley & Young, 1998). Matching appropriate strategies to outcomes has improved learning outcomes (McKeague & Di Vesta, 1996). Learners have benefited from meaningful and directed practice (Karabenick & Knapp, 1990) and from using cognitive and metacognitive strategies (Brozo, Stahl, & King, 1996; Davis, 1994; Frazier, 1993; Nist & Simpson, 1990). Learners tend to use study strategies because they are familiar not because they are effective (Garner, 1990) therefore the instruction can extend the range of strategies by structuring how to learn the targeted skill or concepts. Because to some extent SR is a content dependent activity (Alexander, 1995), including proven content specific learning approaches should strengthen the instruction by presenting effective ways to learn a particular domain.

Organizing strategies

The instruction might suggest or require the learner to use a specified order and approach for learning concepts and skills taught in a module. Study techniques for learning particular skills, such as mathematics or reading comprehension, may be included with examples or demonstrations of cognitive and metacognitive strategies (c. f., Hofer, Yu, & Pintrich, 1998). The instruction could include content outlines or advance organizers that will structure the learning sequence and identify concepts for individual modules and, with less detail, for a course. Unit glossaries or graphic organizers could define and present relationships among concepts and skills presented in the instruction.

Principle 3: Monitor

Prompt the learner to record how and when he or she engages in learning and the results of the effort.

Rationale

"Self monitoring is an important component of self regulated learning . . . and faculty can help students learn how to self monitor" (Zimmerman & Paulsen, 1995, p. 13). Self regulators use external and internal feedback to monitor how well they are meeting learning goals, how effective their learning strategies and tactics are, and the quality of their learning outcomes (Butler & Winne, 1995). Feedback "is inherent in and a prime determiner of processes that constitute SR learning" (Butler & Winne, p. 245). Learners who exercise metacognition are aware of their own learning processes, the results of the processes, and can adjust their behavior or thinking to improve or correct deficient learning processes (Gagne & Glaser, 1987). They monitor their progress by using metacognitive strategies to adjust cognitive strategies that compensate for progress or difficulties (Garner, 1990; Pressley, Woloshyn, Lysynchuk, Martin, Wood, & Willoughby, 1990; Ridley, Schutz, Glanz, & Weinstein, 1992). Learners who recorded their learning activities on a self monitoring protocol scored higher on examinations than did learners who recorded teacher activities or did not record either (Lan, 1996).

Monitoring strategies

Instruction may include a form for monitoring learning activities and require the learner to log her time spent on learning activities such as taking notes in class, reading the text, attending a lecture, working homework problems, etc. (c. f., Lan, 1998). The instruction may require the learner to submit his progress tracking as part of the instructional process. The instruction should present explicit interim process and product assignments that are the occasion for feedback and that lead the student to the desired learning goals.

The instructional process should offer the learner frequent feedback on interim process and product assignments that includes whether his or her response is correct or not, why it is incorrect, and how to correct the response. The instruction should allow for the external feedback on interim process and products that the student submits on the way to the terminal learning outcome. For example, if the learning goal is to write a technical report,

the instruction may require the learner to submit and receive feedback first on the quality of the learner's proposed information sources, then an outline of the report, followed by feedback on a draft of the report, graphics that support the report, etc. In other words the instruction incorporates learner performances and learner feedback on many, if not most, of the component activities in the order in which they are accomplished to produce the desired learning goal.

Instruction might deliver to learners frequent printed progress reports that compare what they have learned or accomplished to date to what future assignments will be required to meet the instructional goal. Feedback should indicate progress toward learning goals, that is, mastery and what the learner should know or be able to do, and not toward performance goals, that is, scores, grades, relative standing since a wealth of research indicates the former are associated with higher achievement and the latter are counterproductive (Hagen & Weinstein, 1995). Therefore Feedback which includes scores should reflect degree of mastery not relative standing in a group of learners.

Principle 4: Evaluate

Instruction should enable learners to determine how well they have learned. Self evaluation occurs when the student reflects upon the quality of his or her completed work to prepare for further learning or performance evaluations. Similar to monitoring, self evaluation entails learner comparisons between what he or she has accomplished to a standard or goal.

Rationale

Self evaluation processes have been significantly weaker in low achieving high school students (Zimmerman & Pons, 1990) and college students (Lan, 1996; Ley & Young, 1998) when compared to their higher achieving counterparts. Furthermore, higher achieving students review previous tests significantly more than do lower achieving college students (Lan, 1996; Ley & Young, 1998). For instructional purposes, reviewing tests serves the same function as self evaluation because both induce the student to reflect upon instances in which the quality of his or her learning fell short of the quality required. College statistics students who recorded their study behaviors reported reviewing previous tests significantly more often than did those who recorded instructor behaviors or did not recording (Lan, 1998). Less regulated learners do not attend to their own course progress with the same diligence as the more self regulated learners.

Evaluating strategies

Instruction should require learners to submit and receive feedback on interim learning processes and products. For example, computer based instruction which tests a learner frequently and provides the learner with explicit feedback on what he or she is and is not learning supports self evaluation and compels the learner to review of test materials. Computer based instruction that prompts students to use learning processes encourages self regulation (c. f., Winne & Stockley, 1998). Instructors who initiate frequent graded or ungraded tests followed by their in-class review of the test with corrective feedback would assure learner self evaluation and test review. To further compel students to review their work, instruction might require learners to suggest how they might improve the quality of a product based on external feedback provided through the instruction or the instructor. Another technique especially adaptable to distance learners would be to use the same performance criteria as the learner's quality control checklist during assignment preparation and as an evaluation checklist during feedback as part of a multi-step process: (a) provide the learner with a set of measurable criteria for a product or process in the format of a checklist, (b) instruct the learner how to use the criteria as a quality control checklist when preparing the activity or completing the product, and (c) provide the learner with feedback on the quality of the learner's completed process or product using the same criteria checklist (Ley, draft).

Conclusion

Several distinct activities and cognitive processes comprise self regulation and a select few of them differ between higher and lower achieving adult learners. Low achieving learners will do far better when their choices instructional choices are limited by high structure (Kulik & Kulik, 1991). Lower achieving learners are more likely to be poor self regulators and to benefit from the high structure inherent to the SR principles. The SR principles guide the design process so that the learner is not left to choose his or her learning environment. Although SR is to some extent context dependent, instructional designers should consider using a framework of general principles that have been developed to address the distinct SR deficiencies associated with achievement levels among adult learners.

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A SYSTEMS APPROACH TO ADOPTING NEW TECHNOLOGIES IN EDUCATION

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Abstract

Many educational institutions face a variety of pressures to adopt emerging technologies in their every-day endeavors. If emerging technologies are adopted without adequately considering the systems in which they are to be used, the results can be less than desired. This paper describes one College's efforts to effectively adopt emerging technologies on a general basis. The various systems which come into play in this context are discussed, along with a theoretical model examining faculty needs when adopting emerging technologies in education. Educational institutions must support faculty on many fronts for successful adoption of emerging technologies.

Educational institutions face many difficulties in dealing with the adoption of new technologies in their educational endeavors. In an era in which political pressures include having the same proportion of computers on desktops in the U.S. as in Japan, or providing every school child with access to the internet, educators are constantly forced to adopt new technologies, if for no other reason than to "keep up." In the rush to adopt and change, it is easy to lose track of basic considerations, such as how the changes will affect learning, if at all, or how new technologies will be supported. This paper will examine the on-going efforts of one college to address the multi-faceted problems of adopting new technologies in an educational endeavor, and will do so in the context of general systems theory, theories of innovation, and our own hierarchy of faculty needs when adopting technology in education.

Defining Systems

Merriam-Webster (1998) defines "system" as "a regularly interacting or interdependent group of items forming a unified whole." Romiszowski (1981) points out that "a system exists because we have chosen to consider it as that." Using a bicycle as an example, he points out that a bicycle might be considered part of any number of systems (a transportation system, for example). A bicycle might also be considered a system itself, and might be said to contain sub-systems (such as the derailleur and associated shifting mechanisms).

Systems interact. In general, that which interacts with a system might be called an "input" and the result of the interaction (what any given system produces as the result of an input) is commonly called an "output." For a current example, a public school might be considered an educational "system"; having a new internet connection installed in every room might be considered an input to that system. Those who push for and pay for the new internet connections are probably hopeful that the resulting output will be higher grades, or higher mean scores on standardized tests, or "better educated" children. In the context of this paper, the university functions as the macro system, of which various micro systems, such as colleges and departments, are a part. The inputs and outputs we will examine have to do with the adoption and implementation of new technologies.

To approach a problem "systemically" entails more than simply acknowledging that the context for the problem in question can be considered a system which interacts with other systems. A systemic approach also entails examining a system's inputs and outputs and attempting to make changes that result in (hopefully) better, or more acceptable outcomes. If such an examination is done as the result of a problem, it frequently follows a pattern. Romiszowski (1981), provides a fairly representative pattern of a systemic problem-solving process: a) defining the problem, b) analyzing the problem, c) selecting and synthesizing an optimal solution, d) implementing the solution in a controlled setting, and e) evaluating and revising the solution. This pattern illustrates the basic structure for any number of systemic instructional design models frequently employed by professionals in our field (Gustafson & Powell, 1991).

Identifying the Systems in Question

A complete description of our instructional support context has been provided elsewhere (Danielson & Burton, 1999) to which the interested reader can refer if desired. The description here will be limited to providing that information necessary to understand the systems involved.

The Macro-System

The overall system to which we will refer is Virginia Polytechnic and State University (Virginia Tech), a large land grant university in south-west Virginia. The administration at Virginia Tech has long valued the importance of remaining abreast of emerging technologies. In keeping with these values, beginning in the early

nineteen nineties, the administration at Virginia Tech decided that it would be advantageous to provide faculty of the University with computers to aid in their instructional endeavors. This was realized through a program known as the Faculty Development Institute (FDI).

The goal of FDI was two-fold. First, FDI would place a computer on each faculty member's desk every 5 years. Second, FDI would provide faculty with the knowledge and skills necessary to use their computers for developing courseware. In exchange for receiving a new computer, each faculty member would be required to attend a series of 3-5 all-day workshops, aimed at teaching them how to use their new computers effectively. In a related effort, State Council of Higher Education in Virginia (SCHEV) monies were made available through the University to departments to spend on hard "technology" as they saw fit. In systems terms, the hope was that if hardware, software, and a training session went "in" (to the college/department systems) effective technology-assisted instruction would come "out."

The Sub-Systems

If the University is the macro system in the context of this paper, the sub-system of interest directly subordinate to it is the College of Human Resources and Education (CHRE) (once two colleges which were forcibly merged shortly after the advent of FDI). Faculty in the college returned from FDI with brand-new computers and a generally superficial knowledge of how to use presentation, e-mail, and web-browsing software. The technology was "in" the system and it was time to wait and see what came out.

Sub-systems (departments and programs) within the college played an important role. Some departments (including, generally, several from the education "side") used their SCHEV money to maintain and build on what was initiated with FDI. Computers were replaced when outdated, and efforts were made to keep software up to date. Other departments, on the other hand, tended to allocate their SCHEV moneys in other ways, leaving faculty and staff with old systems (both in terms of hardware and software) which became unreliable and difficult to maintain and support. Many faculty rarely or never used their computers for every-day tasks, much less to create and maintain courseware. Training that was not immediately useful was quickly forgotten. Even when the training might have been considered useful by some faculty, it was frequently not easily implemented. For example, the first several groups of faculty receiving FDI training learned how to do e-mail at a time when there were very few others to correspond with via e-mail.

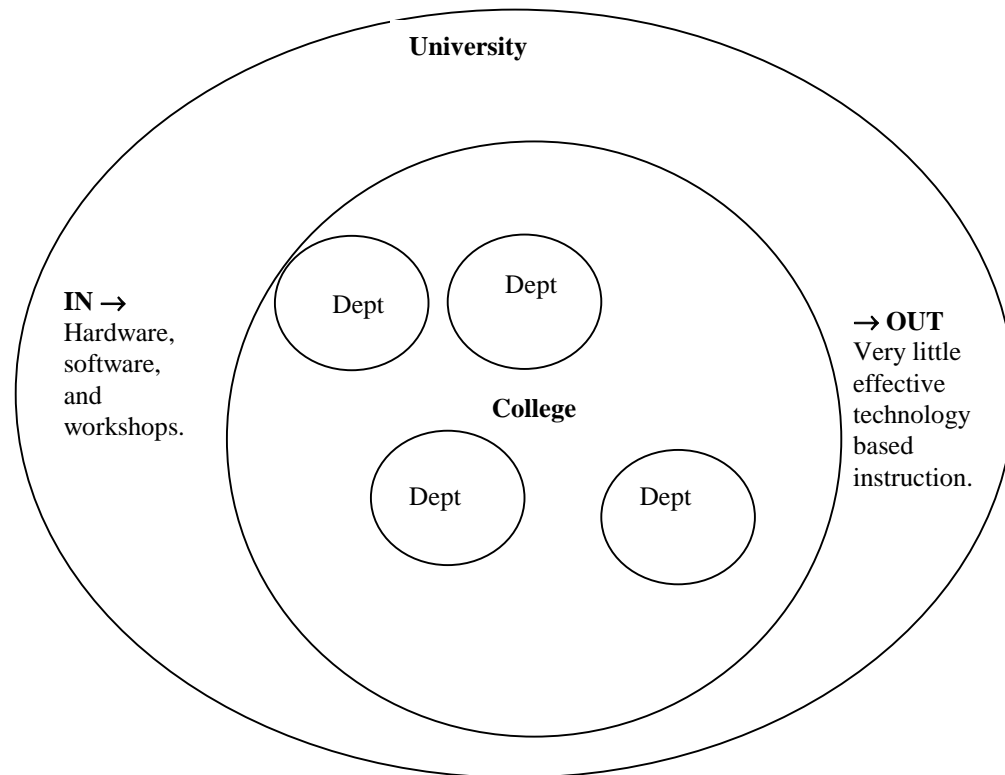
Those faculty who made an effort to use their new equipment and skills soon discovered other problems. While FDI had provided them with computers and training, it did not provide for follow up support to deal with the myriad of technical problems associated with computer use. Some professors, frustrated by incessant system crashes, inability to network correctly, inability to print reliably, etc., abandoned the thought of using their computers for course development. Some professors abandoned their computers altogether, and found vacancies for them on the floors of their offices.

Figure 1, below, illustrates what had occurred. The University "system" had introduced a new input into several sub-systems, with the hope that effective technology based instruction would emerge. As will probably surprise few experts in IT, however, the problem was not so simple, and the results did not meet hoped for expectations.

The fact that FDI alone did not result in faculty using emerging technologies effectively for teaching can probably be explained relatively easily. Scholars and practitioners in IT generally understand and accept that hard technology is not an educational panacea. Most IT experts could glance at figure 1 below and immediately suggest other "inputs" that, combined with hard technology and limited training would be more likely to result in effective technology-assisted training outcomes. Most would even suggest that, in the absence of an effective front-end analysis based on a well-defined "problem" any particular set of inputs amount to a "shot in the dark" at an unidentified target.

In this context, however, those working in the sub-systems of Virginia Tech were not generally given the option of determining the "inputs" (from the macro system) but were rather left to use, (or not use) what they got. Recognizing the difficulty faculty were facing in attempting to put FDI-gained knowledge and tools to work, administrators in the College of Human Resources and Education determined to address this multi-faceted problem

Figure 1. From the macro system into the sub-system



The most immediate problem facing the college appeared to be of a technical nature. Faculty were not using their newly acquired technology because they couldn't get it to work, or didn't know how to use it. Frequently, they turned to office staff for technical help, or to act as a buffer between themselves and their technology. (One faculty member, for example, would print electronic mail messages and ask a secretary to re-type them into a word document, because the faculty member was unfamiliar with the cut and paste function.) Meanwhile, office staff struggled with technical problems of their own. Frequently, they were unable to keep their own machines functioning properly, much less maintain machines for faculty members while still performing their regular work.

A Compensating Sub-System Introduced -- "Housecalls"

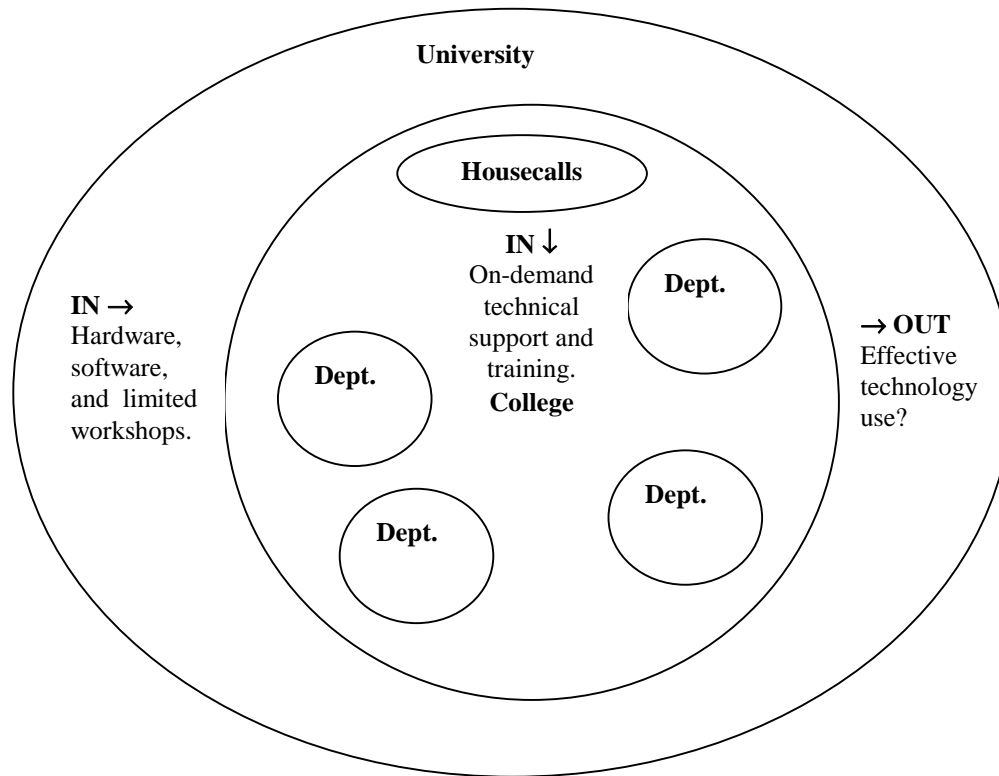
In an attempt to resolve the myriad of technical problems plaguing the college, administrators at the College level and within the department of Teaching and Learning determined to create a service which would, a) provide technical support for the college, b) provide a venue for training and supporting graduate students, and c) support faculty in their efforts to use their computers as educational tools. With this decision, the "housecalls" program was created.

The initial and primary focus of the housecalls program was to provide reliable, prompt (contact within the hour), and personal technical assistance to faculty within the college. Housecalls was not to be merely a technical service, however. It was to provide "human contact", (97% of housecalls calls are dealt with face to face), advice and on-the-spot training for technical and instructional questions, and in-service training for technical and instructional issues. The following points summarize the housecalls service as it exists in the CHRE (8/96 - 11/98).

1. Housecalls serves the College of Human Resources and Education including approximately 170 faculty and 65 staff using about 400 machines (Mac and IBM compatible).
2. Housecalls employs six GA's (at approximately \$15,000.00/yr. = \$90,000.00), one staff member (approximately \$21,000.00/yr.), and other wage employees (approximately \$10,000.00/yr.). Operating and inventory costs are approximately \$15,000.00/yr. The total costs reach approximately 135,000.00/yr.
3. Housecalls handles on average 124 calls per month. Less than 3% are not handled in person, and less than 1% are referred to another level of maintenance. Time per call ranges from 2 minutes to 7+ hours. Technical difficulty of calls ranges from wiggling a wire to reformatting a hard drive and reinstalling all software. Level of difficulty of training-type calls ranges from teaching someone how to increase margins, to helping someone design an effective course web page or design an effective course strategy for asynchronous communication. Level of difficulty of calls increases as clients learn and become more sophisticated.

Returning then, to our systems analogy, figure 2 illustrates the role of housecalls -- introduced as a compensating system at the College level to provide additional inputs to those introduced through FDI. The administrators who introduced the housecalls program saw it as a tool to not only solve technical problems, but to also move the college in the direction of addressing the goal that led to FDI -- that of seeing faculty use emerging technologies effectively in their teaching. This strategy has been initially successful, as will be seen.

Figure 2. Introducing the Housecalls System to the University/College/Department System



Our Context and Theory of Diffusion and Adoption of Educational Technology

Before examining the specific results of the housecalls program, it seems appropriate to examine it from the perspective of research and theory in the area of diffusion and adoption of emerging technologies in education. In his summary of such research, Holloway (1996) concludes that three factors: training, resources, and involvement, are consistently shown to be instrumental in the adoption of emerging technologies by educators. The housecalls program's focus is primarily on providing the former two (in the form of technical support), and not on the third (encouraging faculty involvement in adopting emerging technologies). Such an emphasis seems appropriate in our context for two reasons. First, it hardly seems appropriate for educational technologists to "push" hard technology use for its own sake in any situation. Second, research seems to indicate that teachers and faculty are most moved to adopt emerging technologies in their educational endeavors when they see peers doing so (as opposed to being "pushed" to do so from the outside) (Holloway, 1996).

Rogers, (1971) one of the pioneers in the field of diffusion research, introduced five attributes of innovations: relative advantage, compatibility, complexity, trialability, and observability. Ely, (1990) building on the work of Rogers and others, identified eight conditions that facilitate the implementation of Educational Technology. His work is still consistent with more recent findings, and his eight conditions provide a convenient framework for analyzing our context. We will briefly examine each of Ely's conditions, providing examples from our context which demonstrate the presence of these conditions. Those conditions are: a) dissatisfaction with the status quo, b) knowledge and skill exist, c) resources are available, d) time is available, e) rewards or incentives exist for participation, f) participation is expected and encouraged, g) commitment by those who are involved, h) leadership is evident.

Housecalls and Ely's Eight Conditions

1. **Dissatisfaction with the Status Quo:** Clearly, most faculty and staff in the CHRE were dissatisfied with a situation in which they were expected to use computers without technical support. (It is unclear

- the extent to which initial dissatisfaction led faculty members to take FDI machines in the first place). The housecalls service does address faculty dissatisfaction with technical problems. Increasingly, dissatisfaction in other areas is leading to other kinds of implementation as well. For example, at Virginia Tech more and more students are demanding the luxury of having notes and outlines, etc. on-line. This is causing some faculty to change in ways that they probably would not have otherwise.
2. **Knowledge and Skill Exist:** The housecalls program is staffed by graduate students in the Instructional Technology program in the Department of Teaching and Learning. The collective knowledge and skills of this group makes providing technical assistance possible.
 3. **Resources are Available:** Without the availability of money from the State Council of Higher Education in Virginia (SCHEV) equipment trust fund, and original FDI-provided computers, most faculty and staff would not be able to support original purchase of or continued upgrading of equipment and software. In the department of Teaching and Learning, all faculty and staff are provided with a computer to take home and work/play on. The department also provides a modem and pays the monthly internet access fee for faculty and staff.
 4. **Time is Available:** It is not clear that faculty at Virginia Tech have any more time to spend adopting new technologies than faculty anywhere else. Indirectly, however, the housecalls program does "give" faculty time, because those who use hard technology can spend less time fighting trivial technical problems.
 5. **Rewards or Incentives Exist for Participation:** Faculty members receive new computers for participating in FDI. Increasingly, there is anecdotal evidence to suggest that faculty are rewarded for adopting emerging technologies and effective instructional design strategies in the form of higher approval from students. There are formal incentive structures which encourage adopting emerging technologies in instruction as well. The university supports a grant program which awards monies for an "innovations in learning with technology" program. Similarly, the College of Human Resources and Education has an Associate Dean of Innovations, who allocates monies for the implementation of instructional technology. It is not clear, however, whether or not faculty efforts in this area will be rewarded in the area of promotion and tenure.
 6. **Participation is Expected and Encouraged:** Faculty members are required to participate in FDI. Various innovations (such as the use of e-mail) are also required on a department by department basis.
 7. **Commitment by those who are involved:** Because the housecalls program was started at the College level, and because FDI was started at the University level, there is commitment to the success of each from administrators. Similarly, in the case of the housecalls program, because the services provided are so universally required, there is general commitment to its continued success. The fact that the housecalls program continues to be funded, in spite of the non-trivial costs involved, is perhaps the surest indication of commitment on the part of decision makers.
 8. **Leadership is Evident:** Various leaders have proven instrumental in the support of the housecalls program, and in the adoption of emerging technologies in the College of Human Resources and Education. At the University level, the provost has stressed the importance of utilizing new technologies as much as possible. At the College level, the Dean of Innovations has consistently supported and funded initiatives to integrate technology in teaching and learning endeavors. The department chair of the department of Teaching and Learning has also been instrumental. He introduced and championed the housecalls program, and has consistently supported the department of teaching and learning in adopting new technologies. He has also stressed the importance of thoughtful application of technology, acknowledging the weaknesses of using technology for technology's sake, and stressing the importance of supporting faculty regardless of their support needs.

Hierarchy of Faculty Needs when Adopting Technology in Education

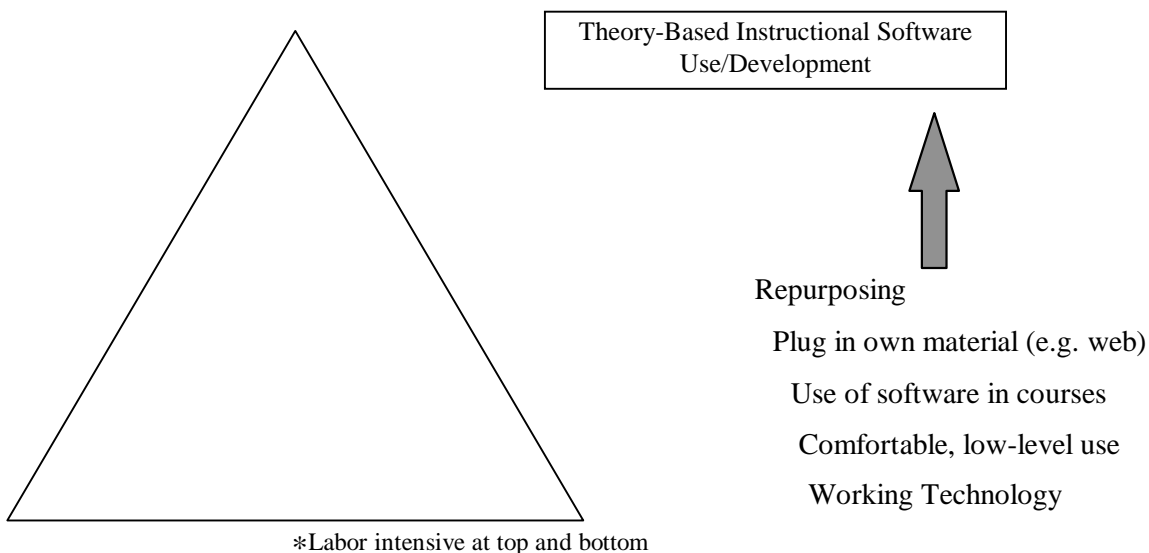
Our experience with the housecalls program and the intriguing set of circumstances leading to its creation have led us to conceptualize a model for conveying faculty needs in adopting technology in higher education. If research suggests that training, resources, and involvement are required for the adoption of emerging technologies in education, then our model assumes involvement (i.e., faculty are seeking to use emerging technologies already, -- we are not pushing it) and suggests an order in which training and resources might most effectively be provided.

In early 1999 we introduced a "hierarchy of instructional technology needs" (Danielson & Burton, 1999) reminiscent of Maslow's (1970) hierarchy of needs. Maslow's hierarchy illustrates the theory that meeting certain fundamental human needs is prerequisite to meeting others. In his hierarchy, the need for food and shelter is fundamental, and is prerequisite to meeting higher needs such as the need for human affection.

In our analogy to the implementation of educational technology, certain basic technological needs precede and are prerequisite to others. Our original version of the hierarchy of faculty needs when adopting technology in education appears in figure 3 below. As can be seen, we proposed that the most basic of all requirements (if faculty

are to use these tools effectively) is that of having equipment functioning properly. The highest level requirement is that of creating good, theory-based instructional products. Clearly, while the latter is the ultimate, and certainly more glamorous goal, we argue that it will not happen until the requirements below it have been met. It has also been our experience that the needs which require the most time to address are those found at the top and the bottom of the pyramid. Therefore, any endeavor which strives to meet these requirements must have the ability to spend a great deal of time and resources “at the bottom” before moving its way up. Furthermore, we argued that it is futile to “sit at the top” of the pyramid, so to speak, and wait for faculty to come ask for assistance with weighty and important matters of theory and development. This is the case because, a) most faculty, without support at the bottom, will never arrive at the top, and b) those faculty who have had the drive to arrive to the top unaided are unlikely to solicit help once there.

Figure 3. Hierarchy of Faculty Needs when Adopting Technology in Education

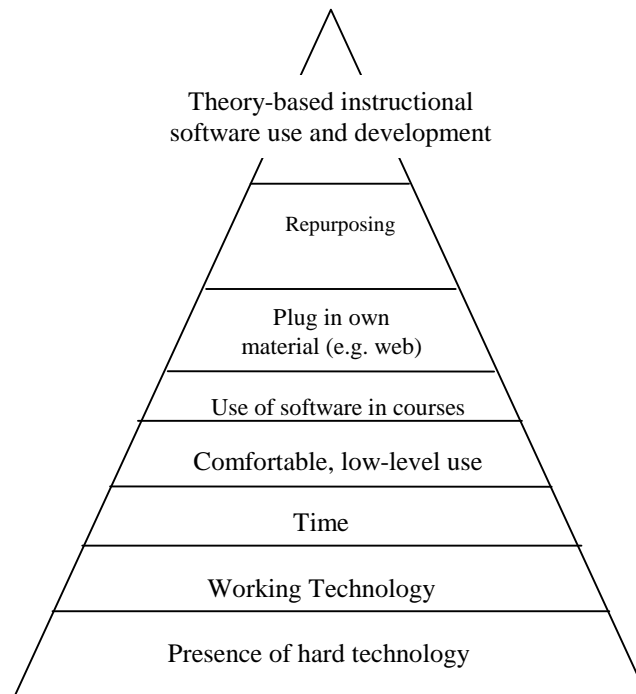


Supporting and Enhancing the Hierarchy

Since conceiving of the hierarchy presented above, we have had an additional year to examine our assumptions, collect additional relevant data, watch the housecalls program at work, and talk with faculty. We have observed a fair amount of anecdotal evidence supporting the underlying assumptions of the hierarchy. Our experience with the housecalls program, as well as our conversations with faculty members have also led us to make several adjustments to the bottom of the hierarchy. First, because there is clearly an important distinction between the presence of hard technology (e.g. hardware and software), and "working technology" (which implies that the technology gets fixed when it breaks), we have chosen to divide the "working technology" section into two sections: a) presence of hard technology, and b) working technology. Second, because the necessity of time is such a prevalent part of relevant literature, and because we've found it mentioned so frequently by faculty as an essential factor, we have also chosen to include it as a "need" on the hierarchy. The adjusted hierarchy appears in figure 4, below.

Data supporting our assumptions can best be summarized through general statistics about the housecalls service, highlights from several in-depth interviews with faculty from the CHRE, and finally, several general reports of how similar programs are being implemented elsewhere.

Figure 4. New Hierarchy of Faculty Needs When Adopting Technology in Education



General Statistics on the Housecalls Service

Observing the trend of housecall use since its introduction in August of 1996 reveals the following:

1. Since its introduction in 1996, the requirement for housecalls services has remained stable. Housecalls handles, on the average, 124 housecalls per month. However, housecalls staff indicate that the nature of the calls is becoming more complex. This could indicate that, while faculty and staff are becoming more sophisticated and calling on housecalls less for trivial service, they are also managing to "get into more trouble" (i.e., their use is more sophisticated, and, therefore, their problems have become more sophisticated as well).
2. While the need for basic technical support has remained solid, there has been a gradual increase in requests for services "higher up the hierarchy." Lately, this has come mostly in the form of faculty requests for help designing and "putting up" web pages. We believe that this indicates a couple of things: a), faculty and staff are learning how to solve some of their simpler low-tech problems, making them more willing to take on "higher-tech" ones. b) Faculty and staff have developed a trust for housecalls and are willing to call on them for one-to-one training. c) Faculty and staff are actually doing more sophisticated instruction with their technology (i.e., they're higher up the pyramid) than they used to be. This is due, in part at least, to the fact that they aren't being held back by lower-level problems. Interviews with faculty indicate that web page development is also partly due to pressure felt from students who are demanding more availability of services on-line.

Interviews with Faculty

Four faculty members who have called upon housecalls for help with higher-level tasks were interviewed at length regarding their technology use in their teaching endeavors. These faculty come from a variety of backgrounds. Two have taught several televised courses. Another has taught a course that was conducted strictly on-line. The other is the editor and manager of an on-line journal. All also use (to varying degrees) electronic presentation software and web pages in their instruction.

Several basic trends could be found throughout all the comments of the faculty members. First, all agreed that basic support in the form of university-supplied computers and technical assistance is very important, (and in three of the four cases) essential, to their adoption of emerging technologies in education. None of the faculty members expressed willingness, with their own money, to provide themselves (at work) with a computer equivalent to the one that had been supplied by the university.

Second, all faculty members (consistent with Ely and others) indicated that the availability of paid time to develop technology-assisted courses is a great help in doing so, and that the lack of time is a major deterrent. One professor commented that he was able to build an on-line course because the University bought out his classes for a

semester so that he could have time to dedicate to the course he was building. Two mentioned that they have not been able to make desired technological enhancements to courses they teach for lack of time to do so.

Similarly, all faculty stressed the importance of the housecalls program. All four mentioned both housecalls' training and technical support functions. All mentioned the convenience of having a housecalls representative available the same day (and frequently the same hour) as their request for assistance to deal with problems. Issues that they felt they would have spent hours resolving on their own, they were able to refer to housecalls, and spend their time on other endeavors. Three faculty members went so far as to say that they would not have been able to use the technology they are using without the support of housecalls (or a similar service), and the other acknowledged that attempting to do what they had done without housecalls would have been very difficult.

The faculty members interviewed also reported relying heavily on housecalls for learning how to use their teaching tools. For example, one learned how to design, build and "put-up" a homepage through several hour-long sessions with a housecalls staff member. Another spent similar long hours getting questions answered relating to how to use the Mac operating system to transfer files, and then, after switching to a PC platform, how to use the PC for file transfer -- all within the context of building a web page for a class.

Finally, housecalls was considered important for its continuity. After a call has been completed, a housecalls staff member calls the faculty or staff member who was served to verify that the problem was solved and check for subsequent problems. Records are kept on all calls made, so specific recurring problems can be dealt with in a systematic way. Faculty consider this kind of continuity valuable.

Generalizability of Housecalls and the Hierarchy

Obviously, our observations lack statistical generalizability. However, there is some evidence that the principles discovered here are applicable elsewhere. Several colleges in the Appalachian College Association have built support structures for their colleges patterned after the housecalls service. The following observations come from administrators at two of those colleges, who have been involved in such programs.

1. The two programs investigated are quite similar to each other. Both employ 10 staff members, and serve about 200 hundred faculty and staff and 1000-1500 students. Both provide software and hardware support.
2. Both programs report that technology use by those supported (ranging from e-mail correspondence to having and maintaining web pages) has increased dramatically since the services began.
3. Both programs report requests from faculty and staff for services beyond the services provided. In one case, faculty are requesting support for web page development (which is not provided). In the other, users want more computers available for checkout, and service of personally-owned computers (which is not provided).
4. Both programs report that faculty are using the new support services to employ emerging technologies in their instructional efforts. This use ranges from setting up web-sites for students to access, to using presentation software for teaching classes.

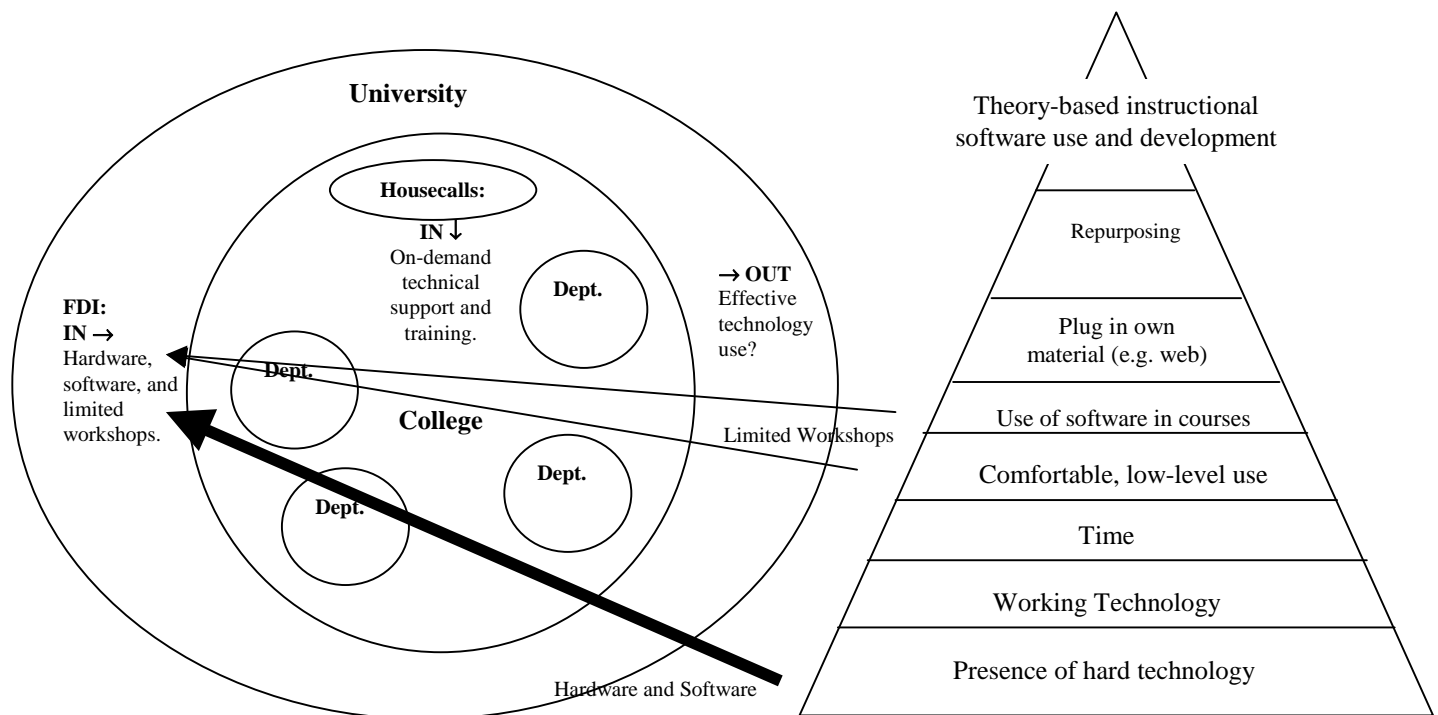
In general, what administrators at these colleges have found seems consistent with the idea that educators will not and cannot use emerging technologies effectively without support, and that, given support, they will be more likely to use emerging technologies in their teaching.

Systems and the Hierarchy of Faculty Needs when Adopting Technology in Education

FDI (The Macro-System's Contribution)

We will return now to our context at Virginia Tech, and the systems that we initially examined. We suggested that the university might be considered a macro-system of which Colleges (in our case the CHRE), departments, and programs play a role as sub-systems. In summarizing the University's initiative to encourage faculty use of technology in teaching, the university made available money for computer equipment, and a training program in the form of 3-day to one-week seminars (FDI). Comparing this to our hierarchy (see figure 5 below) this seems an appropriate first step in promoting the use of emerging technologies in education. This is the case because the most basic element of working technology (looking at the bottom of the pyramid) is hardware and software. The two upper arrows in figure 5 illustrate FDI's initial training efforts, and the bottom arrow demonstrates the initial hardware and software in. The fact that the FDI program was inadequate for achieving the desired outcome (theory based instructional software use and development), does not negate the value of either of these initial inputs. They simply were not enough.

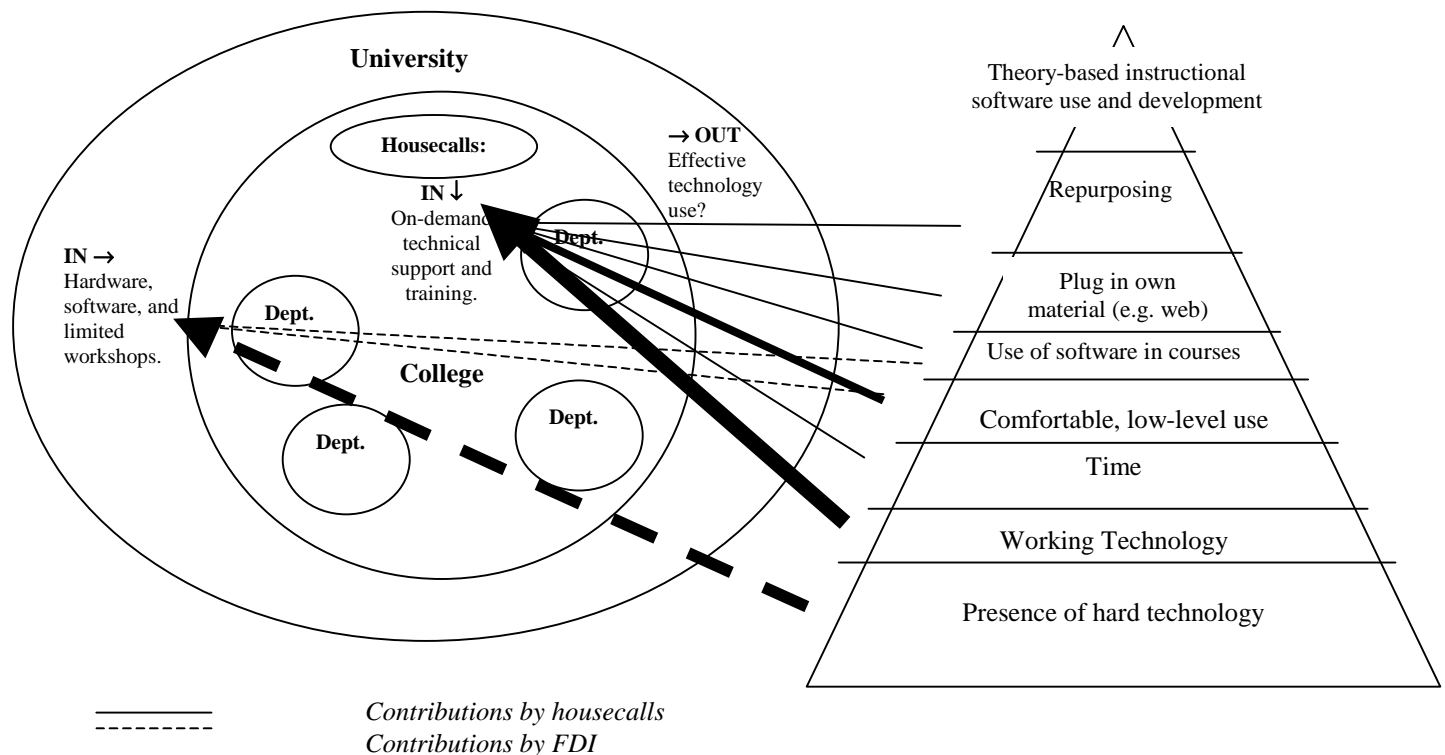
Figure 5: FDI's contribution to the University's End Goal



Housecalls (One Sub-system's Contribution)

The fact that the original FDI efforts were not producing the desired outcomes led administrators in the CHRE to introduce new system "inputs." The input in this case was a new system, "housecalls." Figure 6, below, illustrates how the housecalls system specifically contributed to meeting specific faculty needs. As the arrows reflect, the housecalls program has provided some service for faculty, at nearly every level of the hierarchy, though, as the thickness of the arrows is designed to indicate, the bulk of that support continues to focus on maintaining working technology. It seems clear, nonetheless, that the housecalls service has helped compensate for some of the deficits left by the FDI program in moving towards the ultimate goal of theory-based instructional software use and development. It also seems clear that if university and college administrators are serious about wide-spread theory-based instructional software use and development, there are still some pieces of the puzzle missing. The most notable of these pieces is time. While the housecalls service continues to "free-up" faculty time somewhat, it still seems clear that for most faculty to consistently use new technologies effectively, they must be given time to do so. We also anticipate that as more faculty attempt to integrate emerging technologies in their courses, the housecalls service will receive an increasing number of requests for service higher up the hierarchy. As the need for technical support will likely remain strong, housecalls will likely need to expand somewhat to meet the increased need, or another system will have to be introduced to provide more specialized service.

Figure 6: Housecalls and FDI Contribution to the University's End Goal



Conclusion

Given current political and educational climates, there may be any number of reasons why educators might be expected to adopt emerging technologies in their educational endeavors. Our hope is that regardless of the context, the hierarchy we have provided might prove useful to practitioners who have "pieces" of a technology solution, or who are trying to put one together. We contend that anyone seeking to adapt emerging technologies in an educational endeavor must take into consideration all the "technology" needs faculty will face, and the order in which those needs are addressed.

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NAVIGATIONAL STRUCTURE ON THE WORLD WIDE WEB: USABILITY CONCERNS, USER PREFERENCES, AND "BROWSING BEHAVIOR"

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Abstract

A primary consideration in web site design is that the site be easily navigable for its intended audience. For "informational" sites, where the primary purpose is to provide information about a service or program, a menu structure is often used to direct the users to different areas of the site. There are several approaches a site designer considers in developing a menu structure. One consideration is the content of the menus themselves (what choices are available to the user). Another consideration is the physical layout of the menu structure itself. The physical layout of a menu may be described as being one of at least three different types. The "traditional," hierarchical menu structure is used most often. Persistent menus, or menus which remain on the screen, are often accomplished by the use of HTML tables or frames. A third approach is the use of graphic or textual "maps" which show the user the path taken to a particular document. The purpose of this study was to determine whether visitors who are "just browsing" can do so more effectively under one of the three menu schemas described above (hierarchical disappearing menus, persistent menus via frames or tables, and representations of navigational maps).

Introduction

A primary consideration in web site design is that the site be easily navigable for its intended audience. For "informational" sites, where the primary purpose is to provide information about a service or program, a menu structure is often used to direct the users to different areas of the site.

There are several approaches a site designer considers in developing a menu structure. One consideration is the content of the menus themselves (what choices are available to the user). This is often accomplished through a combination of intuition and investigation. If one of the purposes of a site is to provide information that would normally be available through other means, such as direct inquiry to the information provider via a telephone call, consultation with those responsible for such inquiries can provide a well-established listing of frequently asked questions and answers. Another consideration is the physical layout of the menu structure itself. This consideration is often less dependent on inquiry or even intuition; it may be that aesthetics, visual design, and the limitations of servers and browsers determine how a menu is presented. The physical layout of a menu may be described as being one of at least three different types:

1. The "traditional," hierarchical menu structure is used most often. In this structure, menus are "pick lists" which move a user through a number of choices. At each step, the content of the previous menu disappears and is replaced by its subsequent menu.
2. Persistent menus, or menus which remain on the screen, are often accomplished by the use of HTML tables or frames. Frames are actually sets of HTML pages which appear together. An advantage of this approach is that the menu can remain on the screen at all times, regardless of the content of the subsequent pages. In other words, the menu remains within one frame, and choices made via that menu are displayed within another frame. The disadvantage of this approach is that not all web browser clients can support frames; some usability experts actively discourage the use of frames because they tend to change the metaphor of the web page and can be confusing to some users. (Nielsen J., 1996). In an article by Andrews (1996) web designer, Frank Forbes, offered both frame and non-frame versions, his finding was that only 1 of the 10 users preferred the frames version.
3. A third approach is the use of graphic or textual "maps" which show the user the path taken to a particular document. An example of that type of design is: <http://www.useit.com/alertbox/9612.html>. On that design type, the path one followed is shown as an active link at the top of each page. This may help the user to see where he is, how he reached there, and enable him to return to directly to the level he wants.

In determining which approach is most useful and usable for visitors to a web site, designers often employ development and test procedure which can spot strengths and weaknesses of an emerging system. One process for doing this is described in Practical Web Development: A Systematic Process (Boling & Frick, 1998).

Needs analysis determines the typical questions users desire answers for and guides the development of the structure, layout, and content. Paper prototypes are developed for the proposed site. The paper prototype is tested with "typical" users. These users are given tasks, as identified in the needs analysis, and asked to complete these tasks. Revisions are made as necessary, and the paper prototype is converted to a computer-based prototype. Again, usability testing is conducted, this time with the computer prototype. Once again, the usability testing is conducted with users being asked to complete predetermined tasks.

However, not all visitors to a web site arrive with particular questions in mind. These users are "browsing," or in other words simply visiting the site to see what it has to offer. They may return later with particular questions, but their first visit can be characterized as "just looking." Usability testing with predetermined tasks can provide valuable clues as to whether the site meets the needs of the information provider (is the site's content logically and intuitively arranged, so that "typical" users' questions are answered?). However, predetermined tasks do not address the usability issues posed by visitors who are "just browsing."

The purpose of this study is to determine whether visitors who are "just browsing" can do so more effectively under one of the three menu schemas described above (hierarchical disappearing menus, persistent menus via frames or tables, and representations of navigational maps). An additional research question pertains to the usability-testing procedure itself: should usability testing include unstructured tasks, as well as predetermined tasks? In this study, the content is three versions of the top-level structure of the web site for the Indiana University School of Education.

This study examined which of the three menu designs worked better for a user who is not given a particular task. For example, after using a site for 10 minutes without a specific task, what would be the user's conception of the structure of the web site?

Literature Review

Boling & Frick (1998) describe an approach to web design which depends largely on the determination of frequently-asked questions and designing usability tasks related to those questions. This approach is built upon the fundamental premise that users are looking for particular information and have predetermined goals when accessing a web site. This method for web design has proven successful in developing information-intensive sites at Indiana University. One shortcoming of this approach is its inability to incorporate what some have called "browsing" type behavior. "A major source of hypertext usability problems stem from the fact that hypertext systems are designed to encourage and facilitate browsing" (Smith, 1997).

Implications of Browsing Behavior

Browsing, due to its serendipitous nature, is difficult to simulate. When truly browsing a site, users have their own goal set, which may or may not be obvious to the researcher and which may change over time as information is gathered and refined. This may help to explain the findings from Remede, Gomez and Landauer (1987) which suggest that the main cause of inability to find information in a system is that users describe what they are looking for in different terms to those the system knows.

Because the web is a relatively recent development, most research studies involving the web have been studies provide demographic information about users with only scanty information about how they are using it (Catledge, 1995). Recent studies by Raman (1996) about browsing behavior in particular, found that individuals enjoyed the feeling of exercising control over what they wanted to see, and the ability to tap into vast amounts of information on diverse topics. In evaluating a hypermedia library information system, Zhu (1995) found that users chose browsing much more often than querying and used content-based browsing much more often than using an index.

Hendry and Harper (1997) discuss how opportunistic searchers (those who work the way they want to, as opposed to following a determined set of goals or strategies) might benefit from "simple systems that create a flexible and revealing dialogue between the system and user." They suggest that by representing search plans or navigational routes on a page, opportunistic searchers may be better equipped to perform informal problem-solving. However, usability tests which rely on predetermined tasks do not support the opportunistic searcher; those needs may be less-formally defined.

Attention to cognitive organization of the user was also the focus of study in Coll (et al. 1993). This study found relevance in the common design guideline of using nine or fewer menu items, in addition to finding that good conceptual layout of the menu on screen is more important than good physical layout.

The non-linear way in which we learn, and this similarity with the structure of hypertext was tested by Jannasch-Pennell (1996). This study investigated the impact of learner control on performance in a hypertext instructional environment. The study examined five learner levels across different educational levels (middle school, high school, undergraduate, graduate). Performance was measured through scoring on a criterion measure. Using covariance analysis, the study examined the performance of the educational levels against the variables of computer

confidence/competence, level of statistical knowledge, experience with the Web, and gender. While the abstract identified the hypothesis of this study to be "the educational level and the interface characteristics have a direct impact on user performance," no mention of the study's outcome was provided.

Catledge (1995) points out that most usability studies that have been conducted are generally performed in a closed, single-authored system. It is apparent that given the complexity, size and ever changing nature of the web, any global scale usability study would prove less than fruitful. Because of the known propensity of many users to browse, additional testing measures should be taken to simulate such behavior, to ensure more authentic generalizations from the research findings.

Consistency and Persistence in Navigation

Although "pre-web" in its origin, a study by Lucas (1991) provides several recommendations of design for computer-learner interface, mostly based on previous research and testing. He suggests consistency in screen layout, using visual/graphical images to enhance textual descriptions, and menu selection interfaces that prevent the need for the learner to learn commands. Consistency is also a primary concern in the Apple Web Design Guide (1997), which states that "providing navigation links in standard places helps people to develop a perception of stability in your site and makes navigation easier." Among his 16 recommendations on web page design Tillman (1997) makes these navigation-related prescriptions: each node/destination be able to stand alone, provide visual clues indicating users' selections are being processed, and employ labeled and unlabeled links.

Hardman (1989) used observational evidence to decipher that many users return frequently to the screen from which they began, which may suggest that users desire to get back to a known place instead of working out a route which will take them from where they are to where they want to go. Additional credibility is given to this finding through a study at the Georgia Institute of Technology involving 107 users over a three week period in which using the browser's "Back" command or button accounted for a full 41% of all navigation.

Catledge's study at GIT revealed that the typical user accessed on average 10 pages per server, which would lead to the conclusion that the "must see" information should be accessible within two or three jumps of the initial home page (two/three navigation's in, two/three out, performed two/three times) a finding also suggested by Apple.

Other relevant studies in persistent navigation include, Smith (1994) where testing was done using both two-and three-dimensional, spatial and schematic navigational aids, as well as Andrews (1996) where the use of a two-dimensional structure map which visualizes link and membership relationships, with a three-dimensional landscape visualization, presenting a combined display of both hierarchical structure and hyperlink relationships helped to prevent users from losing their orientation.

Utilizing Mental Maps in Information Recall

In her doctoral dissertation, Tyan (1989) showed that a top level structure awareness greatly enhanced readers recall performance. This study was done in part by having readers complete a schematic diagram of a passage previously read, and found a positive correlation between knowledge of structure and recall of information within the structure. Although this study was done with print-based text, the principles of recall may apply to web based text as well.

Increasingly, researchers and design practitioners are calling for the integration of spatial metaphors when designing Web pages. Dieberger and Bolter (1995) argue the Web is inherently geographical, leading users to organize their search strategies in spatial forms. And Heid (1996) suggests image maps actually help improve navigation by allowing developers to include backward compatibility with forward-looking design.

In one study, Philleo asked a group of preservice teachers, for whom the Internet was a relatively-new area of study, to draw "...a diagram or picture of the Internet as you understand it" (1995). Philleo concluded that "it may be that in order to solve problems that arise with Internet use or to be fully empowered to explore its resources, some sort of realistic-looking mental image might prove helpful." Taking Philleo's findings further - or perhaps, by scaling it down to the scope of a single web site - it may be that a browsing user's pictorial image may provide information about what the user thinks the site contains (see also Apple, 1997). Beyond this, by providing a persistent site map, one which shows how a user arrived at a particular page, a user may be helped in maintaining a mental image of the site, making subsequent visits more fruitful and productive.

In a similar study to this proposal, Chang (1995) used three types of hypertext menu designs while testing against individual difference variables. The three menu styles were 1) hierarchical structure signaled by explicit menus and referential links presented by embedded menus, 2) hierarchical structure signaled by embedded menus and referential links presented by embedded menus, and 3) referential links presented by embedded menus without structural information. The two individual variables were cognitive style (field-dependence versus field-independence) and epistemic beliefs and preferences (simple versus complex). The study population of 52 students at the University of Illinois yielded the following conclusions: Cognitive style was found to an influential factor on searching performance as field-independent users fared far better, especially when no structural information was

provided; Users' beliefs about whether knowledge is simple or complex did not affect searching performance; Program #1 proved to be the most efficient, but did not always produce the best search scores; and most novice subjects given simple search tasks chose linear links over non-linear hypertext.

In summary, the literature indicates that:

1. Current research shows that people use various types of browsing behavior in navigating through web sites, and such behavior is difficult to simulate in research activities.
2. Consistency in screen layout and design assists users in navigation through a particular web site.
3. Users tend to return frequently to the "top level" or screen from which they first entered a site rather than working out paths which will take them where they want to go.
4. A mental awareness of the structure that information is presented in aides in the recall of the material.

Methodology

The comparative inquiry of the three treatments used volunteer graduate and undergraduate subjects from Indiana University Bloomington. As subjects were recruited, they were assigned at random to one of the three treatments (total $N = 44$). In keeping with University policy concerning the use of human subjects, participants were given a copy of an Informed Consent document, which explained the nature of the study and assured anonymity. After reviewing and signing the Informed Consent document, the subjects were asked to complete a brief questionnaire to determine their level of familiarity with the current web site.

Because many of the hypertext links within this site were originally designed to take the user to other web sites, and because our research questions concerned only the navigability of the site in question, off-site links were changed so that they would produce an error message (normally, this would produce a "404 not found" error message; the server was reconfigured to deliver a more user-friendly message). The error message was pre-set to describe the reason the document was missing, and the subjects were told that finding one of these pages was a possibility; that if they did, they should use the browser's back button to return to the previous page and continue browsing.

The subjects were then shown the home page for the treatment they were assigned to; they were told that their assignment was to simply browse the site for a period of time and get an idea of its content. The three treatment conditions can be viewed on the Web at URL: <http://education.indiana.edu/~frick/aect99/designs.html> (A = non-persistent (changing) hierarchical menus displayed as vertical lists of choices with non-hot exemplars to the right; B = A + persistent top-level menu displayed as a vertical list of choices in the left column of the screen; C = A + horizontal hierarchical lists of choices at the top of the screen that represent the path taken down the hierarchy [textual map]).

The subjects then proceeded to browse the site while the researchers observed and recorded; the starting time, number of "back button" clicks, and subject comments were the primary observations made. Browser back button clicks were recorded as having been "forced" or "unforced." Forced back button clicks were the result of having arrived at a "document not found" page (as described above); unforced back button clicks were all others.

After browsing the web site for about ten minutes, the researcher asked the subject to stop. A questionnaire was then completed which gathered general information about the subject and their opinions about certain aspects of the site. General information included native language, major, and various aspects of computer use; opinions about the web site concerned navigability, affective response, and understanding of the purpose and navigational structure of the web site. The subjects were also asked four open-ended questions regarding what they liked or did not like about the web site.

In the final aspect of the session, the subjects were asked to complete a conceptual map of the web site. Because recall of the material may be a factor in the subjects' conceptual understanding of the site, it was decided that at least ten minutes should elapse between the end of the browsing activity and the beginning of the conceptual map test; if the subject completed the questionnaire in less time, an unrelated activity was begun to take up the remainder of the time.

Analysis

Following the data collection process described in the methodology, each subject's responses were reviewed and analyzed. The data yielded through the testing included (1) overall browsing time, (2) total unique pages visited, (3) conceptual map score, (4) the number of times the "back" button was used, and (5) ancillary data such as comments made during testing and written responses on the post-test questionnaire. The web page logs were also retrieved for each subject's testing period to verify the team member's observations.

Conceptual map tests were first scored independently by two persons, then the average of two was calculated. However, we found the correlation between two persons' scores was not sufficient (0.74). In order to improve the reliability of scoring, two scorers scored each conceptual map together by reaching a consensus score for each. Then, three tests from each design were chosen randomly and a blind observer scored them without

knowing which design they were. The blind observers' scores were then correlated with the consensus scores, but again the correlation was low (0.68).

In the statistical analysis, the recorded variables were coded into an SPSS file and subjected to a number of statistical manipulations. In particular, an attempt to correlate total browsing time and conceptual map scores, as well as total unique pages visited and total browsing time was made through correlation (Pearson r) and a one-way analysis of variance (ANOVA).

Unfortunately, the data collected on back button usage was not usable. This occurred for a number of reasons. Observers attempted to record usage of the back button as an "ordinary" choice of the user compared to a "forced" choice. Since all pages in the designs that led to external links under normal conditions were closed, users were forced back to a previous page. Due to an oversight on the research procedures, not all observers distinguished between these two uses of the back button. Furthermore, the web logs could not accurately verify the types of back button usage as had been anticipated, so the data was discarded.

Research Findings

An ANOVA was undertaken to see if there were any statistically significant differences among three different designs. Average conceptual map scores in the three designs were nearly identical.

Table 1. Means and Standard Deviations for Conceptual Map Scores in the Three Menu Designs

<i>Design</i>	<i>Mean</i>	<i>Standard Deviation</i>
A (traditional non-persistent hierarchical menu) $n=14$	3.43	2.62
B (persistent main menu -- left side) $n=15$	3.87	1.92
C (persistent textual map -- top left-to-right) $n=15$	3.27	2.31

There were no statistically significant differences among the three groups ($p < .05$) with respect to subjects' conceptual understanding of the overall structure of the Web site. Based on both the statistical analysis and the interpretation of test subject's written and verbal comments, few subjects noticed the differences between the three test designs. Observers noted that subjects tended to use the non-persistent links for navigation that were present in all three designs. Most subjects did not use the persistent menu on the left (sidebar) or the textual chain (top) for navigation while browsing, since they apparently did not "see" them. Moreover, these conceptual map scores were quite low with little variation among subjects within groups. Not only did this limit reliability of the measure and hence the possibility of significant differences, but it also indicated poor conceptual understanding of the Web site (lack of an accurate mental model).

Pearson product-moment correlation's were run between demographic and other variables and conceptual map scores. While most of the correlation values were not significant, there were statistically significant correlation's between conceptual map scores and how often subjects used web the web per week (0.319) and the number of software products used frequently (0.338). These findings indicate those subjects who used the Web and computer software products more frequently were better able to grasp the conceptual structure of a new Web site in a relatively short period of time.

Conclusion and Reflections

While this study did not discover a design format that convincingly facilitates browsing behavior over other formats, as the study had intended, there are several possible interpretations, which will require further research before any firm conclusions can be reached. One interpretation is that subjects tend not to form mental models of Web site structures, which would explain the low conceptual map scores overall and lack of differences among the three menu formats. Spool et al. (1997) conclude from their experiences in usability testing that most people do not form mental models of Web sites. Another interpretation is that there are no differences in conceptual understanding that can be attributed to the three types of menu designs that were studied. Evidence to support this are observations that most users did not use those persistent navigation features because they did not notice them. If so, then we would not expect differences among the designs, since *there were none* from the user's perspective. What does appear to be supported by findings in this study is that more experienced computer users do seem to achieve a greater conceptual grasp of a Web site's structure when browsing over a relatively short period of time. The number of software products used frequently indicates greater computer experience, as well as more frequent use of the Web.

A number of points should be considered on how this study was conducted and how a similar future study might do things differently. As previously mentioned, tracking usage of the back button proved difficult in this study. In general, the speed at which subjects browsed through the pages indicates that a more efficient method of accurately following browsers' paths needs to be devised. While Web logs are useful to verify the pages a subject visits, they do not reveal if she or he uses the back button, or specially designed navigation buttons like the ones included in designs B and C as alternative shortcuts to previously visited pages. Moreover, browsers cache Web

pages recently visited, and no Web server log entries are made when they go back to those locally cached pages. Videotaping subjects' use of the Web site (or capturing with a mediator and recording on video) would allow observers afterwards to more accurately track rapid navigation by users and the means by which they navigate.

Future studies should also consider the type of test subjects employed. This study was limited by its use of mostly undergraduate students, many of whom were only first or second year students. Since the awarding of extra-credit was necessary to leverage an adequate supply of test subjects, the motivation of a large proportion of the test population, and thus the results of their test sessions could be questioned. Perhaps future studies should consider using a different population, such as professional staff of a school or department. This would also allow extending the testing period over a longer period, rather than just the average 10 to 30 minutes experienced with the student population. Indeed, an expanded test period of, for example, two days a week for 30 minutes over the course of several weeks would most likely yield more conclusive results than those found here.

The last observation for potential future studies relates to measuring a users structural understanding of a web site. This study measured comprehension through the completion of a conceptual map. As cited in the literature review, there is evidence that users form their understanding of web page arrangements in spatial patterns. While the methodology used here was in accordance with previous studies, future studies may consider using an alternative measurement tool.

In the case of this study, a more effective alternative method may have been to ask the user, after browsing the site for a period of time, to list what kind of answers this site could provide to them. While this approach would place greater responsibility on the researcher to interpret user's responses, it would eliminate the constrictions users faced in this study in terms of the way in which they were required to recall multiple first- and second-level headings. As noted earlier, the speed at which many of the subjects moved through the test sites may have inhibited their ability to form a spatial interpretation of the site. While the speed of navigation witnessed in this study suggests the designs presented the information efficiently, this efficiency had an unintended negative impact on comprehension and recall.

One final thought on this study addresses the very nature of web browsing and the inherent difficulty in measuring it. Based on the observation of the test subjects, a question emerged related to the way the information in the design sites was presented. This question, which also applies to other web sites, is whether the manner in which information is presented creates self-forming goals within the user. Through observations made in this study, many test subjects "found" a topic or point of interest, which prompted them to continue searching for additional information related to their discovery. For example, when coming across the faculty and staff directory, the subjects began searching for one particular individual, usually a professor whose class they were enrolled in. This led them search that individual's personal page, or look for their office in the School of Education building map. When these subjects "found" something of interest and began pursuing addition related information, they were no longer browsing, but they were now driven by a task.

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IMPACT OF NAVIGATIONAL MODELS ON TASK COMPLETION IN WEB-BASED INFORMATION SYSTEMS

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Abstract

This study investigated performance differences between three different web-based navigation models: linear, persistent, and semi-persistent menu structures. Forty-four college students were placed into one of the three navigation conditions and completed information-finding tasks. No significant differences were found among the models with respect to success in completing tasks or overall completion time. Use of other navigation aids built into the browser such as the HOME and BACK buttons was also measured, as well user satisfaction and perceived usability. No differences among models were found here either. Results of this study tentatively indicate that the three navigation models, as tested, performed equally well and further that designers should perhaps give fair consideration to each of the models pending the purpose and audience of the site being designed. Further research is needed, since several potentially confounding factors were identified.

Introduction

Everyday thousands of people around the world make it a part of their day to locate some piece of information on the World Wide Web (WWW). Sometimes users of the WWW are browsing, simply looking at various web sites to find something that interests them, while other users access the WWW with a specific task in mind.

Web sites vary a great deal in terms of the audience being served and the purpose of the content being provided. There are sites that target children, adolescents and adults; educators, business executives, and researchers; vacationers, television junkies, and sports fanatics. The list goes on as long as there are topics and people who are interested in them. Of all these sites that are currently in use, some are intended to be used occasionally or even rarely, while there are other sites, such as corporate Intranet sites, that are used daily for very specific, job-critical tasks.

Regardless of the usage context for a particular web site, all web sites must employ some kind of navigation scheme to aid the user in traveling from one page to another. Designers of web sites currently enjoy little in the way of published, empirically supported guidelines specific to navigation issues. Site navigation is an essential element of an effective web site and there is a pressing need for researchers to begin investigating the issues and questions surrounding web-based navigation models. Most sites today are still built based either on personal experience and taste, an incompatible medium (i.e., paper), or at best on usability data with limited generalizability.

The purpose of this study was to investigate the effectiveness of three popular navigational models used in on the WWW. Specifically this study had hoped to begin laying the foundation for future studies dealing with web sites and how people perform using them.

Review of Related Literature

Though the research base on navigating within a WWW environment is limited, there are a number of studies which have been done in the last twenty years that have important implications for designing navigation schemes for web-based information systems. The varying research areas of influence include studies done on paper-based navigation, pre-web hypertext models, and web site usability. Hierarchical and persistent menu strategies on the web are a relatively new area of interface design interest. Only recently have researchers begun to address the question of menu development as applied to a hypertext environment, and in particular the World Wide Web. Empirical research is just beginning to emerge, mostly in the form of dissertations and research-oriented courses and seminars.

Effectiveness and Challenges of Hierarchical Information Structures

Research done by Chang (1995) indicates that hierarchical structures result in the most efficient navigation and information retrieval. In designing specific hierarchical menu structures, depth (the number of levels) and breadth (the number of items per page) were shown to be prime considerations by Harney (1990). Other factors that have been shown to be of importance in hierarchical menu design include:

1. menu dimension,
2. task complexity, and
3. the knowledge structure of the WWW user (Jacko, 1994).

It has been shown that WWW users experience difficulty navigating large information systems. McKnight, Dillon, and Richardson (1990) provided evidence that users can become disoriented during hypertext searching tasks. In this study, as in many information spaces, the challenge for the user is to know where they are in the system, where they want or need to go to in the system, and finally to somehow keep track of where they have been in the system. Disorientation results when users can not accomplish those tasks. It has been proposed that hypertext designs can be improved by providing structural cues to the WWW user, thereby facilitating user orientation (Rouet, et al. 1996).

One of the few recommendations one can locate in the research comes from Sano (1997) where he states that an effective and intuitive online information structure has two critical characteristics. First, the information which users need the most should be within two to three levels away from their starting point. Second, grouping of related items is essential to avoiding long lists of information that the user must scroll through.

Structural Cues

Paper documents have long used a wide array of navigation aids to help users find the information they need. Tables of contents have been shown to be effective navigation aids in paper documents. Indices, vertical tabs, and other devices have also been used effectively in paper-based documents.

Many web-based information systems continue to use individual vertical lists of links for each level in a hierarchy. Frick, et al. (1995) and Corry, et al. (1997) found that these lists worked well in meeting user expectations and resulted in high navigation performance on a university web site. In the same design, exemplars were added to each link to aid the user in understanding more about what each link would really provide them.

Users in this study reported that these exemplars were helpful. Spool (1997) also reports that link descriptors have been shown in usability testing to be extremely effective aids in helping users to decide whether the link is in fact what they want or not.

Another navigation tool used extensively in online systems is the expanding/contracting hierarchy. Such lists of choices have been shown to be effective in the Windows operating system, as well as in the Apple Computer OS. Early hypertext systems such as Superbook have also been shown to use expanding/contracting outlines successfully (Egan, et al. 1989). Specific to the web, Nation, et al. (1997) conducted an evaluation of an expandable/contractible table of contents tool called WebTOC. The tool is a Java applet that displays a dynamic hierarchy on the left of the screen with the content to the right side. Early results show that the applet can assist users in navigating web sites. Lastly, expanding/contracting tables of contents have also been shown to decrease browsing times when compared with fully expanded versions (Chimera et al. 1994).

Another navigation aid that is popular on the web is what we call hierarchical chains. These chains are structural cues in that they communicate to the user exactly where in the hierarchy they are and where they are currently. Usually a horizontal line of hypertext items separated by colons or arrows, each item in the chain is a level in the hierarchy that is hot-linked, allowing the user to return with a single click to any previously visited level. Examples of this navigation strategy can be seen at two popular and heavily usability-tested web sites. They are:

<http://www.yahoo.com>

<http://www.useit.com>.

Nielsen has usability tested this method and found it to be an effective aid in helping users navigate web-based information systems.

Additional Design Considerations

After determining the overall hierarchical design, other issues that need to be addressed concern types of menu structure (embedded versus explicit) and sub-menu design. Some research indicates that embedded menus produce more accurate searches, permit fewer screens viewed, and are preferred overall by users (Koved & Shneiderman, 1986). Menu design can also be divided into three levels: alphabetical, categorical, and random. In

terms of overall efficiency for novice users, there is no significant difference between alphabetical and categorical (Coll, Coll, and Nandavar, 1993).

Another consideration for web designers concerns the type of tasks that need to be supported. Navigation aids in a hypertext environment should be developed according to the tasks of the user. In terms of information search tasks, navigation via indexes seems to be the preferred method of users (Edwards and Hardman, 1989, cited in Smith, 1997). Developers should also provide information to the user informing them of their current progress, such as a path history (Jones, Farquhar and Surry, 1995). In terms of sub-menu design, studies by Scheurman and Peck (1991) indicate that users of sub-menus that provide a return to main menu option, versus a return to previous sub-menu option, spend less time on sub-menus and therefore are more efficient.

Other issues of importance that need to be considered are usability and its measurement, which have included various factors in the past such as: time to completion, number of errors, and deviations from optimal paths (Smith, 1994, cited in Smith, 1997). Other considerations could include finding required information, identifying the meaning of a link, and obtaining the required information when it is requested (Smith, 1997).

There are currently a number of different navigation strategies that designers implement in web-based information systems. Some of the many navigation options available to web designers include:

- plain hypertext, often in the form of lists, categories, hierarchies (e.g. <http://www.indiana.edu/iub/>)
- frames that provide persistent or perpetual navigation (e.g. <http://www.macromedia.com> and <http://www.steelcase.com>)
- expandable/collapsible hierarchies (Danny Goodman's site)
- forms, that scroll and/or drop down lists of linkable items (e.g. <http://www.pw.com>)
- hierarchical chains (e.g. <http://www.yahoo.com>, and <http://www.useit.com>)

Some of the navigation methods listed above have been tested with users both in usability settings and in empirical studies. We have described the outcomes of those efforts. Other methods have yet to be tested at all, or at least in any published format.

Methods

Research Design

The methodology used in this study was a classical experimental design with subjects randomly assigned to one of three treatment conditions. These three treatments were three web sites, which contained same information but different navigation menus.

- Condition A: non-persistent (changing) hierarchical menus displayed as vertical lists of choices with non-hot exemplars to the right,
- Condition B: A + persistent top-level menu displayed as vertical list of choices in the left column of the screen, and
- Condition C: A + semi-persistent horizontal hierarchical lists of choices at the top of the screen that represent the path taken down the hierarchy (textual map).

These navigation models can be viewed at URL: <http://education.indiana.edu/~frick/aect99/designs.html>.

The dependent variables in this study were the subjects performance on the task component of the study, the number of times the user voluntarily used the back button, and each subject's attitude. Attitude variables were constructed to collect subjective data about (a) appeal of the designs, (b) their usability, and (c) perceptions of "getting lost" in the web sites.

Pilot Tests

Six pilot tests were completed prior to actual data collection. The pilot tests were used to determine the usability of data collection instruments, to determine the difficulty of the tasks, and to ensure that data collection procedures worked satisfactorily.

Instruments tested during pilot testing included a background questionnaire, task list, and the attitude survey. The results of the pilot tests were used to ensure the background and the attitude questionnaires were understandable and usable. The pilot test was also used to finalize the task list. Over 30 tasks were tested during the pilot tests. The difficulty and usability of each task was determined based on the whether the subjects found the correct answer and the time it took to find the answer. The easiest tasks were deleted from the task list, and 24 tasks were selected for use in the actual study.

Instruments

The background questionnaire consisted of five questions about the subjects web and computer experiences. The task instrument consisted of 24 items. The task items were standard usability tasks that users were asked in order to find specific information in the web site. The tasks were evenly distributed among the web site. The attitude questionnaire was an instrument consisting of 18 Likert-type questions and one open-ended question for general comments. The 18 items consisted of positively and negatively worded statements about the navigation model used,

which were intended to measure its: (a) appeal, (b) usability, and (c) "getting lost" issues. In response to each statement, participants indicated which one of five ordered responses, ranging from *Astrongly agree@* to *Astrongly disagree@*.

Prior to individual sessions with each subject, the researcher needed to set up the computer and browser for the test. The monitor screen resolution was set to 640 X 480. The browser was opened and maximized. The *Adirectory buttons@* were disabled. The URL was set to the treatment tested in that session. The *AHOME@* button on the navigation bar was set to the Home Page URL of the treatment. The *Amemory cache@* and *Adisk cache@* were set to zero so that web server logs would contain navigation moves from page to page. The IP number of the computer workstation was recorded for later web server log analysis. Finally, the link history list was reset.

Subjects

Potential participants were screened beforehand to help determine who would be appropriate for the research study. The major criterion that was used to select subjects was little or no prior experience with the Indiana University School of Education web site. Subjects were excluded who were already familiar with this web site, since prior knowledge might confound the results. The resulting 44 subjects were undergraduate and graduate students and public school teachers, who were randomly assigned to the three treatment conditions ($n = 14, 15, 15$ respectively).

After completing the background questionnaire, each subject was asked to find answers to the 24 information tasks (e.g., What is the phone number of the External Relations Office? Find the Web page for the Education Library. Find information pertaining to Graduate Admissions.). The tasks were randomly ordered for each subject, who was given up to three minutes to find the answer. When the subject believed she had found the answer, she notified the researcher. If the answer was not found within three minutes, the subject gave up, or if the subject came to the wrong place in the web site, it was counted as an incorrect response. The researcher also recorded task completion time, and navigation buttons used.

Immediately following the completion of the 24 task questions, each subject was asked to complete the attitude questionnaire. Most subjects completed the experiment in 45 minutes to an hour.

Results

Reliabilities of the attitude scales were estimated by Cronbach's alpha for appeal (0.90), usability (0.89) and getting lost (0.70). The number of completed tasks, the total time for completing the tasks, the total number of voluntary back button clicks, and the attitude scales were analyzed by using the one-way Avon's. The statistical significance level used for hypothesis testing was set *a priori* to .05.

There was no significant difference among group means on number of tasks completed successfully.

Table 1. ANOVA for the number of tasks completed successfully

<i>Design</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>Sig.</i>
A ($n = 14$)	19.29	2.16	.069	.934
B ($n = 15$)	19.20	2.43		
C ($n = 15$)	18.93	3.30		

There was no significant difference among the three designs on the total amount of time to do all 24 tasks.

Table 2. ANOVA for the total task completion time in seconds.

<i>Design</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>Sig.</i>
A	1249.71	226.16	1.407	.256
B	1194.65	271.70		
C	1388.63	435.64		

There was no significant difference among the three designs on the number of voluntary uses of the back button.

Table 3. ANOVA for the number of voluntary back button clicks

<i>Design</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>Sig.</i>
A	18.92	14.31	2.997	.062
B	7.64	6.89		
C	16.86	15.69		

Note that the significance level (.062) approaches the .05 level, and it is possible that Design B (persistent top-level menu along the left side) results in fewer uses of the BACK button, compared to the other navigation models.

There was no significant difference among groups with respect to the appeal of the navigation model.

Table 4. ANOVA for subjective perception of appeal

<i>Design</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>Sig.</i>
A	12.43	2.56	.369	.694
B	13.07	3.71		
C	13.53	3.93		

There was no significant difference among groups with respect to the perceived usability of the navigation model.

Table 5. ANOVA for subjective perception of usability

<i>Design</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>Sig.</i>
A	9.21	1.89	.163	.832
B	9.20	3.08		
C	9.73	3.45		

There was no significant difference among groups with respect to the perception of Agetting lost@ in the navigation model.

Table 6. ANOVA for subjective perception of Agetting lost@

<i>Design</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>Sig.</i>
A	13.36	1.39	.841	.832
B	13.53	2.72		
C	13.93	3.33		

Discussion

We should emphasize that the web site for the School of Education (which is similar to Design *A* in our study, with its bottom-of-page navigation system removed) was previously developed and revised through extensive usability testing, making it as easy as possible for users to find answers to typical information seeking tasks such as those in our study. The persistent or semi-persistent menus, which were added in Designs *B* and *C* in our study, apparently did not significantly enhance its perceived usability or appeal, which was very good from the start. With web sites where little or no usability testing is used in the design process, we can speculate that persistent or semi-persistent menu systems might make a bigger difference.

We strongly believe that more research is needed before we can be sure that no differences exist among these different navigational models, because several usability factors became apparent during the study. Factors that pertained to a majority of respondents are discussed below, and each of these behaviors was either observed by the research team or specifically mentioned by the subjects.

First, most subjects were not *initially* cognizant of the menu schemes in Designs *B* and *C*. In Design *B*, after six to seven questions subjects typically started to use the sidebar menu scheme that was provided in the left column. Most subjects mentioned that they did not notice the sidebar menu function until after the tasks had started. Also, it took answering a few questions before the subjects understood how the side bar in Design *B* was applicable to their task-searching behavior. In Design *C*, several subjects mentioned that they did not notice the hierarchical menu at the top until they had navigated the structure for several levels. It took considerably more time for subjects in Design *C* to notice and begin to use the menu chain at the top of the page versus the time required for subjects in Design *B* with the sidebar at the left of the screen. One exception to the time factor in Design *B* was a subject who was a media specialist who immediately understood and consistently used the menu.

A majority of subjects mentioned that the exemplars were the most beneficial aspect of navigation. Design *A* contained exemplars for all its menus. Designs *B* and *C* contained Design *A* with the addition of menu choices on the side or top, respectively, which did *not* contain exemplars due to limitations in screen real estate. We can speculate that if users visit a site frequently, they would learn the meanings of the labels used for the menu items and be less dependent on exemplars for deciding which part of the hierarchy they need to go to. Our study was relatively short (less than an hour), and subjects were screened to ensure that they were *not* familiar with its structure.

In addition to the exemplar confound, most subjects used the home button for navigation at the beginning of each task. As part of each treatment, the home button was set to go to the home page for that design. For most subjects, it was much easier to navigate to the home page using the home button and then to use the exemplars to find specific pieces of information. This would be atypical for most web sites, and hence may have confounded our results.

Most subjects mentioned that during Design *B* the sidebar menu should have been contained on the home page as well as the other pages in the document. Subjects stated that having the sidebar menu on sub-levels and not on the main level was confusing. They did not understand how the side bar menu was helpful until they discovered it, typically after six to seven questions.

Subjects were confused by the dead links. In order to keep subjects from leaving the experimental web designs used in the study, links to web pages outside the navigation models were disabled intentionally to prevent confounding by other inconsistent navigation schemes used on external pages. It was not practical to reproduce the entire School of Education web site for each of the three treatment conditions, which would have consisted of literally thousands of web pages developed by different departments and units. Consequently, several subjects gave answers to the task they were completing based on the link name with exemplars itself instead of clicking and following the link.

Conclusion

In summary, the results were somewhat disappointing in that we expected to find designs *B* and *C* to be more efficient with respect to time to find answers to information seeking tasks. If choices are visually present to navigate by means of shortcuts to other parts of a menu hierarchy, then this increases the compactness of the hypermedia system (i.e., shorter distances between nodes). It also increases the flexibility, since users have multiple ways to move around a site. However, our data from this study do not support these expectations (with the exception that Design *B* may decrease reliance on the use of the back button for navigation, since the differences approached statistical significance). One could conclude that there are indeed no differences among the three types of navigation models, and hence could use other design criteria for making a choice among them. For example, if screen space is needed to minimize scrolling, then traditional non-persistent menu structures are more efficient with respect to use of screen real estate. The purpose of the web site might also dictate which model is preferable. For example, Yahoo is a large clearinghouse for links to the web (a *Ayellow pages@* function). For such a large, deep hierarchy of choices, the use of semi-persistent hierarchical chains (or textual maps, as represented in our Design *C*) occupies less screen real estate than a sidebar menu and yet provides flexibility for moving around the hierarchy.

We suggest that future research should be done, given constraints we faced in this study and the possibility of confounded results due to those constraints.

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MULTIDIMENSIONAL KNOWLEDGE STRUCTURES

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Abstract

Multidimensional knowledge structures, described from a constructivist perspective and aligned with the Mind as Rhizome metaphor, provide support for constructivist learning strategies. In this qualitative study, cues and trajectories in the children's re-presentations of knowledge were identified. Implications of these structures for generating and developing multiple perspectives and developing learner ownership are discussed.

Background

Hypothetical knowledge structures have been proposed and are used to discuss and describe mental processes from a cognitive theoretical perspective. Schemata (Rumelhart & Ortony, 1977), frames (Minsky, 1974/1997), semantic networks (Woods, 1975), and scripts (Schank, 1975) provide a framework for describing how knowledge is organized in memory, allowing for easy retrieval of information and playing a role in perception and comprehension. Schema, as an example these knowledge structures, are described as existing for generalized concepts (Rumelhart & Ortony, 1977). Yet, when these structures are studied, they are often isolated within a domain of interest for the researcher, and, in fact, are described as being domain organized (Bruning, Schraw, & Ronning, 1995). For example, schema are described for social studies (Duis, 1996; Torney-Purta, 1991) and mathematics (Jitendra & Hoff, 1996; Zeman, 1991). The role of gender schema has been considered in reading and story memory (Day, 1994; Welch-Ross & Schmidt, 1996).

Although a domain focus provides for description of knowledge and knowledge construction processes within particular domains, knowledge and learning that aligns with the constructivist perspective requires a broader look at knowledge structures. Although constructing relationships related to domain knowledge is an important activity in the learning process, just as important is the learner's prior knowledge not related to that domain, which is somehow activated by information in that domain. New information is interpreted by an individual in terms of existing knowledge that is divergent and unique to that individual. This pilot study of elementary students begins to look at how knowledge structures extend beyond the domain, thus providing for the multidimensionality of knowledge structures.

Theoretical Perspective

The traditional cognitivist perspective, as was initially aligned with the information-processing view, tends to view knowledge construction as a process whereby learners develop representations of an ontologically objective reality (Lakoff, 1987). An orientation to teaching that would align with this perspective is a knowledge or information transmission model (Kember & Gow, 1994). Critical in the learning process is the way in which the information is organized, allowing for easy acquisition and retrieval. In the instructional process, the information is often presented in final form (e.g., in Ausubel's (1961) meaningful reception learning), and the learner is to internalize this information (Driscoll, 1994). Although a learner's prior knowledge and experience provide ways for an individual to link to the new information, the instructional process proceeds from the instructor's point of view (Wagner & McCombs, 1995).

From the constructivist view, not only is knowledge constructed, as could also be described from the cognitivist perspective, but a learner has no alternative but to construct knowledge based upon his or her own experience (von Glaserfeld, 1995). The constructivist perspective is based on a subjectivist or interpretivist view of the world. Although a real world is posited to exist, what an individual knows of that world is based upon his or her own experiences and interpretations of that world. Two primary constructivist views currently exist: cognitive-constructivist where learning is a process of active cognitive reorganization and socio-constructivist where learning is acculturation into an established community of practice (Cobb, 1994; Duffy & Cunningham, 1996). The current study focused on knowledge structures of individual students, and is more appropriately aligned with the cognitive-constructivist view. From this view, learners are to reshape or transform information, resulting in new cognitive structures (Brooks & Brooks, 1993). These structures, rather than being prescribed and defined by a teacher, are idiosyncratic to learners based upon their own experience and prior knowledge.

In constructivist learning, the instructor acts as a facilitator or coach, supporting students in the learning process by providing resources and modeling thinking skills. More critically in this bi-directional process, the instructor should come to understand the learner's point of view, then pushing the learner to the edge of his or her thinking to foster a perturbation that will extend the learner to expanded understandings (Duffy & Cunningham, 1996). Principles of constructivist learning environments include that of learner ownership where problems have

relevance to the students, generation and evaluation of multiple perspectives, and problem and environment complexity appropriate for the learner and faithful to the task (Duffy & Cunningham, 1996; Honebein, Duffy, & Fishman, 1993; Savery & Duffy, 1996).

These characteristics provide a rationale for broadening the view of knowledge structures, not only beyond domains, but also to capture the idiosyncratic experiences and knowledge of learners. Knowledge is often described as being idiosyncratic (Alexander, Schallert, & Hare, 1991) thus, there needs to be an opportunity for learners to create, consider, and express their own unique knowledge as well as descriptions of knowledge structures that capture the idiosyncratic nature of knowledge.

Accessing Knowledge Structures

Typically, concept maps (Beyerbach, 1988; Shavelson & Stanton, 1975) and semantic ordered trees (Strahan, 1989) have been used as methods for gathering information about knowledge structures. There are variety of ways in which these have been implemented. For example, when using structured concept maps, concepts are provided and the learner is asked to identify the links among the concepts. In unstructured maps, the learner is provided the topic area rather than individual concepts. This method can provide for idiosyncratic views among individuals (Winitzky, Kauchak, & Kelly, 1994). However, even within the unstructured maps there may be implied constraints to remain within the topic or domain and not identify meaningful connections beyond. In fact, few studies have avoided limiting a learners knowledge structures to predefined concepts (Lederman, Gess-Newsome, & Latz, 1994). Ginsburg (1997) challenges that if one is to consider knowledge from a constructivist perspective, one has no alternative but to consider more non-standardized forms of data collection, ones that allow for the point of view of the learner.

Alternative Perspective

The Mind as Rhizome metaphor provides an alternative perspective from which to view knowledge. A biological example of a rhizome is a root crop such as tulips or crab grass, a system of stems, roots, fibers with fruits of tubers, bulbs, and leaves (Duffy & Cunningham, 1996). When applied as a metaphor of mind, the rhizome provides a number of characteristics that aid understanding of mind from a constructivist perspective and captures the idiosyncratic nature of knowledge as well. A rhizome continuously grows in dimension, changing its own nature as it increases in dimension. Thus, the rhizome is a dynamic system, one that changes through time. Features within the rhizome are heterogeneous, not needing to be similar to one another, each point having the potential to be connected to any other point. This potential connectedness has no hierarchy or genealogy, there being no subordinate points within the structure. A rhizome has an infinite number of entrances, or points from which it is viewed, yet it has not outside. Without an outside, it can only be described from the inside, from one of the infinite vantage points within. It is an open network in a which everything could be connected to everything else within a multidimensional space (Deleuze & Guattari, 1983; Duffy & Cunningham, 1996). Because of the potential for infinite connections and its dynamic existence, each view or perspective from within must be idiosyncratic.

Traversing the rhizome, moving through the maze-like structure, is described as a map (Deleuze & Guattari, 1983), although a path may provide a better way to conceptual this process. A path through the rhizome (a trajectory through the dynamic system) is not static, but a continuous construction capturing knowledge as a process. In contrast, if one considers that a concept map could capture a portion of the rhizome, knowledge appears a static commodity. A concept map seems to sever the connections that exist between the concept map and the rhizome from which it was removed. Thus, knowledge's idiosyncratic nature is suppressed. Knowledge, when considered as a dynamic path or trajectory through the rhizome, is affected not only by new information it encounters, but the entire path from which it emerged. The multidimensional rhizome of infinite connections captures a mind that includes past experience and knowledge as a basis for a continuing construction process as new information and experience are encountered.

When considering the multidimensionality of the rhizome, it is not difficult to speculate what the dimensions of multidimensional knowledge could be. At a minimum, time is an added dimension. Alexander and Murphy's (1998) description of an individuals knowledge base, based on learner-centered psychological principles aligned with the constructivist perspective, included sociocultural, strategic abilities, personal beliefs, and goals as interactive dimensions. Ginsburg (1997) stated that "cognition without emotion is vacuous" (p. 65), adding another dimension. These, and likely many others, provide a trajectory or path, reflecting the many types of connections an individual can construct at any given time, based on personal experience and knowledge. Any one of these dimensions may be encountered and followed at any time during learning. When studying knowledge structures, all types of trajectories should be considered relevant. Domain or subject areas, along with these other dimensions, do provide potential for infinite connections with unique past experience and knowledge of learners. The rhizome metaphor with its heterogeneous infinite connections, coupled with data gathered through non-traditional methods as suggested by Ginsburg, provides a framework for study of a more divergent look at knowledge.

Purpose and Guiding Question for Study

The purpose of this study was to begin description of hypothetical knowledge structures based on empirical data gathered in learning situations. The rhizome metaphor provided a framework from which characteristics of broader knowledge structures could be described. The study sought a description of knowledge structures that (a) were distributed, allowing for heterogeneous, multiple connections that existed within one's knowledge, and (b) contained connections that extended beyond domain-specific boundaries thus adding dimensions. The broad guiding question for this study was: How can knowledge of these elementary school children who were situated in an existing school environment be described as multidimensional knowledge structures?

Methodology

A qualitative study was conducted seeking empirical support for a description of multidimensional knowledge structures, focusing on the idiosyncratic nature of knowledge that arose in the classroom and was based upon children's individual prior experience and knowledge.

Participants

Participants for this study were a first and a sixth grade parochial classroom in a small Midwestern city. The first grade class had 14 boys and 11 girls, ages 6 to 7, of which 13 consented to participate in the study (8 boys and 5 girls). The sixth grade class had 9 boys and 15 girls, ages 12 and 13, with 3 boys and 9 girls participating in the study. Prior to the beginning of data collection, the researcher visited the classrooms, was introduced to the students, and, in the first grade class, interacted with the children by assisting them with their class work. The first grade teacher stated that these early encounters with the children identified the researcher as a helper and increased the children's comfort level and willingness to talk in the interviews. The sixth grade teacher was used as a secondary participant.

Procedure

Data was gathered through a variety of sources using a number of methods as appropriate for a qualitative study (Lincoln & Guba, 1985). Each classroom was observed three times, the first grade during a variety of subjects and the sixth grade during social studies. In the initial design for the study, instances of idiosyncratic comments and questions by students were sought. Students were to be interviewed about the source of these idiosyncratic comments and questions, seeking connections between them and the new information. After the first observation in each class it became clear that these instances would not occur in any abundance, perhaps resulting from the didactic nature of the classrooms. The design evolved so that interview students were randomly chosen. Nine first grade students and three sixth grade students were interviewed. The individual interviews were conducted after the classroom observation, were audio taped, and later transcribed.

Each semi-structured interview began by having the child describe what he or she remembered from the class session. Open-ended questions followed, asking the child about idiosyncratic comments that he or she may have brought up during class (e.g., During your lesson today you brought up _____. What made you think of that?) or may have had covertly (e.g., At times, when we're learning one thing, other things pop into our head that are not what about we're learning. Sometimes we hear the teacher say might remind us of something else we know. While you were studying ____ this morning, did anything like that pop into your head?). The interview followed from the child's comments, each interview lasting less than 15 minutes.

The sixth grade students also completed a brief writing activity on the Vikings, their topic that day in social studies. A 15 minute introduction to the writing task allowed the students to ask questions about what they were to do and helped ensure their understanding. Students were provided open-ended prompting questions to help them begin the activity (e.g., Describe the conquests of the Vikings.) and were told that if something popped into their heads, regardless of its relationship to social studies, to follow that thought and write about the new topic. Students were asked to include why the new topic was related and were provided a number of example transition sentences to aid this process (e.g., This reminds me of ____ because ____). Writing time was extended from the 30 minutes initially planned to 45 minutes as the students continued working on the activity. Students were able to use their textbooks for the writing activity to help them with ideas and spelling and were asked to indicate if they used their book none, some, or a lot.

The sixth grade teacher was interviewed following student data collection. This interview was a means to further triangulate the data and gain further understanding if some of the links that the students provided in their writing and interviews had occurred previously in classroom instruction or in school. In this, the role of the teacher was not to confirm or deny the students' knowledge construction, but to provide information about the basis of some of the connections.

Analysis

Analysis proceeded as typically done in a qualitative study, seeking trends among the data from the various sources (Bogdan & Biklen, 1982; Lincoln & Guba, 1985). Data from the observations, interviews, and writing activities were reduced to series of propositions (Novak & Musonda, 1991), generally single sentences or topic areas. These were then reviewed for points or ideas from which one topic or idea moved to the next.

Results

Heterogeneous, Multiple Connections: Cues

Two primary trends emerged through the analysis. First, within the children's writing and interview data there existed cues, stimuli that allowed the child to turn a mental or verbal corner, digress from the topic at hand and follow a path to a related concept or idea. Although these cues seemed similar to the cues described from the cognitive learning perspective used to aid information storage and retrieval (Bruning et al., 1995) they were not teacher defined or mediated (i.e., a part of the pre-planned structure of the topic to be learned). These cues occurred either in the learning environment, generally from a teacher's comment or question, or from a child's own thoughts (verbally or in writing) as a type of re-presentation (in the Piagetian sense) where individuals replay or reconstruct their knowledge to themselves (von Glaserfeld, 1995). For this study, cues often appeared as single words or concepts, making it clear where the learner turned a cognitive corner or chose a path in the rhizome that was different from what the teacher was presenting or what the learner was currently writing. Analysis identified the following cues: sounds like (two words that sounded alike but shared no meaning), looks like (a visual cue that looked like something else), same word but different concept (a word or derivation of a word that described two different ideas), same concept but different context (an idea or concept that occurred or existed in other circumstances), series (an itemized set of words), and complex relationships (an inference is an example).

An observation of Tim's¹ first grade reading group provides an example of a same word but different concept cue. Tim has a different conception of the word "meadow" when it is presented as a new word.

The teacher, introducing the story *The Frog and the Toad*, asked the small first grade reading group what a meadow was. Meadow was a new word in the story.

"A meadow is a place with a few buildings," Tim said.

The teacher paused, "Meadow Wood, where your grandpa lives," she interpreted his response.

"Animals live in a meadow," another student offered.

"There's a fountain in a meadow," Tim said.

The teacher tried to clarify, "They call it Meadow Wood because it looks like a meadow."

The students offered other descriptors of meadow. "A meadow is flat." "A meadow has flowers." "A meadow has deer." "A meadow has raccoons."

The teacher added, "A meadow has possum." Still addressing Tim's idea about meadows, she said, "In Meadow Wood sometimes animals come near the buildings and eat the plants. A meadow is a flat, grassy place." (observation, grade 1, April 6, 1998)

It is clear that Tim's definition of the word meadow, although the same word, does not match that of the teacher's. Although Tim's idiosyncratic definition of the word is incorrect based on the teacher's definition, it is a definition consistent with his prior experience and knowledge. As the teacher tries to clarify this, it becomes clearer that although the same word, Tim has a different concept in mind.

The interviews and writings of the sixth grade students provided examples of more sophisticated cues. Beth brings up a question in her interview that she wondered about during class, "If we had a test question on what happened on Christmas day in the 800s would it be both answers?" (Beth, age 12, April 13, 1998). Her question occurred in a lesson on Charlemagne where the students were told the Charlemagne had been crowned Holy Roman Emperor on Christmas day. Broader than being the same word, as was Tim's case, Christmas is a concept, or idea. Beth had the same concept of Christmas as the teacher. Her question indicated that this concept can extend beyond contexts (that of learning a particular event in social studies in the classroom and that the traditional view of Christmas).

In the same sixth grade lesson, Anne's interview provided another concept that was touched on in class that she moved into different contexts.

I asked Anne, "When you're sitting in class, or when you're sitting anywhere, but we'll kind of focus on social studies today (yeah) and you're hearing things, like Mrs. Larson is asking questions, and you're discussing the topic, or you're looking at the book or whatever, a lot of times other things will pop into our minds (uh huh) so I was wondering if during social studies anything popped into your mind."

"Well, I have a track meet this afternoon so I was thinking about if it was going to be rained out or not. ("OK," I interjected.) and I was thinking about how I went to the art museum in Chicago when she mentioned art." (Anne, age 12, April 13, 1998)

1 Student and teacher names are pseudonyms.

The teacher had mentioned that art was encouraged in the schools during Charlemagne's time and that churches were like museums because of the artwork in them. Since the mention of art in the class was at the end of the lesson, perhaps Anne's recall could be attributed to a recency effect. But, later in the interview, when prompted about the most interesting thing about the class, she returned to the topic of art showing that she had considered the concept a bit beyond the mention in class, making a comparison to art work in the churches now, although not expanding any further.

"I thought the art work in the church was because usually these days all you see is stained glass and everything (OK) and you don't really see anything except like the stations, but you never really see any art work."

"OK, why do you suppose that is?"

"I don't know." (Anne, age 12, April 13, 1998)

Anne mentioned twice in the interview that social studies was boring. When called on to answer a question during class, Anne had to ask the teacher to repeat the question, then thumbed through her book, and eventually provided an answer. Another sixth grade student, who said that history was her favorite subject, identified a different concept that she extended beyond the current context in her re-presentations. Wendy focused on the wars that Charlemagne had fought, being able to identify his foes.

Well, in history I was thinking, because I really looked over the chapter really good. I was really thinking more about all the wars we've been through with other countries, Vietnam War and World War I and World War II, and I started thinking about the Titanic ship, because I read a lot on that, and how there were three boats named Titanic and they all sank. So, I was thinking if that was a curse name or something. And then she started talking about how they switched the Franks and stuff and I thought about that in history, and I eventually when back to thinking about other stuff. (Wendy, age 12, April 13, 1998)

When asked later in the interview to talk more about the idea of wars that were triggered, asking if she saw relationships between the two, Wendy continued following a path among her areas of interest. The concept of wars is extended to fighting and the use of peace treaties, again returning to a war that she had mentioned earlier.

Yeah, I think we still fight, except we fight a lot more about stupider things, like religion, I know it's important but it's not something we should really fight over, we should just get along and try to like divide it. I watch a lot of videos because my mom works for National Geographic company and if she sells so many products she gets a video. So I sit down and watch it. Like the Titanic one. That was a little boring because it was mostly stuff I knew. But when it was about Egypt and stuff and talked about the mummies I thought that was cool. I think they considered things more about violence because you're basically surrounded by it. Basically, like guns and all that, like kids killing other kids and the wars going on around us. I know they're trying to have a peace treaty with, I forget with what country, and I don't think peace treaties work because they break them like when Hitler broke the one in WW II. They usually keep them for a couple of years, or a decade or so and then they'll break them which is not very good. I think if you make a promise you should live up to your promise unless something really big comes along. (Wendy, age 12, April 13, 1998)

Wendy later continued by talking about freedom, linking the idea of being forced to change religion (as was done with Charlemagne's conquests) and the idea of being able to choose things for herself, such as books to read. Although the tangents of discussing Egypt and the Titanic in the interview seem irrelevant, two weeks later during the sixth grade writing activity on the Vikings (where Wendy stated that she used the book some) she returns to the same topics.

I like the Vikings tons but who could beat the Romans. Talk about cool. They rule everything. They had everything right till their good ruler died then they had their downfall. Egypt was cool too. I liked how they wrapped their dead up. My great uncle just died it was sad. I can't turn my book to the Egypt pgs at school because on 3 pages it [was] all muddy. I did not mean to do it. I left my book open and my dog jump with his muddy paws all over it. I'm planning to tell Mrs. Larson the last day of school and I will bring \$5 to pay for it. I just don't want to be yelled at. I hate that. Egypt is hot but they have nice pyramids and statues [statues]. The Egypt people had grave takers. That would be mean to take some ones thing and not let them have their peace. I know I would hate it if anyone took anything special to me like my bennie babies, titanic stuff, or radio. (Wendy, age 12, April 27, 1998)

The linear format of writing allows only one cue to be followed at a time. But, Wendy's return to the topic at hand, as well as her returning to a topic two weeks later, is a way that multiple connections to the same concept can be captured.

These few examples of cues, of which 76 were identified in the data, indicate how simple a cue can be. Yet, a cue has the potential for multiple heterogeneous connections stemming from it. For example, the concept of "art" in Anne's thoughts did not have only one connection, but many. Further, the types of connections, the context where they initially developed, were different. Beth was building a number of connections stemming from the Christmas cue. Wendy had a number of connections with the concept of war. That these cues are not singular concepts, although reported as such, suggests distributedness. Anne's knowledge about art is not a self-contained singular

concept described in a hierarchical structure. Neither is Wendy's knowledge about war. When comparing Wendy's interview and writing, we see that some concepts reoccur (e.g., Egypt), yet the context and description of them has changed, based upon the current reporting and situation. While Tim seemed to have only one connection to the word meadow, we can speculate that perhaps after the class he had another. Tim's meadow cue, whether described as correct or incorrect, as well as the other cues identified that might have been categorized as being off-track, reach beyond the topic at hand, perhaps even beyond the domain. The cues provide the prompt to move beyond a topic and connect the information in an idiosyncratic way, a corner to a different dimension in one's knowledge.

Beyond Domains: Trajectories and Dimensions

Once a cue was encountered, the learner followed a path, or trajectory, through the current slice of the rhizome. If a cue is a cognitive corner, the trajectory is the street that the learner is on once the corner is turned. Rather than describing the trajectory by the actual script of experiences and thoughts, a trajectory may be better described by the nature of the path, or the dimension at which the learner arrived. The nature of this path could be characterized in a number of ways, based on the type of experience and who the players in the experience were. Trajectories identified in the data were: experience (activity), personal (thoughts and ideas), family, friends, school, society, emotion/affect, and abstract ideas.

Following the observation of the first grade reading group, Tim was interviewed. He confirmed the observation made by the teacher, Tim derived his meaning of the word meadow from personal experience based on where his grandfather lived.

Tim gave me a summary of The Frog and the Toad, the story his reading group had discussed, which had contained a new reading word: meadow. I asked "I remember you were talking about your grandpa. What made you think about that?"

"I don't know. When she said 'meadow' I thought of that one."

"Yeah, because he lives in place that's called Meadow," I paused, not remembering.

"Wood," he quietly interjected.

"What was it called, Meadow Wood?"

"For old people that have strokes," he continued. "He had a stroke and he's paralyzed and, um, we just go there to visit him."

"Oh, sounds like a nice place for him."

"Yeah, it has a water fountain, there's a dining place where he used to be able to go out and get food there, when my great-grandma was alive, but she died. And he can't go there any more because his foot's too swollen."

"Oh."

"There's lots of neat things there."

"Yeah. They called it Meadow Woods and your teacher said that's maybe because it used to be a meadow, right."

"Used to be a meadow," he, again very quietly, said.

"So what's a meadow like?" I asked.

"I don't know. It's pretty calm, quiet." (Tim, age 6, April 6, 1998)

Although it is not clear if Tim ever developed the teacher's definition for the word meadow, it seems clear that Tim's conception of meadow, and the context from which it emerged was a particularly meaningful connection of Tim's. The meadow cue led to a rich description characterized by a number of dimensions. Tim's trajectory, the nature of the path that the cue "meadow" led him, could be characterized as an experience because he had experienced Meadow Wood first hand and visited his grandfather, and also has a family dimension. Although Tim doesn't express emotion overtly about this grandfather, his way of communicating and his mentioning sickness and death, provided an emotion/affect dimension. Tim's trajectory extended beyond the domain area of reading, the story of The Frog and the Toad, and the new word "meadow."

Anne's trajectory on art could be classified in multiple ways as well. It followed from an experience, but also included society (art in churches) and also school given that she attends a parochial school. Beth's Christmas cue likewise had both society and school connections. Although she didn't specify, we can also speculate that there would also be experience and family connections.

Wendy's re-presentations provide an example of ties both within and beyond a domain. The nature of the paths largely focused on society and school (although the wars she mentioned had not been studied in the current school term) as well as personal (without an identified experience). Wendy's ability to synthesize ideas is instructionally encouraging, indicating a number of possibilities for considering knowledge in a multidimensional way, synthesizing within the domain, as well as reaching outside of it to broader societal issues. Although history was Wendy's favorite subject, she struggles with it and her other school subjects when it comes to assessment. Her interest and synthesis abilities do not seem to emerge in the classroom.

Cues are easy to identify, often being of singular type and usually simple (such as a single word). Trajectories are more difficult to capture, given the number of ways the nature of the path could be described. While it seems redundant to classify a trajectory as both experience and family for example, the further classification

provides a more accurate description of the context that surrounds the trajectory. When considering another context, notions like Tim's view of meadow can no longer be incorrect, only idiosyncratic.

When considering cues and trajectories in relation to the rhizome metaphor, they begin to provide a description of a slice of the rhizome, a local description from the view of the individual. A cue is that point from which there can be an infinite number of connections. At that point, the trajectory that will be followed is not only based upon that cue, but the infinite number of connections that exist with that cue. The path a learner follows at the moment relies on past experience and knowledge that have been parts of previous trajectories, each leaving "cue residue" that can be connected at any time should the context and new information be remotely appropriate. These cues are not teacher defined. Only the meadow cue reported here might be considered an intentional cue, the teacher trying to build cues by building vocabulary. Both classrooms were didactic in nature and the teachers were seeking answers that had been defined a priori to their questions. The trajectories of the students were not a part of the intended path that the teacher would have set through the rhizome yet provided potential relevant connections for that particular child. This brings up compelling questions about the implications for instruction from a constructivist perspective, a view that should find value in the nature of these self-identified cues and idiosyncratic trajectories.

Implications for Instruction

Within the constructivist perspective a number of instructional strategies have been discussed, including problem based learning (Savery & Duffy, 1996), cognitive apprenticeships (Collins, Brown, & Newman, 1989), and anchored instruction ((CTGV), 1990). Principles that these instructional strategies embrace include that of learner ownership, generating and gaining multiple perspectives, providing a range of contexts in which the concept might appear, anchoring to a larger task or problem, and providing for reflection on the process and content (Honebein et al., 1993).

A number of these characteristics provide a framework for the role of cues and trajectories in instruction. Learner ownership, taking responsibility for his or her own learning and performance, is something which cannot be directly handed to a learner (Honebein et al., 1993). In fact, oftentimes, learners will reject the specific learning objective that might be specified by the teacher (Savery & Duffy, 1996). In this study, it is difficult to imagine that Anne, for example, accepted and owned the predefined instructional goal in the study of Charlemagne, considering her boredom with the class and her inattentiveness. However, even for Anne, there was a cue, or hook, that could potentially provide relevance for her learning. Art is a concept that Anne had some interest in and could be used to provide her an opportunity to find relevance in her learning of a boring subject. The didactic nature of the classroom did not allow for this opportunity to occur and, in her summary of the lesson, Anne seems to know little about the topic. A self-defined cue, such as art for Anne or any of the cues that occurred in Wendy's re-presentations, could provide avenues whereby ownership could be developed by learners within the instructional process. Although a teacher cannot know what simple ideas or words might serve as cues for each learner, the facilitator role allows interaction to occur where a student may be willing to express a cue and what trajectories might be followed—providing personal relevance to the topic. The teacher can then guide the learner to purposefully choose a trajectory that is relevant for the learner as well as appropriate within the curriculum.

We could consider that Tim actually clung to the notion of learner ownership as he kept trying to use his meadow as the meadow the teacher was talking about, offering his characteristics of meadow from his perspective. His personal definition, although seemingly incorrect, provided an opportunity for him to add personal relevance to his learning. Further, Tim provided a perspective different than the teachers, his own. Generating and gaining multiple perspectives can only come after a child has developed his or her own perspective. Further, learners' perspectives must be considered to be viable. What is the chance of generating multiple perspectives if a perspective is immediately labeled by another as not viable?

Anne, Wendy, and Beth's interviews were all held after the same class lesson on Charlemagne. Yet, each of them had different self-selected cues that provided them an opportunity to extend beyond the class topic and the explicit information presented. As each child provided a brief synopsis in her interview of what had been covered in class, each remembered different aspects, personally relevant because of her own experiences, knowledge, concerns, and interests. Not surprisingly, Beth's synopsis contained a statement about Charlemagne being crowned Holy Roman Emperor, Wendy's included a listing of his wars and who he fought, and Anne mentioned the artwork in the church. Each could develop a different perspective on the topic if provided the opportunity. Sharing these perspectives could lead to gaining multiple perspectives. But, for that to occur, each child would need the opportunity to further expand their personal view of the topic into a perspective.

A methodological question arises when one considers that the re-presentations described in the interview did not actually occur previously in the classroom as reported. Certainly, it is possible that the students (other than Tim) could not have had these re-presentations in class at all. But, perhaps it is not important. The fact that cues and trajectories could exist, whether in the classroom or in a private interview, indicates that the connections between personal experience and knowledge to the new information are easily accomplished. Perhaps learners have been trained to self-regulate their learning too well, not offering personal links. What is needed is support for students to

thoughtfully consider meaningful cues based on personal experience and synthesize the trajectories with the new information. Rather than convergence, divergence and a broader view of knowledge is needed both for teachers and learners.

It seems that learner ownership and generating and gaining multiple perspectives will go hand in hand. It also seems that a likely place for these to develop is by providing students opportunities to self-identify cues and then follow a personal trajectory. Despite a didactic teaching environment, cues did emerge on their own. The fruitfulness of the trajectories that a learner may choose to follow will only become evident if the instructional method provides an opportunity for it to be followed and considered. Given the infinite number of entrances into the rhizome, each one unique to an individual learner, it seems like it might be easier to consider knowledge structures as multidimensional than to constrain them.

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THE RELATIONSHIPS BETWEEN NAVIGATIONAL PATTERNS AND INFORMATIONAL PROCESSING STYLES OF HYPERMEDIA USERS

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Abstract

This study investigated the relationships between hypermedia users' information processing styles and navigational patterns. Three aspects of navigational patterns were investigated: (a) navigational depth patterns which reveal how comprehensively users access, (b) navigational path patterns which display what sequences users follow, and (c) navigational method patterns which show what methods users employ when using the system.

Information processing styles were measured by the Human Information Processing Survey. The subjects were 102 undergraduate students enrolled in management courses at a university. Participation was voluntary. 34 students were selected for each of left, right, and integrated information processor group. The subjects interacted with A.g.i.l.e. Resource™ program to complete two types of searching tasks, open-ended and closed-ended tasks.

Findings indicated that:

1. Significant differences were found among groups in navigational depth patterns. The right dominant information processing style subjects accessed significantly more new nodes than did the left dominant information processing style subjects.

2. There was a significant relationship between information processing style and navigational path pattern. The right dominant information processing subjects followed significantly more linear paths than the integrated information processing style subjects. The right dominant information processing subjects also followed a lot more linear paths than the left information processing style subjects, although it was not statistically significant.

3. There was a significant relationship between information processing styles and navigational method patterns. The left dominant information processing style subjects employed significantly more analytical methods than the right dominant information processing style subjects. In addition, the integrated information processing style subjects used significantly more analytical methods than did the right dominant information processing style subjects.

The present study demonstrated that the information processing style seems to play an important role in how an individual interacts with the hypermedia systems. The conclusion should be confirmed by additional research.

Introduction

Statement of the Problem

Hypermedia systems, used as sophisticated databases and instructional delivery systems, are becoming more powerful and hence more popular in educational and corporate environments. A review of the literature on hypermedia systems indicates that these rapidly evolving systems offer two unique features over traditional media: (a) increased richness of information and (b) nonlinearity of information structure. Many researchers claimed that the overall advantage of hypermedia systems with these two unique features is the ability to accommodate individual differences in various users' learning styles so that learning can be more effective for everyone (Ayersman, 1993; Bermudez & Palumbo, 1994; Grice & Ridgway, 1995; Jonassen, 1988; Larson, 1992). Current interest in hypermedia systems, however, has focused mainly on the systems implementation and software development. Little attention has been paid to the complexity of how different learning style users actually interact with non-linear hypermedia systems (Ayersman, 1996; Beasley & Waugh, 1997; Harmon & Dinsmore, 1994; Savenye, Leader, Jones, Dwyer, & Jiang, 1996).

Many research studies, on the other hand, have focused exclusively on analysis of general users' navigational patterns and categorizing navigational patterns in hypermedia systems themselves. These studies indicate that there are considerable variation among different users in their navigational patterns, including navigational depth which reveals how comprehensively users access the system, navigational path which displays what sequences users travel, and navigational method which shows what navigational means users employ when using the system (Barab, et al., 1997; Beasley & Vila, 1992; Canter et al., 1985; Horney, 1993; Orey & Nelson, 1994; Savenye, 1996; Qiu, 1993). However, relatively few studies have investigated further to identify the factors that might impact diversity of navigational patterns among different users.

The information processing styles implies great influence on variation of individuals' navigational behaviors. The findings of separate bodies of research in information processing styles and navigational patterns imply that left-right brain dominant information processors might interact quite differently within nonlinear

hypermedia systems applying different navigational strategies. Unfortunately, there has been little research to bring the possible implications of information processing styles on users' interaction related to hypermedia systems.

Purpose of the Study

The purpose of this study was to investigate the relationships between users' information processing styles and navigational patterns within hypermedia systems. This study investigated individuals' information processing styles and examined whether information processing styles is related to users' navigational patterns in hypermedia systems. Three aspects of navigational patterns were investigated: (a) navigational depth patterns which reveal how comprehensively users access, (b) navigational path patterns which display what sequences users follow, and (c) navigational method patterns which show what methods users employ when using the system.

Theoretical Framework

Nonlinearity of Hypermedia Systems

Traditional computer-based instruction (CBI) systems are rigid in their information structure (Ellis et al., 1993). The learner has to follow a limited number of predetermined paths, which are structured usually in a linear fashion. Therefore, little opportunity exists for individual choices and hence everybody has to use the system in much the same way.

In comparison, hypermedia systems eliminate the constraints of sequential presentation of information. Instead of organizing and presenting information sequentially with traditional books and CBI systems, hypermedia systems adapt a different concept of information structure. Information in a hypermedia system is stored as small discrete units and is linked together into complex networks. Unlike traditional information systems, which have mostly linear structure, hypermedia systems are nonlinear.

In general, nonlinear hypermedia systems provide users much greater control over navigational strategies than any other traditional media. Nonlinear hypermedia systems allow users to use personalized information-seeking strategies and hence users of hypermedia systems can make their own decisions about navigational strategies based on individuals' preferences to accomplish their objectives and/or needs. In this context, researchers claimed that hypermedia has great potential to address individual differences in users' learning styles (Ayersman, 1993; Rabbitt & Miller, 1996; Jonassen, 1988; Knussen, Kibby, & Tanner, 1991; Reed & Oughton, 1997). The researchers believed that individuals will actively interact with the systems, exploiting the navigational advantage of the nonlinear structure according to users' preference for learning styles. This belief requires further study.

Present State of Research on Navigational Patterns in Hypermedia Systems

According to Ayersman (1996) and Barab, Bowdish, and Lawless (1997), few studies have been conducted to investigate the nature of different individual users' navigation within hypermedia systems. Reed and Oughton (1997) and Savenye et al. (1996) also argued that little empirical research pertaining to how different users interact with nonlinear hypermedia applications has been conducted to date, and that more research needs to be done.

Meanwhile, many other research has focused more exclusively on categorizing navigational patterns in hypermedia systems themselves. The navigational patterns found in the literature are mainly divided into three categories: (a) navigational depth patterns which reveal how comprehensively users access the system, (b) navigational path patterns which display what sequences users follow, and (c) navigational method patterns which show what methods users employ when using the system.

Researchers examined users' navigational depths accessed within hypermedia systems (Canter, Rivers, & Storrs, 1985; Schroeder and Grabowski, 1995). Canter et al. examined navigational depths as an indication of the range of exploration undertaken by users. They grouped navigational depth patterns into three different ranges as high, medium, and low exploration.

Other studies examined users' general navigational path patterns in hypermedia systems. Orey and Nelson (1994) identified four categories of navigational path patterns: *rings*, *loops*, *paths*, and *spikes*. Similarly, Horney (1993) described five navigational path patterns including *linear traversal*, *side trip*, *star*, *extended star*, and *chaotic*. Although these researchers identified various and specific navigational path patterns with hypermedia systems, other researchers categorized navigational path patterns in hypermedia systems more generally, as linear and nonlinear path patterns (Beasley & Vila, 1992; McCluskey, 1993; Parunak, 1989).

Researchers also examined prominent navigational methods users employed when using the system (Beasley & Vila, 1992; Dias & Sousa, 1997; Nielson, 1989; Qiu, 1991, 1993; Savenye et al, 1996). Navigational methods commonly included in hypermedia systems consist of index, keywords search functions, maps, hypertexts, menus, and tables of contents. These navigational method patterns were categorized into two groups, analytical and holistic methods, based on the property of the navigational methods (Campagnoni & Ehrilch, 1989; Marchionini & Shneiderman, 1988; Qiu, 1993). According to Marchionini and Shneiderman (1988), analytical methods are direct navigational means which involve a well-structured search for specific information, while holistic methods are more likely indirect means which involve a relatively unstructured search and assist users' searching process indirectly.

The overall conclusion of those studies on navigational patterns is that there is a great deal of diversity in navigational patterns which individuals employ, including navigational depth, path, and method patterns. In addition, it is widely accepted that the diversity of navigational patterns results from individuals' travel within hypermedia systems using different navigational strategies. Most of the studies, however, did not investigate further why different users rely on so many different navigational strategies when utilizing hypermedia systems. Furthermore, few of these studies considered individuals' learning styles that might impact on users' navigational strategies.

Learning Styles and Information Processing Styles

The term "learning styles" has been used interchangeably with "cognitive styles," "brain dominance," "information processing styles," and "learning modalities" by many (Ayersman, 1993 & 1996; Entwistle, 1981; Liu & Reed, 1994; Marrison & Frick, 1994; Shaughnessy, 1996).

Learning style has long been considered a fundamental element in individual differences, which impact on problem solving strategies in various learning situations (Ayersman, 1993; Carbo, Dunn, & Dunn, 1986; Hanson, 1996; Leader & Klein, 1996; Wilson, 1988). Numerous models for learning styles have been developed. The models are slightly different based on which cognitive variables each model stresses in the learning process.

Witkin's Cognitive Styles (Witkin, 1950) focuses on how learners perceive information in terms of learners' dependency and independency on a surrounding learning environment. Kolb's Learning Styles (Kolb, 1985) deals more with learners' general attitudes in the learning process, such as converger, diverger, assimilator, and accommodator. Sensory Modalities (Sprinthall & Sprinthall, 1990) focuses on individual preferences for sensory input of information as visual learners and auditory learners. Brain hemisphericity (Sonnier, 1992, 96) deals with specific problem solving strategies in performing cognitive tasks based on hemispheric processing preference style.

The information processing styles based on brain hemisphericity theory focuses particularly on individuals' differences in overall information processing strategies for problem solving based on hemispheric information processing preference (Gardner, 1985; Hunter, 1976; Sonnier, 1992; Torrance, 1982; Torrance & Taggart, 1984). The information processing style model examines closely the cognitive strategies of how individuals approach problem solving differently in various learning situations. In this context, information processing style model suggests greater implications on users' navigational strategies than any other learning style models described, since navigational patterns are representations of the strategies used by individuals to process information in nonlinear hypermedia systems.

Functional lateralization of the brain has been investigated in efforts to explain the differences in the abilities of the two halves of the brain. There has been much evidence indicating that there are areas of specialization giving each hemisphere dominance in controlling particular cognitive functions. The overall indications in related literature are that the left hemisphere is predominantly involved with analytic thinking, specifically, language and logic. The right hemisphere, on the other hand, is involved primarily with holistic thinking, responsible for orientation in space, artistic talents, and bodily awareness (Gardner, 1985; Hellige, 1993; Iaccino, 1993; Springer & Deusch, 1989; Taggart & Torrance, 1984).

In addition, human beings are thought to vary in terms of their cerebral dominance. The notion of hemispheric dominance among people is that the individual has an overall preference for using cognitive ability of one side of the brain for problem solving. Numerous studies support the notion of preferred style in hemispheric processing preference among individuals (Herrmann, 1981; Shaughnessy, 1996; Torrance et al., 1984; Zaidel, Clarke, & Suyenobu, 1990). These studies suggest that left-dominant processors usually prefer structured tasks, approach tasks systematically, use analytical strategies, solve problems logically, and are more likely to process information in linear fashion. In contrast, right-dominant processors tend to prefer open-ended tasks, approach tasks by exploration, use holistic strategies, solve problems intuitively, and process information in nonlinear ways.

Implications of Information Processing Styles on Users' Navigation Patterns

Findings of research in brain hemisphericity theory suggest that each side of the brain is dominant in controlling particular cognitive functions for problem solving and that human beings vary in terms of their cerebral dominance. Many studies investigated the effects of individuals' cerebral dominance on problem solving strategies and these studies indicated that cerebral dominance impacts problem solving strategies among people in various learning environments (Herrmann, 1981; Hough, 1987; Robey & Taggart, 1982; Shaughnessy, 1996; Zaidel et al., 1990).

Information processing styles categorized according to brain hemisphericity theory might impact on users' navigational patterns within hypermedia systems. That is because navigational patterns are representations of the strategies used by individuals to process information in nonlinear hypermedia systems much the same as with individuals' problem solving strategies in various other learning environments. Then, there might be relationships between information processing styles among people and navigational strategies they employ within hypermedia systems.

On the basis of the findings of research in information processing styles and navigational patterns, it is implied that left brain dominant information processors might prefer to explore hypermedia systems in a relatively limited depth while right brain dominant information processors might tend to explore with hypermedia systems in a relatively comprehensive depth pattern. Left brain dominant information processors might prefer to access nodes in much more linear path patterns while right brain dominant information processors might be inclined to interact with hypermedia systems in relatively nonlinear path patterns. Similarly, left brain dominant information processors might prefer to navigate within hypermedia systems using more analytical navigational methods such as using index and keyword functions. In contrast, right brain dominant information processors might travel hypermedia systems using more holistic navigational features such as map, hypertext, and table of contents.

Research Questions

The general research questions of this study were as follows:

1. What are the relationships between hypermedia users' information processing styles and their navigational depth patterns?
2. What are the relationships between hypermedia users' information processing styles and their navigational path patterns?
3. What are the relationships between hypermedia users' information processing styles and their navigational method patterns?

Significance of the Study

Results of the study would provide insights into the relationships between navigational patterns and information processing styles of hypermedia users. These results then would provide useful information for advising learners regarding selecting more efficient and effective navigational patterns based on their information processing styles. In addition, the detailed information of users' navigational behaviors could provide further guidance for designing hypermedia applications that are more effective and more user-centered. The results of this study could also provide additional information that would verify the effectiveness of hypermedia systems in terms of addressing individual differences.

Method

Operational Definitions

Hypermedia Environment: The A.g.i.l.e. Trainer™ hypermedia program developed by Knowledge Solutions Inc. Bethlehem, PA (Harvey & Nelson, 1995).

The A.g.i.l.e. Trainer™ includes a more flexible navigational structure that uses pull-down menus than other programs in which “next” and “previous” buttons are the most obvious navigational means to travel the system. Refer to Figure 1 through Figure 3 for basic screen layouts of three sets of pull-down menus in the A.g.i.l.e. Trainer™.

It is important to note that lists of resources in the pull-down menus represent the available nodes in the experimental system. The researcher used the term node when referring to an information resource in the system.

Figure 1. Pull-Down Menu in “Course” Interface

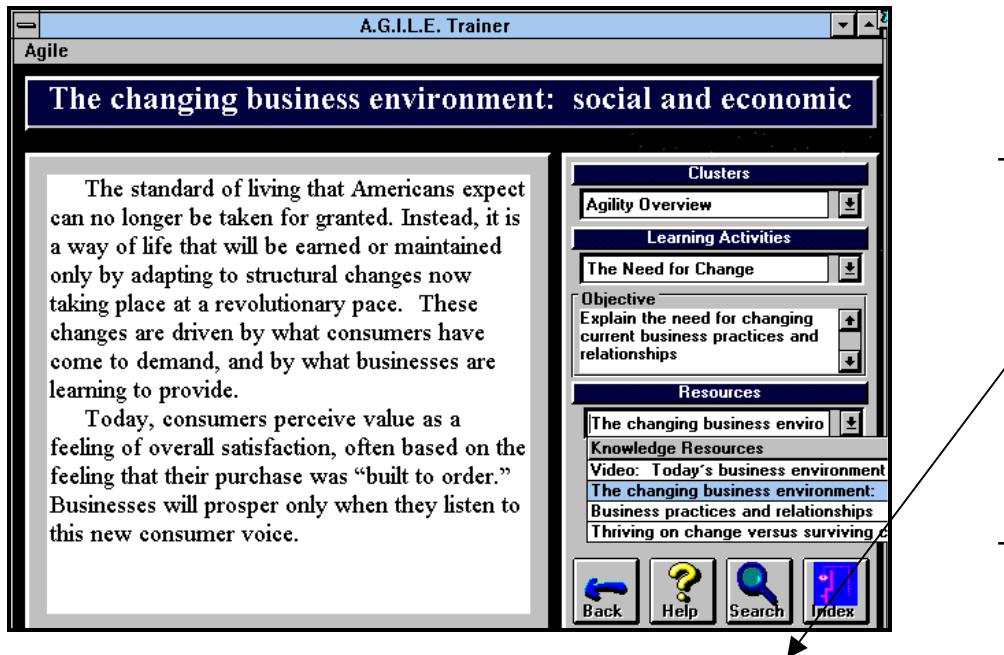


Figure 2. Pull-Down Menu in “Search” Interface

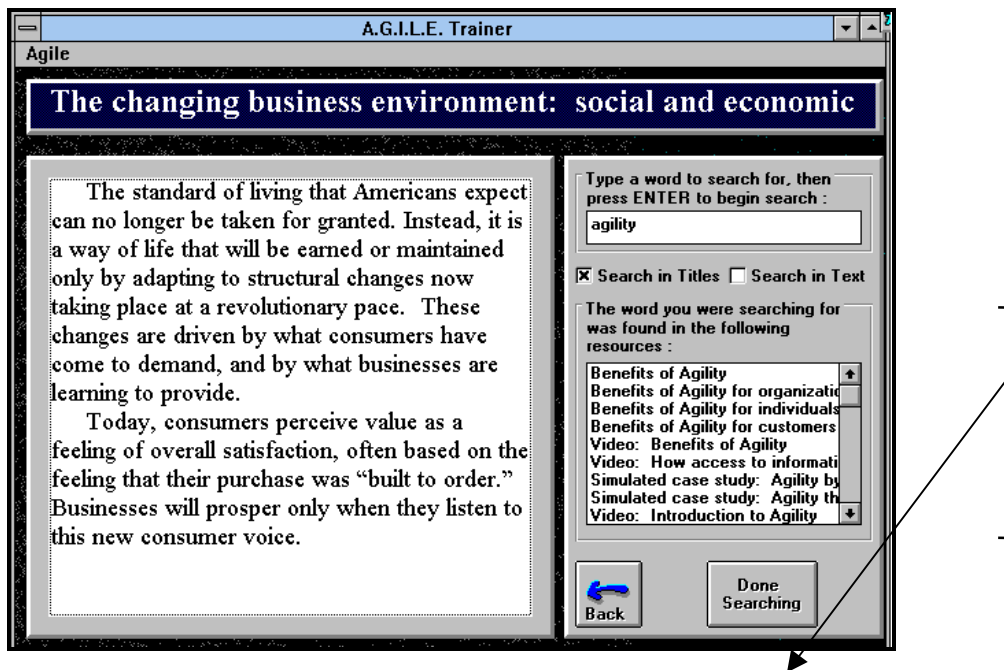
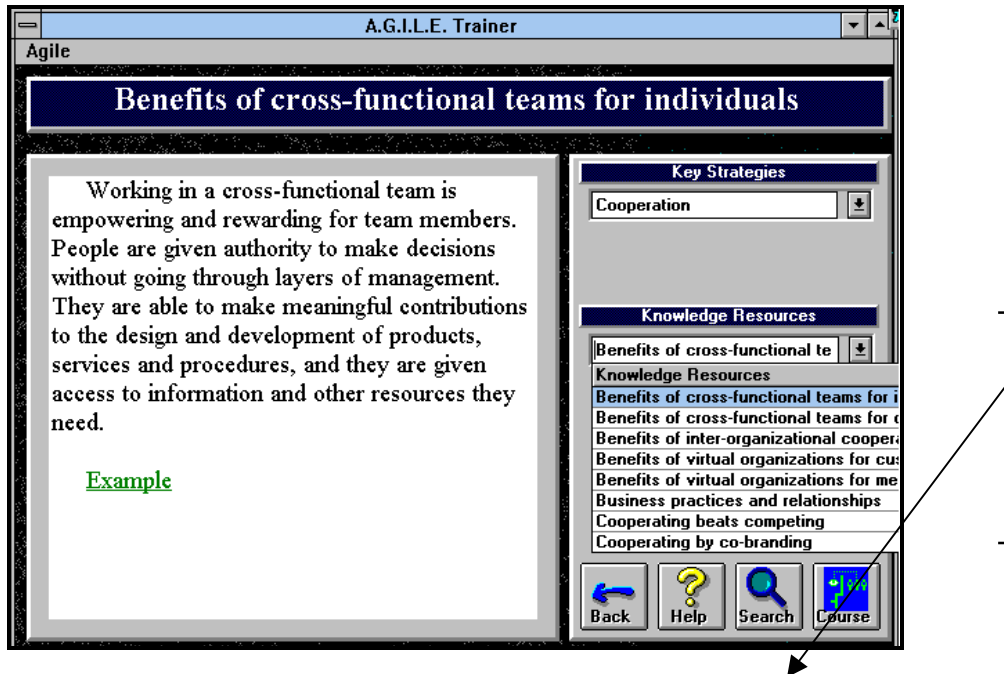


Figure 3. Pull-Down Menu in “Index” Interface



Left, Right, and Integrated Information Processors:

Three different styles of information processors categorized by the Human Information Processing Survey (HIPS) (Torrance et al., 1984).

It should be noted that the HIPS categorizes four different information processors: (a) left, (b) right, (c) integrated, and (d) mixed. The mixed information processors, however, was excluded from this study. The reason for excluding this group was that mixed information processors typically use either left or right brain dominant strategies at random and therefore this group of people was not likely to show any dominant navigational patterns.

Navigational Depth

Subjects' scores on exploration value, which is adapted from Canter et al. (1985):

$$\text{Exploration value} = \frac{\text{The number of different nodes visited}}{\text{The total number of nodes available in the system}}$$

The exploration value ranges from 0 to 1. The higher the exploration value, the more comprehensive the navigational depth pattern is and the lower the exploration value, the more limited the navigational depth pattern is in the current study.

Depth refers to the degree of users' exploration by accessing nodes both in different levels and across the same level in the system structure. It should be noted that nodes visited repeatedly are counted only once in the current study. That is because the objective here is to examine how comprehensively users explore various nodes available in the system. The performance of subjects who take repeated visits to the same node will be analyzed in a follow-up study.

Navigational Path

Subjects' scores on linearity value, which is defined as:

$$\text{Linearity value} = \frac{\text{The number of linear navigational links followed}}{\text{Total number of either linear or nonlinear navigational links followed}}$$

A linear link is defined as a link between two nodes connecting a node to a subsequent node that is listed adjacent to the first node chosen in a pull-down menu. A navigational link between two nodes connecting a node to the previous node visited using "Back" button is also a linear link. A nonlinear link is defined as a link between two nodes connecting a node to a subsequent node that is not listed adjacent to the first node chosen in a pull-down menu. In addition, a link between two nodes connecting a node in a navigational method to a subsequent node in

another method is a nonlinear link. Any navigational links connecting two nodes by clicking hypertexts were also considered as nonlinear links.

The linearity value ranges from 0 to 1. The higher the linearity value, the more linear the navigational path pattern is and the lower the linearity value, the more nonlinear the navigational path pattern is in the current study.

The pull-down menus display the list of nodes available in the system and users can access any information in the list at any time in any sequence. Users can navigate the system in either a linear or nonlinear sequence simply by choosing nodes which are listed adjacent to each other or which are not listed adjacent to each other, respectively, as indicated in the pull-down menus.

Navigational Method

Subjects' scores on analytical methods value, which is adapted from Qiu (1993):

$$\text{Analytical methods value} = \frac{\text{The number of analytical methods employed}}{\text{Total number of navigational methods employed by analytical, holistic, or mixed methods.}}$$

Analytical methods are defined as navigational means that lead a direct and well-structured search for a specific information sought. Analytical methods include search (keyword search) and index. Holistic methods are defined as indirect and less-structured navigational means that assist users indirectly to find information sought. Holistic methods include course (table of contents), help, back, done searching, and hypertext.

An analytical or a holistic method were counted each time one of the method is used to create a link between two nodes. A mixed method was counted each time combinations of analytical and holistic methods are used to create a link between two nodes.

Analytical methods value ranges from 0 to 1. The higher the analytical methods value, the more analytical the navigational method pattern is and the lower the analytical methods value, the more holistic the navigational method pattern is in the current study.

The A.g.i.l.e. TrainerTM program supports the following navigational methods summarized in Table 1.

Table 1. Types of Navigational Methods in A.g.i.l.e. TrainerTM Program

Methods	Description	Analytical-Holistic
Back	To return to the node user most recently visited.	Holistic
Course	To bring an interface which allows user to search information using a pull-down menu.	Holistic
Search	To bring an interface which allows user to search specific information by typing keywords.	Analytical
Done Searching	To return to the course interface from search interface.	Holistic
Help	To go to a help screen about general guidelines for navigating the system.	Holistic
Index	To bring an interface that allows user to search specific information presented in index.	Analytical
Hypertext	To go another node which describes the content about the hypertext by jumping to a node out of sequence in the system.	Holistic

Sample

The sample subjects were 102 undergraduate students enrolled in management courses in the College of Business and Economics at Lehigh University. Participation was voluntary. To ensure maximum participation, incentives in the form of bonus points were offered in the courses in which the subjects were enrolled. Thirty four students were selected for each type of hemispheric processing preference style (left, right, or integrated).

Instruments

Human Information Processing Survey

Human Information Processing Survey (HIPS) is a tool for assessing individuals in terms of hemispheric processing preference (Taggart & Torrance, 1984). This survey yields four possible categories of information processors: (a) left dominant, (b) right dominant, (c) mixed, and (d) integrated information processors. According to Taggart and Torrance, left brain dominant processors think in predominantly systematic ways, approach tasks sequentially, and solve problems analytically. On the other hand, right brain dominant processors are believed to adapt primarily the opposite strategies in problem solving such that they think in an exploratory manner, approach tasks non-sequentially, and solve problems in holistic ways. Integrated information processors are individuals who use simultaneously the left and right dominant strategies in proportion appropriate for the situation while mixed information processors are individuals who use either a left dominant or a right dominant strategy at random.

Open-Ended Questions and Closed-Ended Questions

The researcher designed two types of computer task questions, 3 items for open-ended tasks and 5 items for closed-ended tasks in order to assist users in using the experiment program purposely and comprehensively. Open-ended tasks in this research required users to respond in general terms based on understanding the overall content of the hypermedia system. Close-ended tasks in this research required users to respond in specific terms that can be found in the hypermedia system.

The questions were reviewed by the developer of the A.g.i.l.e ResourceTM hypermedia program, Dr. Nelson, Vice President for Development, Knowledge Solution Inc. to determine whether questions adequately address the intention for leading users to use the program purposely and comprehensively. He agreed that the questions adequately address the purpose. It was not necessary to make any changes to the instrument. No formal statistical analysis to determine reliability of the instrument was performed since the questions are a part of treatment to assist the subjects in using the experiment program purposely.

Subject Demographic Information Questionnaire

The researcher designed a subject demographic information questionnaire. The questionnaire was used to collect demographic data on the sample in order to determine gender, age, year in college, previous computer training, and computer expertise of each subject.

Demographic data were used to determine whether there were initial differences other than brain hemisphericity among three information processor groups. No formal statistical analysis to determine validity and reliability of the instrument was performed since the questionnaire was not for testing any effects. Rather, the questionnaire was for collecting demographic information of the subjects.

Research Design

The causal-comparative research design was used to explore the relationships between hypermedia users' information processing styles and their navigational patterns. The causal-comparative research method was selected instead of the experimental method because it allows the researcher to study the relationships between variables under a condition where experimental manipulation is not possible. It was impossible for the researcher to manipulate hypermedia users' information processing styles and their navigational behaviors in using the program. The hypermedia program were also given as a study environment rather than as an experimental treatment manipulated for the study.

The independent variable in the present study was the informational processing styles of the users. It had three categories: (a) left dominant information processors, (2) right dominant information processors, and (c) integrated information processors. The dependent variables were the three different navigational patterns: (a) navigational depth patterns, (b) navigational path patterns, and (c) navigational method patterns.

Three separate one-way analysis of variance (ANOVA) were used to test the three hypotheses stated individually. ANOVA was selected to test the null hypotheses because the study involves comparison of three groups. The researcher also judged that three separate one-way ANOVA would be appropriate to test the hypotheses since the study had one categorical independent variable and three measured dependent variables which were not related to one another (Borg & Gall, 1989).

The Statistical Package for Social Science (SPSS Inc., 1995) was used to perform the ANOVA procedures. An alpha level of .05 was set as the criterion for rejection of the null hypothesis. According to Borg and Gall (1989), the .05 level is the most commonly chosen alpha level for rejecting the null hypothesis in educational research.

A power level of .70 assuming a medium effect size of .25 was used throughout the study. Cohen (1969) reported that .80 serves as a convention for desired power level.

Pilot Study

A pilot study was conducted to make sure that the procedures and the instruments to be used in the study operate properly. The main objective of the pilot study was to test the hypermedia system and computer utility that records users' interactions within the hypermedia system. At the conclusion of the pilot study, procedures and instruments were examined by the researcher to determine if they performed satisfactorily. Some minor changes were made according to the results of the pilot study.

Research Study

Hypermedia Program - A.g.i.l.e. Trainer™

The A.g.i.l.e. Trainer™ is an interactive multimedia CD-ROM knowledge base about organizational agility and examples of agile practices. The A.g.i.l.e. Trainer™ is developed by Knowledge Solutions Inc., Bethlehem, PA (Harvey & Nelson, 1995). The program is designed as a reference tool or self-teaching module. It is aimed toward various levels of users in terms of computer experience from novice computer users to expert computer users.

The A.g.i.l.e. Trainer™ contains various types of information including text, graphics, sound, video, and animated segments that illustrate principles and provide examples about agility. The A.g.i.l.e. Trainer™ provides hundreds of resources about agility and introduces more than 175 companies as examples of high-performance in business. The A.g.i.l.e. Trainer™ has powerful features that are easy to use. Hundreds of information-providing text screens are electronically linked and the relationships among them are apparent.

The A.g.i.l.e. Trainer™ requires a 386 or higher IBM compatible computer, 256 color VGA monitor, MPC compatible sound card and speakers, at least 4MB RAM, 5MB HD space, and Windows 3.1 or later.

Search Tasks

Previous studies indicated that the search task is a major factor that influences navigational patterns in general (Campagnoni & Ehrlich, 1989; Nielson, 1989; Qiu, 1993). For instance, an open-ended task leads users to navigate the hypermedia system using holistic methods while a closed-ended task leads users to employ more analytical methods. The current research, however, attempted to determine the relationship between users' information processing styles and navigational patterns within hypermedia system regardless of search tasks. The researcher, therefore, provided two types of tasks, open-ended tasks and closed-ended tasks for all users, so that users would navigate the hypermedia program for identical tasks.

Procedures

The research study administered by the researcher and an assistant throughout most of data collection process. The assistant trained to help the research process only as directed by the researcher in order to avoid any risk of having the results affected by the assistant. The assistant was not allowed to respond to any requests or questions directly related to the research study. Rather, the assistant helped only for mechanical tasks such as distributing materials, collecting materials, installing the A.g.i.l.e. Trainer™ program, trouble shooting, and other activities that would not affect the results.

The research study was divided into two sessions, session A and session B. Session A was for drawing sample subjects and session B was for conducting the main experiment with the hypermedia program.

In session A the researcher visited three management classes, MGT 269(1), MGT269 (2), and MGT 270, in the College of Business and Economics. The combined enrollment of these classes was approximately 200 students with about 65 students for each class. Professors of each class, Dr. Trent and Dr. Poole, agreed to have their students participate in the study and to offer incentives in the form of extra credit in the courses that the subjects were enrolled. The researcher visited the three management classes at the end of each class. Each student was given a brief explanation of what was required of him or her in the experiment and a consent form was signed. The subjects were then be asked to complete the Human Information Processing Survey (HIPS) which is a pencil and paper self-report inventory. The survey took 20 to 30 minutes.

Upon completion of the HIPS, the researcher scored the responses and identified subjects' hemispheric processing styles following the instructions in the HIPS. the researcher selected randomly among the participants approximately 40 subjects, using a lottery system for each type of hemispheric processing preference style (left, right, or integrated) for the experiment. The selected subjects then were asked to choose a time slot on the schedule arranged for the main experiment. Experiment times were scheduled at least twice a day for five days, one AM and one PM, for an hour so that subjects could participate at times that were convenient for them.

In session B subjects were assigned identification numbers randomly by following a lottery system. These assigned numbers were used on all tests and forms to be completed by the subjects. The master list of assigned numbers were maintained by the researcher.

Subject demographic information questionnaires were administered to all subjects before they participated the main experiment with the hypermedia program. The directions for how to use the hypermedia system and the

main experimental procedure were given using a videotape recording in order to keep the consistency among subjects who participated in the experiment at different experiment times. Prior to conducting the formal experiment with the program the videotape provided a short demonstration to the subjects about the experimental system including the overall structure of the hypermedia system and how to navigate within the system. All subjects had an opportunity to try out the system until they feel confident about using it.

The subjects then were asked to perform the two tasks. The first task was to answer the open-ended questions based on the content in the hypermedia system. The subjects were asked to browse the hypermedia system, A.g.i.l.e. TrainerTM, to get familiar with the concept of Agility and to answer the three general questions in the work sheet. A copy of the open-ended questions were given to the subject after subjects review the program as they might wish. The researcher was not be able to answer any questions the subjects might have while subjects interacted with the experimental program, other than making sure equipment was operating correctly. The users interaction activities with the hypermedia system were recorded using a Window environment utility called 'Recorder.' The Recorder recorded user interactions simultaneously while users interacted with the hypermedia system. The computer files of the recording results were saved by the researcher and the assistant when the subject indicated he or she was finished.

Next, the subjects were asked to perform the second task which were closed-ended questions to answer based on specific information that could be found in the hypermedia system. The researcher did not answer any questions the subjects might have while subjects interacted with the experimental program, other than making sure equipment was operating correctly. The users' interaction activities with the hypermedia system were again recorded using a Windows environment utility called 'Recorder.' The Recorder was running while users interacted with hypermedia system at the same time. The computer files of the recording results were saved by the researcher and the assistant when the subject indicated he or she was finished.

Data Collection

Details of each user's interactions with the hypermedia program were recorded using the 'Recorder' utility for Windows (Windows 3.1, 1993). The 'Recorder' automatically recorded and saved as a movie file exactly what users did and how they interacted with the program.

The measurement of the variables of the study required the development of a data processing procedure specifically for the study since the study uses a non-standard (self-developed) measure (Borg & Gall, 1989).

The researcher applied guidelines on data processing procedures from several research handbooks (Borg & Gall, 1989; Kidder, 81; Livingston, 1988; Savenye & Robinson, 1996) to develop valid and reliable data processing procedures. The data processing procedures in the study were as follows:

Data reduction procedures. The original data were collected using the 'Recorder' program. The 'Recorder' recorded exactly what users did and how users interacted with the experimental environment program saving the result as a recorder file just as the same format as a videotape recording. A data reduction process was needed to convert the original raw data from recorder files format to a written document format in order to simplify the process of representation and analysis of the data for the study (Kidder, 1981). One third-party reviewer reviewed the "Recorder" files and recorded subjects' interactions within the experimental program in a data reduction form in order to make the data ready for data coding process.

Data coding procedure. The researcher developed specific data coding rules for the study that included a set of specific steps to follow for data coding. An external evaluator reviewed the protocol of data coding rules in order to validate the rules for the study. The evaluator checked the coding rules to ensure clarity and the appropriateness of information so that raters could make decisions based on the coding rules.

The researcher refined the coding rules based on the evaluator's suggestions. When the final coding rules were ready, two external raters coded the data, following the coding rules. Two separate external raters coded the entire data set in order to yield more valid and more reliable results than would be produced by one rater alone. The coding rules were fully tested with the two raters before the raters actually applied the rules to code the data.

After coding trials indicated that the raters yielded satisfactory codes for the same data, each rater began to code separately the entire subjects' data. The researcher examined the results of the raters' coding data and resolved any disagreements in coding between the two coders.

Results

Descriptive Analysis

Demographic Data

The demographic data were obtained to determine whether there were initial differences other than information processing styles among three information processor groups. A demographic information questionnaire designed by the researcher was used to obtain complete descriptions of the subjects in three groups.

The researcher found strong similarities in the distribution of subjects among three groups in gender, age, years in college, previous computer training, and computer expertise. This demonstrates the benefits of drawing subjects from a large population group. The researcher used formal tests to verify that the groups were equivalent and represented the data in a later section of analysis of demographic data.

Analysis of Navigational Pattern

Navigational depth. Navigational depth is a measure reflecting how many new nodes a user visits when navigating in a hypermedia system. In this study, navigational depth was measured by the subjects' scores on exploration value, which was defined as the ratio of the number of different nodes visited to the total number of nodes available in the system. The exploration value will range from 0 to 1.

Table 2. Means and Standard Deviations for Navigational Depth

Groups	<u>n</u>	<u>M</u>	<u>SD</u>	<u>S. Error</u>
Left Information Processors	34	.0489	.0125	.0021
Right Information Processors	34	.0581	.0184	.0032
Integrated Information Processors	34	.0493	.0133	.0023

Navigational path. Navigational path is a measure reflecting which sequences a user travels when navigating in a hypermedia system. Navigational path was measured by subjects' scores on linearity value, which was defined as the ratio of the number of number of linear navigational paths followed to the total number of either linear or non-linear navigational paths followed. The linearity value ranges from 0 to 1.

Table 3. Means and Standard Deviations for Navigational Path

Groups	<u>n</u>	<u>M</u>	<u>SD</u>	<u>S. Error</u>
Left Information Processors	34	.3528	.1301	.0223
Right Information Processors	34	.4076	.1244	.0213
Integrated Information Processors	34	.3325	.0722	.0124

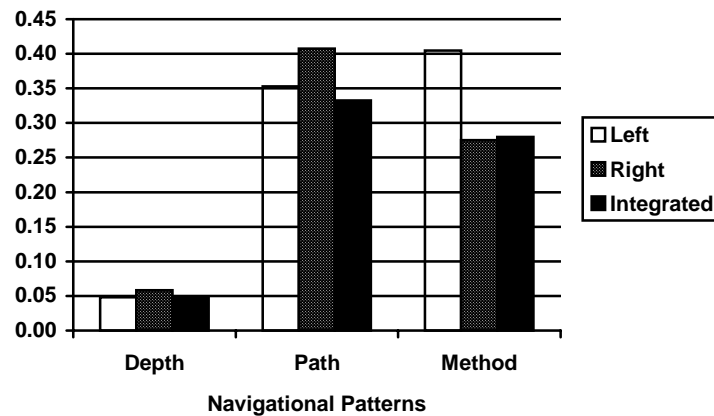
Navigational method. Navigational method is a measure reflecting which methods users employ when navigating in a hypermedia system. The score was measured by the analytical methods value, which was defined as the ratio of the number of analytical methods employed to the total number of either analytical or holistic navigational methods employed. Analytical methods value ranges from 0 to 1.

Table 4. Means and Standard Deviations for Navigational Method

Groups	<u>n</u>	<u>M</u>	<u>SD</u>	<u>S. Error</u>
Left Information Processors	34	.4048	.2271	.0390
Right Information Processors	34	.2751	.1717	.0294
Integrated Information Processors	34	.2797	.1665	.0286

A graphic comparison of the mean scores for navigational depth, path, and methods among left dominant information processors, right dominant information processors, and integrated information processors is presented in Figure 4.

Figure 4. Mean Scores for Navigational Patterns among Left Dominant Information Processors,



Right Dominant Information Processors, and Integrated Information Processors

Inferential Analysis

Three separate one-way ANOVA's were performed to determine whether there were significant mean differences in three different navigational patterns (navigational depth, path, and method) among left dominant information processors, right dominant information processors, and integrated information processors.

The independent variable in the present study was the information processing style of subjects, which had three levels: left, right, and integrated information processors. The dependent variables were the three different navigational patterns: (a) navigational depth patterns, (b) navigational path patterns, and (c) navigational method patterns.

Analysis of Demographic Data

One-factor ANOVA's were performed to determine whether there were initial differences between groups on several variables. There was no significant difference between groups on gender ($F(2, 90) = .770, p > .05$), age ($F(2, 90) = .132, p > .05$), and year in college ($F(2, 90) = .125, p > .05$). There was also no significant difference between groups on previous computer training ($F(2, 90) = 1.998, p > .05$) and computer expertise ($F(2, 90) = 1.573, p > .05$).

Information Processing Style and Navigational Depth Pattern

Null hypothesis 1. There is no significant difference in navigational depth patterns among left dominant information processors, right dominant information processors, and integrated information processors when navigating in a hypermedia environment.

Null hypothesis 1 was rejected. There was significant mean difference in the average of navigational depth among left dominant information processors, right dominant information processors, and integrated information processors ($F(2, 99) = 4.052, p < .05$).

Table 5. One-way ANOVA for Navigational Depth

Source	df	SS	MS	F	p
Between	2	.0018	.00089	4.052	.020
Within	99	.0022	.00022	--	--
Total	101	.0239	--	--	--

Post hoc Scheffé analysis indicated that the comparison between navigational depths for left dominant information processors and for the right dominant information processor was significant at the .05 level of significance.

Table 6. Post Hoc Scheffé Analysis for Navigational Depth

Comparison of Navigational Depth	Mean Difference
Left versus Right	.0091*
Left versus Integrated	.0004
Right versus Integrated	.0087

*. The mean difference is significant at the .05 level.

Information Processing Style and Navigational Path Pattern

Null hypothesis 2. There is no significant difference in navigational path patterns among left dominant information processors, right dominant information processors, and integrated information processors when navigating in a hypermedia environment in terms of the degree of linearity.

Null hypothesis 2 was rejected. There was a significant mean difference in the average of navigational path among left dominant information processors, right dominant information processors, and integrated information processors in terms of the degree of linearity ($F(2, 99) = 4.089$, $p < .05$).

Table 7. One-way ANOVA for Navigational Path

Source	df	SS	MS	F	p
Between	2	.103	.0513	4.089	.020
Within	99	1.241	.0125	--	--
Total	101	1.344	--	--	--

Post hoc Scheffé analysis revealed that the only comparison between navigational paths that was significant at the .05 level of significance was the comparison between navigational paths for right dominant information processors and for integrated information processors.

Table 8. Post Hoc Scheffé Analysis for Navigational Path

Comparison of Navigational Path	Mean Difference
Left versus Right	.0548
Left versus Integrated	.0220
Right versus Integrated	.0751*

*. The mean difference is significant at the .05 level.

Information Processing Style and Navigational Method Pattern

Null hypothesis 3. There is no significant difference in navigational method patterns among left dominant information processors, right dominant information processors, and integrated information processors when navigating in a hypermedia environment in terms of navigational methods they employ.

Null hypothesis 3 was rejected. There was significant mean difference in the average of navigational methods among left dominant information processors, right dominant information processors, and integrated information processors in terms of navigational methods they employ ($F(2, 99) = 5.075$, $p < .05$).

Table 9. One-way ANOVA for Navigational Methods

Source	df	SS	MS	F	p
Between	2	.368	.1840	5.075	.008
Within	99	3.589	.0363	--	--
Total	101	3.957	--	--	--

Post hoc Scheffé analysis revealed that the comparison between navigational methods for left dominant information processors and for the right dominant information processor was significant at the .05 level of significance. Post hoc Scheffé analysis also showed that the comparisons between navigational methods for left dominant information processors and for integrated information processors was significant at the .05 level of significance.

Table 10. Post Hoc Scheffé Analysis for Navigational Methods

Comparison of Navigational Methods	Mean Difference
Left versus Right	.1296*
Left versus Integrated	.1251*
Right versus Integrated	.0046

*. The mean difference is significant at the .05 level.

Discussion

The difference in the average of navigational depth among the three information processor groups seems to support the suggestion that right brain dominant subjects primarily approach problem solving tasks in an exploratory manner, while left brain dominant subjects approach problem solving tasks in predominantly systematic ways.

Right dominant information processing subjects, as expected, accessed significantly more new nodes than left dominant information processing subjects. This result is consistent with a similar study on cerebral hemisphericity and a Hypercard program conducted by McClusky (1993). McClusky reported that right brain dominant subjects outperformed the other groups (left brain dominant subjects and integrated subjects) in the number of new nodes visited within a Hypercard program.

On the basis of the findings of prior research in the field of hemispheric information processing preference and navigational patterns, the researcher expected that right dominant information processing subjects would prefer to interact with hypermedia systems in a relatively exploratory and comprehensive manner, visiting a large number of new nodes. In addition, surveying the literature also led the researcher to predict that left dominant information processing subjects would prefer to interact with the system in a systematic and conservative manner, accessing only very limited nodes. The result that right dominant information processing subjects accessed significantly more new nodes than did left dominant information processing subjects supports the researcher's expectations in conducting this study.

Given these results, it might be possible that right dominant information processing subjects explored the hypermedia system by actually accessing many different nodes beyond the nodes which were necessary to visit to perform the search tasks, while left dominant information processing subjects interacted with the system by accessing only the few nodes which were required to accomplish the search tasks. It is also likely that right dominant information processing subjects accessed a large number of new nodes freely because they would be less concerned about "getting lost" problem within the hypermedia because of their exploratory manner for problem solving. In addition, it is similarly likely that left dominant information processing subjects accessed very limited nodes because they would be very concerned "getting lost" problem within the hypermedia because of their conservative and systematic tendency of problem solving.

The observed frequencies indicated that integrated information processors visited a larger number of new nodes than left dominant information processors, though the difference between the two groups were not statistically significant. One possible reason the study failed to show a significant difference may be due to the relatively small sample size. This should be examined in future studies.

Although this result does not provide statistically significant support for the researcher's prediction, it still supports the fact that there is a difference in the navigational behavior of left dominant information processors and integrated information processors.

Other research on hemispheric preference for problem solving suggested that integrated information processors are individuals who simultaneously use the left and right dominant strategies in proportion appropriate for the situation. The results of this study might reflect that integrated information processors actually employed the left and right dominant strategies at the same time in proportion appropriate for the search tasks, while left dominant information processors employed predominantly the left dominant strategies.

The two types of search tasks, open-ended and closed-ended tasks, were given to the subjects to accomplish while they interacted within the system. The two different types of tasks were given in order to assist the subjects in using the hypermedia program purposely and comprehensively. The two different types of tasks were also given to keep the overall balance between the right dominant strategies and the left dominant strategies that would be demanded for accomplishing the tasks in the study. The open-ended tasks used in this research required users to respond in general terms based on their understanding of the overall content of the hypermedia system. Closed-ended tasks in this research required users to respond in specific terms that could be found on a certain screen in the hypermedia system. It was assumed that the open-ended tasks might require more of the right brain oriented problem solving strategies, while the closed-ended tasks might demand more of the left brain oriented problem solving strategies.

The results that integrated information processors visited a larger number of new nodes than left information processors might lead the researcher to infer that integrated information processors most likely employed the left and right brain dominant strategies in proportion appropriate for the two different types of search

tasks, while left dominant information processors employed predominantly the left brain dominant strategies for the both types of search tasks.

The results of navigational path patterns, however, were contrary to the researcher's expectation. Right dominant information processing subjects followed significantly more linear paths than integrated information processing subjects. Right dominant information processing subjects followed a larger number of linear paths than left information processing style subjects, although not significantly.

The researcher expected that left dominant information processing subjects would prefer to navigate through the system using much more linear paths, while right dominant information processing subjects would prefer to interact with the system using relatively nonlinear paths. This assumption was based on information processing style research suggesting that left brain dominant processors are likely to approach problem solving tasks sequentially, while right brain dominant processors are likely to adapt different problem solving strategies such that they are likely to approach tasks non-sequentially.

It is difficult to interpret why the results of navigational path patterns of left and right dominant information processors were contrary to expectation in the current study. It might be possible that the contrary results were found for the navigational path patterns because the overall links needed to accomplish the search tasks were predominantly linear themselves. As a consequence, right dominant information processors who visited substantially more nodes for the search tasks in the study obtained higher scores in linearity value than did left information processors who accessed a lot less nodes within the hypermedia system. It is possible that right dominant information processing subjects would have outperformed left dominant information processing subjects in making linear links if the researcher had taken into consideration this aspect of A.g.i.l.e. Resource™ 's operation.

The difference in the average of navigational methods among three information processor groups supports the researcher's expectations in conducting this experiment. On the basis of the findings of research on brain hemisphericity and navigational patterns, the researcher assumed that left dominant information processing subjects would prefer to navigate within hypermedia systems using more analytical navigational methods such as using index and search functions. In contrast, the researcher expected that right dominant information processing subjects would navigate hypermedia systems using more holistic navigational features such as maps, hypertexts, and tables of contents.

The result that left dominant information processors employed a significantly larger number of analytical navigational methods than right dominant information processors confirmed the expectation of significant differences in the navigational methods employed among the three different information processor groups. The results are in agreement with the theory of information processing styles supporting that left brain dominant processors take predominantly analytical approaches to problem solving, while right brain dominant processors employ more likely holistic approaches for problem solving.

The findings for navigational methods in this study are similar to the findings of Leader & Klein (1996). Leader and Klein found that the field independent subjects [who are considered left dominant information processors] performed significantly better than the field dependent subjects [who are considered right dominant information processors] in using analytical navigational methods such as index and find functions in the experimental system. Indeed, left dominant information processing subjects in the present study also performed the search tasks employing substantially more of analytical navigational methods than right dominant information processors.

In addition, the findings of the present study indicated that integrated information processing subjects, as expected, used significantly more analytical methods than right dominant information processing subjects. This result also is in agreement with the findings of previous information processing research for integrated information processors. Information processing research suggested that integrated information processors are individuals who use simultaneously the left and right dominant strategies in proportion appropriate for the situation. The result of this study might reflect that integrated information processors employed the left and right dominant strategies at the same time while interacting within the system, while right dominant information processors employed predominantly right dominant strategies. The researcher assumed, based on the theory of information processing that integrated information processors would employ analytical methods and/or holistic methods in proportion appropriate in the situation for the two types of search tasks, while right information processors would employ predominantly holistic methods for both search tasks.

Conclusions

The results of the study provide insight into the relationships between navigational patterns and information processing styles of hypermedia users. These results, in turn, provide useful information for advising learners regarding selecting more efficient and effective navigational patterns, based on their information processing styles. In addition, the detailed information of users' navigational behaviors provides further guidance for designing hypermedia interfaces that would be more user-centered. The results of this study also verifies the effectiveness of

hypermedia systems in terms of addressing individual differences. The findings of the present study led to the following general conclusions:

1. The present study demonstrates that the information processing styles seem to play an important role in how an individual interacts with hypermedia systems. The three different information processor groups used the hypermedia system in significantly different ways in terms of navigational behaviors. Left dominant information processors interacted with the system by visiting very limited nodes and employing a large number of analytical navigational methods, while right dominant information processors interacted with the system by accessing many new nodes and using a large number of holistic navigational methods. The navigational patterns of integrated information processors also confirmed the assumption that this group of users used simultaneously the left and right dominant strategies in proportions appropriate for the situation.

It appears that the results of the present study provide valuable information for helping users navigate through hypermedia systems more efficiently. The results suggest that the information processing styles of hypermedia users can be translated into a practical guide on advising users in selecting more efficient and effective navigational strategies.

If trainers know a trainee's information processing style prior to a training session or other instruction using a hypermedia system, they would be able to guide the different groups of information processors in using more efficient and effective navigational strategies for navigational depth, paths, and methods. Also, when an instructional task interacting with a hypermedia system seems to demand specifically left or right brain dominant information processing strategies, trainers or teachers should advise right dominant information processors to utilize left brain dominant strategies.

2. The indication of the significant relationships between hypermedia users' information processing styles and their navigational patterns in the present study would also provide further guidance for designing hypermedia interfaces which would be more user-centered.

According to Sonnier (1984, 1985, 1989, 1992), hemispheric information processing preference is the basis for the common thread of individual difference in the ways in which human beings process information. In addition, in a variety of settings, it was verified that learners with different information processing styles could learn more and be better motivated if activities involving information retrieval accommodated the information processing approaches of those learners (Cafferty, 1980; Carbo, 1980; Douglass, 1979; Leader and Klein, 1996; McCluskey, 1993). One of the goals in hypermedia interface design, then, should be to develop interfaces that are easy for a variety of users with different information processing styles to navigate the systems by applying the information processing strategies of those users. How should hypermedia designers design such an interface?

The present study could provide some tentative conclusions to guide more user-centered hypermedia interface design that would be suitable for different user groups by supporting the variety of information processing styles of those users. In general, hypermedia designers and developers should take note of information processing style research when making design decisions related to navigation.

Any decisions about which navigational methods to include in a hypermedia system should take into account the varying types of navigational strategies used by the three information processors. It is worth noting that left dominant information processors employed significantly more analytical navigational methods, while right dominant information processors used more holistic navigational methods. This discovery has an important implication for future design: the numbers of analytical and holistic navigational methods in a hypermedia system should be balanced, to a certain extent. Or, the unbalanced implementation of navigational methods between analytical methods and holistic methods, to a great extent, will benefit one of the information processing groups and exclude the other when utilizing hypermedia systems. Leader and Klein (1996) also suggested that interface designers should consider users' cognitive style factors in the use of hypermedia when they make decisions for the formulation of criteria for navigational methods.

3. The results of this study also provided additional information that is valuable to verify the effectiveness of hypermedia systems in terms of addressing individual differences in navigational strategies. Considerable educational research has demonstrated that the quality of learning can be enhanced when an instruction is matched to individual learning style (Carbo et al., 1986; Wilson, 1988; Barba and Armstrong, 1992; Billings and Cobb, 1992; Ellis et al., 1993; Larson, 1992; Lee, 1992; Liu, 1992; Overbaugh, 1992). Hypermedia has been proposed as one of the superior systems for achieving the goal of accommodating individual differences in learning style. The underlying assumption of nonlinear hypermedia systems is that different individuals will actively interact with the systems and the systems will accommodate individual differences in terms of various users' navigational preferences based on ones' learning styles.

The results of this study support that hypermedia systems are effective learning tools to address individual differences on information processing styles of hypermedia users when navigating hypermedia systems. The study results indicate that the users were able to exploit the hypermedia system taking the navigational advantages of nonlinear structure provided by the hypermedia system according to their preferences of information processing styles.

In conclusion, the present study intended to discover the effect of information processing styles on the navigational behaviors of hypermedia users. The present study demonstrates that information processing styles seem to play an important role in how an individual interacts with the hypermedia system. It is hoped that this study contributes to the body of research on human-computer interaction in general and on navigational behaviors of hypermedia users in particular. The study provides some research-based guidance in designing future hypermedia applications and indicates direction for future research on navigational behaviors of hypermedia users. The conclusions of this study, however, should be considered suggestions not absolute prescriptions for designers or future researchers of hypermedia systems. The conclusions should be confirmed by additional research.

Hypermedia systems, used as sophisticated databases and instructional delivery systems, are becoming more powerful and hence more popular in educational and corporate environments. The current growth in the use of hypermedia both in education and corporate environment suggests that hypermedia system will most likely have an extensive impact on our lives. As the impact of hypermedia on our lives increases, educational technologists should continue research on how the various individuals actually utilize hypermedia and assist facilitation the use of hypermedia systems for all types of users in various environments of our lives.

Recommendations for Future Research

Further research is definitely needed for a comprehensive understanding of the issue of the different users and their specific navigational patterns of hypermedia systems. The following is a list of some possible directions for future research on this topic.

1. Future research should include a replication of this study across other age groups to see whether the results vary significantly from this study. For example, compare the differences between children and adult learners, or elementary school children and secondary students to see whether navigational patterns are different when comparing one age group to the other.
2. Future research should also include a replication of this study across other groups of subjects from different levels of familiarity with the content of the hypermedia system, Agility, to see whether the results vary significantly from this study. For example, to see whether subjects who are already somewhat knowledgeable in the area of agility navigate differently than those who are not.
3. Future research will also need to compare experienced and inexperienced users of hypermedia systems. The experienced users might have developed preferred patterns of navigation, while the inexperienced users have not. Then, there might be a difference in the way that these two different groups navigate through the material. In the present study, most of the subjects had used a computer through computer seminars, computer courses, or personal exploration with a computer in general, but only a few subjects were familiar with hypermedia systems. According to Barfield, Rosenberg, and Levasseur (1991), there exists a great deal of differences in users' interactions when subjects vary to a great extent in their computer experience.
4. In addition, future research should compare subjects with different learning demands. For example, see whether subjects who need to learn the material for a given test navigate differently from those who are simply evaluating the software.
5. Future studies should also investigate other hypermedia applications to see whether the results vary significantly from this study. It would be interesting to note differences between and among a variety of hypermedia programs using identical groups of subjects.
6. In future studies, that provide computer tasks, more tasks should be provided within each task unit. The present study only provided three open-ended tasks and five closed-ended tasks. The limited numbers of tasks were given because of the time constraints in the study.

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INTEGRATING SCIENCE AND MATHEMATICS CURRICULA USING COMPUTER MEDIATED COMMUNICATIONS: A VYGOTSKIAN PERSPECTIVE

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Abstract

Computer-mediated communication technology provides a potential tool for facilitating an integrated science and mathematics curriculum consonant with current standards. This paper presents the sociocultural theories of L. S. Vygotsky as a conceptual framework for implementing instruction that supports concept development and promotes higher level thinking skills in students.

Introduction

Mathematics is the language of science (Steen, 1994), and as such, mathematical understanding becomes a requisite for scientific literacy. The American Association for the Advancement of Science (AAAS) (1989) has identified the *scientific endeavor* or the *scientific enterprise* as a composite of the dynamic interrelationship of science, mathematics and technology. Each component involved in the scientific endeavor has its own character and history, yet each share relevant similarities, and each is dependent upon and reinforces the others. It is the similarities and interdependencies among the components of the scientific endeavor that suggest the efficacy of a blended or an integrated curriculum.

By extending the application of Vygotsky's theories to a technology facilitated model of an integrated mathematics and science curriculum, this paper will build on a previous work that examined the application of the sociocultural theories of L.S. Vygotsky in the implementation of technology in the mathematics curriculum (Harvey, & Charnitski, 1998). In this paper we will first consider three major components of Vygotsky's socio-cultural-historical theories of learning, and then discuss the relationship of these components to the commonalties evidenced in the mathematics and science standards that suggest the efficacy of integrated curricular activity. Next the characteristics of computer-mediated technology (CMC) will be presented and the rationale for its use in an integrated mathematics and science curriculum will be discussed. Finally, we will outline a current project that uses CMC as a facilitating technology for an integrated mathematics and science curriculum that is consonant with both a Vygotskian approach to learning and the mathematics and science standards.

Vygotsky's Theories of Sociocultural Learning

On a continuum of learning theory, Vygotsky's socio-cultural-historical theory lies between the poles of formalism and constructivism (Kozulin, 1990; Moll, 1990; Vygotsky, 1986; Wertsch, 1985). According to Vygotsky (1978, 1986, 1997; Vygotsky & Luria, 1993) concept formation is an ongoing interaction between the concrete and the abstract dimensions that (contrary to constructivism) does not require that the child reinvent information, and (contrary to formalism) does not expect the child to form abstract conceptualizations without first having engaged in concrete activities that support the formation of mental models. Three foundational ideas of Vygotsky's theories are language, scientific and spontaneous concepts, and the zone of proximal development.

Language

Vygotsky (1986) contended that language is an indispensable requisite for all intellectual growth and that the attainment of real concepts is impossible without words. Concept formation is "...not an isolated, ossified, changeless formation but an active part of the intellectual process constantly engaged in serving communication, understanding and problem-solving." (p. 98)

He argued that the language of adults and others which surrounds the child is a major factor in the child's cultural and social environment. This immersion in language influences the content of the child's thoughts and determines how the child thinks (i.e., the interpretation or framing of information). Vygotsky did not isolate verbal interchanges with adults as a separate component in the process of a child's concept formation, but rather stressed the essential interrelationship between sensory material and words as mutual components of a child's concept development.

Two critical observations Vygotsky (1986,) made were that: (a) the role of a child's speech is equally as important as the role of action in attaining a solution to a problem; and (b) as situations demand more complex and indirect actions in finding a solution to a problem, speech plays a more important role in the solution process as a

whole. Vygotsky considered conceptual thinking as arising from a need to solve problems, and judged words to be the tools or the means that direct mental operations and focus their attention toward the solution of a problem.

Spontaneous and Scientific Concepts

Vygotsky (1986, 1997) identified two types of concepts, *spontaneous* and *scientific*, that he distinguished by geneses. According to Vygotsky, spontaneous concepts are those concepts formed by the child through everyday exposure to the cultural environment in which he or she lives; as such, spontaneous concepts are typically unsystematic and highly contextualized. Scientific concepts, on the other hand, are mediated through formal instruction, are typically derived from the structured activity of classroom instruction, and are hierarchically and logically organized.

The essence of Vygotsky's approach to instruction is found in his contention that, while characteristically different, spontaneous and scientific concepts are mutually supporting structures. Spontaneous concepts give body and vitality to scientific concepts and scientific concepts raise spontaneous concepts to the level of conscious and deliberate use. Vygotsky (Davydov, 1990; Ratner, 1991; Schmittau, 1993, Vygotsky, 1986, 1997) maintained that formal concepts (scientific concepts) learned in school must be connected with the child's understandings (spontaneous concepts) that result from their everyday experiences.

Zone of Proximal Development

Contrary to tenets of traditional cognitivist thinking, Vygotsky (1978) argued that a child's developmental level should lead instruction. He maintained that a child's mental age should be viewed as a starting point for determining instruction, and that instruction should be configured in a manner that facilitates a child's movement forward through his or her *zone of proximal development* (ZPD). Vygotsky defined the ZPD as the area that lies between a child's actual mental age (i.e. his or her level of independent functioning) and the level of problem solving that the child is able to reach with assistance. Simply stated, with adult mediation the child can accomplish more than he or she would be able to accomplish independently.

The child's movement through his or her ZPD is supported by verbal communication and collaborative interchange with an adult or with a more competent peer. As the child becomes more capable of independent thinking, the child's state of development rises. As the child's developmental level increases, mediation can reach toward a higher instructional level, thus, instruction leads development.

Movement through the ZPD involves intelligent, conscious imitation, which requires that the child first understand the field structure and relationships between objects. Imitative behavior that is characteristic of movement through the ZPD should not be confused with automatic imitative behavior that shows no signs of conscious understanding.

Similarities Between Mathematics and Science

Mathematics and science are intellectual and social undertakings that share the underlying ideals of order; honesty and openness in reporting; peer review and outside validation of work. NAAS (1989) stated that proficiency in both the mathematics and science disciplines requires extensive student experience using relevant principles to solve problems, to communicate ideas, and to connect and generalize concepts. Participants in mathematical and scientific enterprises require imagination as they apply their human intelligence to figuring out the workings of the world and its myriad of connections.

The standards established by the National Council of Teachers of Mathematics (NCTM, 1989, 1991, 1995) and the National Research Council (NRC, 1996) have given direction to the current reform efforts in the area of mathematics and science education. According to Steen (1994) the following are the similarities between the Standards for School Mathematics (NCTM, 1989) and the National Science Education Standards (NRC, 1996):

- both advocate a significant shift away from the "filter" model of education by raising expectations for all student learning
- both argue for more depth, understanding, and thinking and less memorization, mechanics, and mimicry
- both advocate active learning, increased collaboration, discussion, exploration, and "student talk" and less rote learning, decreased deference to teacher & text as sole authorities and sources of validation
- greater reliance on performance-based instruments that are coordinated with the curriculum and embedded in instruction and viewed as a recursive and reflective process
- both advocate full use of technology as a means and as a goal of instruction

Vygotsky's theories imply a multidimensional, holistic approach to learning; the same type of learning that is prescribed by both the mathematics and science standards, and required by the prerequisite skills for discipline involvement. Learning experiences consistent with a socio-cultural-historical approach are steeped in meaning-making colloquium, connectivity, and multi-layered or multi-tasked instruction (i.e., instruction that engages participants in subtasks at different cognitive levels, each of which contribute to a larger common task). Both sets of standards are aligned with Vygotsky in their imperative to position conceptual learning over memorization and

automatic mimicry, situate content in leveled tasks, and engage students in support collaborative and cooperative enterprises. Agreement also exists in the proposition that the conceptual learning of the mathematics and science disciplines requires learners to be actively engaged in contextualized, authentic, problem-based learning that is facilitated and guided by the teacher. In this learning context, students are characterized by their participation in meaningful communication and, and interactive engagement with educational facilitators, with each other, and with their environment.

The Role of Computer-Mediated Communication

The very nature of our technologically driven society elevates the status of collaboration and connectivity in the processes of gathering, applying and sharing information in the learning process. The growing availability of computer mediated communications (CMC) in the school setting introduces new tools that provide extensive opportunity for curricular integration of authentic activities, engagement in outside collaboration, access to vast databases of information, and efficient and economical means of information dissemination, sharing, and validation.

The NSF issued a joint document with the U. S. Department of Education (1995) which stated that the appropriate use of technology has the potential to improve teaching and learning; expand and enrich opportunities for learning; link schools and learning sites to provide students access to the broader society; and provide equal access to educational opportunities.

Computer Mediated Communication (CMC) is an all-inclusive term that embodies technologies that mediate communication between and among individuals and groups of individuals. Subsets of CMC would include but not be limited to e-mail, the World Wide Web (WWW), listserves, and online searchable databases.

Riel (1996) asserted that computer-mediated communication (CMC) is a tool that can narrow the gap between collaborative and/or cooperative experiences and traditional formal instruction. Scott (as cited in Jonassen, 1996) evidenced that students working in groups through CMC participated more evenly, and accomplished more task objectives than students not using CMC.

The nature of asynchronous communications allows participants a delayed time frame that is generally not afforded in the traditional classroom setting. Romiszowski (1997) contended that this window of time may serve to enhance reflective thought and encourage participation. The author maintained that CMC is "...most promising for the development of the reflective thinking and creative planning skills that are required to close the gap between information and performance in knowledge work." (p. 33)

Kahn (1997b) characterized CMC as an interactive, open system that offers global accessibility that is distance and time independent. He further noted that CMC offers a high degree of learner control and environmental flexibility. CMC can support both formal and informal learning environments (McLellan, 1997), collaborative learning (Hiltz, 1994), and has the potential to extend cooperative and collaborative learning experiences to every classroom that is connected to the Internet (Relan, & Gillani, 1997).

Shneiderman, Alvai, Norman and Borkowski (1995) stated that " The low cost and flexibility of e-mail and Web usage means these technologies are likely to become universal..." (p.41) They liken e-mail to the personal automobile as a means of information transportation; most people will have it and use it daily. Listserves and Web sites they compare to commuter trains; large numbers of people will use it regularly to get to specific locations.

Sabelli (1995) stressed the need for the incorporation of advanced technology in the classroom environment. She asserted that as the affordability of powerful networked technologies increases, educators must assume responsibility for the profound pedagogical implications of change these technologies bring into the areas of science, mathematics and engineering. Sabelli contended that when technologies are properly used in the instructional process, they have the potential to make science and mathematics more understandable and attractive to an increasing number of students.

Computer technology has changed the way society thinks, works, studies and plays. Although Vygotsky died long before our current state of technological advancement was even dreamed of, he provided a theory in which the everyday experiences (i.e., spontaneous concepts) of the child weigh heavily. Computer technology is a part of the child's everyday experiences, from talking cash registers and digital scanners in grocery stores to video games and surfing the net. Accordingly, instruction should be tied to these everyday experiences.

The increasing access to CMC and its collaborative, flexible nature appear to make it a viable instructional tool for the implementation of activities that are consonant with both the curricular disposition and discourse promoted by the mathematics and science communities and with Vygotskian theory.

Curriculum Integration

While effective curriculum integration involves a great deal of time to plan and implement (Brant, 1991; Dressel, 1958; Jacobs, 1989; Palmer, 1991), the effects on student learning appear to make it well worth the invested effort (Levitan, 1991; MacIver, 1990). Lipson, Valencia, Wixson, and Peters (1993) asserted that the positive effects on students who engage in appropriately integrated curricula include: (a) more robust application of skills; (b) faster retrieval of information; and (c) increased depth and breadth of learning.

Palmer (1991) listed the essential elements of an integrated curriculum as: (a) core skills and processes; (b) curriculum strands and themes; (c) major themes; (e) questions; (f) unit development; and (f) evaluation. Mathematics and science emphasize the following common skills and processes that directly affect methodology in both disciplines (Berlin & White, 1994; Davidson, 1995; NCTM, 1989; AAAS, 1989):

- observing
- collecting, recording, and organizing data
- recognizing time/space relationships
- communicating
- interpreting data
- graphing
- predicting

While the literature is replete with examples of CMC's use, or potential use in classrooms across the world (e.g., Dede, 1996; Jonassen, 1996; Goldberg, & Richards, 1995; Kahn, 1997a; Morrison, & Goldberg, 1996), we will discuss the organization of a project in which we are currently involved as an example of how curriculum and methodology may be blended in mathematics and science.

The goal of this project is to have fifth grade middle-school students recognize and apply their existing and emerging mathematical repertoire to a science unit on weather. The students are heterogeneously grouped, and the project is structured to allow students to engage in collaborative ventures that contribute to a cohesive, communal product from multi-leveled and topic-divergent activities. Evaluation is formative and based on teacher-constructed, and teacher and class-constructed rubrics. This project is configured to incorporate Palmer's (1991) six essential components of integrated curricula.

In the beginning of the project, students engage in three concurrent activities: (a) learning basic weather concepts such as types of clouds, rain, snow, fog, windspeed through a variety of hands-on experiments; (b) exploring diverse geographical areas using the World Wide Web which includes recording each site's map location (including longitude and latitude), defining topographical features, seasonal cycles, and identifying characteristics, and (c) subscribing to relevant listserves.

While learning about basic weather concepts, students explore the situational measurements of latitude and longitude. They will then place various locations according to their latitude and longitude coordinates. Students may also relate latitude and longitude to things such as seasonal cycles, overall weather patterns, and time zones. (*recognizing time/space relationships*) After discussing and sharing the preliminary information collected, the students come to consensus on how this information should be categorized, and hierarchically organized. (*communicating; collecting, recording, and organizing data*)

During the next phase of the project, each students group will select a specific geographical area of interest and begin to collect previously agreed upon weather data (e.g., wind speed, temperature, precipitation, wind-chill, heat index) and other relevant information from one of the many weather sites found on the Internet (e.g., WeatherNet at <http://cirrus.sprl.umich.edu/wxnet/>), as well as from newspapers, periodicals, radio, and television (e.g., The Weather Channel). Students will also use other weather information tools easily found on the Internet such as weather-cams, (e.g., <http://cirrus.sprl.umich.edu/wxnet/wxcam.html>), related software (e.g., <http://cirrus.sprl.umich.edu/wxnet/software.html>), computer forecast models (e.g., <http://cirrus.sprl.umich.edu/wxnet/model/model.html>), weather satellite transmissions (e.g., <http://www.intellicast.com/weather/mem/nexrad/>), and weather-sites (*observing; collecting and recording data; interpreting data*).

Group data on each geographical area will be entered into databases and/or spreadsheets. Graphs will be constructed as well as other visual representations that will help each group communicate their data to the other student researchers (*communication; graphing; interpreting data*). When sufficient background information has been collected on the different geographical locations, the students will bring their data to the whole class at which time the all of the student-researchers will discuss, compare and relate findings (e.g., Buffalo, New York and Grand Rapids, Michigan may be experiencing similar amounts of snowfall due to the lake effect) (*communication, interpreting data, make predictions*). During the final phase of instruction, students will follow major weather fronts and make weather predictions based on their accumulated knowledge and past observations.

Conclusions

There appears to be growing acceptance by educators of both the views of curricular content and student discourse promoted in the Mathematics and Science Standards (Chang-Wells, & Wells, 1993; Cobb, Wood, & Yakes, 1993), and of Vygotsky's theories of the socio-cultural nature of learning (Tharp & Gallimore, 1988). The American Psychological Association (1995) stated that environmental factors such as culture, technology, and instructional practices along with social interaction have substantial influence over learning. Bonk and Thomas (1997) asserted that there is increased agreement among educators that meaning is found in the process of

negotiation and knowledge-building in a social context. Curtis and Reynolds (1997) stated, “The learner-centered movement has encouraged instructors to create challenging and novel environments that help learners link new information to old, seek meaningful knowledge, and think about their own thinking.” (p. 167)

CMC is a tool that appears to hold significant promise for supporting teachers’ efforts in this direction. The defining characteristics of CMC and its unique ability to extend and to enhance semiotic exchange make it a potential vehicle for supporting integrative classroom environments that are consonant with the mathematics and science standards and Vygotskian theory relative to language, spontaneous and scientific concepts, and the zone of proximal development.

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DUAL STRUCTURED INSTRUCTIONAL SYSTEMS APPROACH: AN INTEGRATION OF SYSTEMIC AND SYSTEMATIC APPROACHES FOR INSTRUCTIONAL DESIGN

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Abstract

This research assumes that systematic and systemic change are two components in instructional design - not dichotomous terms, but two sides of an interconnected dual structured system. Specifically, this presentation tries to determine the difference between systemic thinking and systematic thinking, the ideal mental model (dual structured systems) for ID, and the benefits from this mental model.

Needs for Dual Structured Instructional Systems Approach

Systems thinking has come to the attention of social scientists, planners, operational engineers, managers, educators, and the like, as a tool for problem solving and decision making. According to the SCANS (The Secretary of Labor's Commission on Achieving Necessary Skills) report (1991), systems thinking is an important problem solving skill needed both in school and industrial training curricula. Also, Reich (1991) has predicted that systems thinking will be an essential skill in promising job areas like symbolic analyst.

We might easily assume that if instructional designers (ID) are to join as members of symbolic analyst group, they should also possess systems thinking skills. Then how can they learn how to increase these skill? At present, there are no essential sources on how to teach and learn systems thinking skills. There is not even a clear definition of or guidelines for system thinking.

Historically, the instructional design field has employed systems approaches under the name of "systematic approaches." Dick and Carey's "systematic design of instruction" (1990) can be selected as representative material for these approaches. According to them, the instructional systems design (ISD) process is regarded as a procedure system, a series of steps such as design, development and implementation. The ISD model has recognized a means for not only effectively carrying out large-scale design and development efforts but also a means for ensuring quality control. The common language established by the model and its procedures facilitates communication among team members (McCombs, 1986).

However, it is argued that if instructional designers only followed the steps given, then quality instructional productions can be created in the same manner as industry productions on a conveyer system. In this approach, most of the ID might be involved in a series of activities such as dividing tasks into small chunks (reductional activities), finding step-by-step sequences (linear thinking), etc. Thus, analytic thinking skill can be important for ID.

On the contrary, there is another group of IDs (Banathy, Reigeluth, etc.) armored with the systemic point of view. They are regarded as a group which seeks authentic systems approaches. They use more the broad term like educational design instead of the narrow term like instructional design. The systemic approach provides instructional design practitioners with "the dynamics of process." for dealing with complex real-world instructional problems. This approach suggests that the design of education should be more open and adaptive to the larger societal system. In this approach, ID has to develop a holistic viewpoint or synthetic thinking skills.

In this context, we think both the systemic and the systematic approach are important and necessary in ID. The systemic approach provides a conceptually sound framework, which ensures the understanding of the complex and dynamic relationship between instructional system and its environment. The systematic approach provides actionable solutions, which are easy to follow. Thus we assume that systematic and systemic are two components interdependent with each other in the instructional systems design. They are not dichotomous terms; rather, the two sides are an interconnected dual structured system.

Specifically, this article tries to determine:

- First, what is the difference between systemic thinking and systematic thinking?
- Second, what might be the ideal mental model (dual structured systems) for ID?
- Third, what benefits can we find from the mental model?

Overview of the problems relating to systematic and systemic

Dictionary definition

According to several dictionaries (The Oxford Dictionary, 1989; The Random House Dictionary, 1983; Webster's Dictionary, 1981), The meanings of systematic and systemic are as follows:

- A. Systematic:
 - (1) Orderly scheme or plan
 - (2) Classification, procedure
 - (3) Manifesting or involving a system
- B. Systemic:
 - (1) Body as a whole
 - (2) Distinguished from local
 - (3) Pertaining to or affecting a particular system

In terms of the first definition, systematic seems to be an orderly scheme or plan and systemic seems to be body as a whole. However, from the third definition, we learn that the terms, systematic and systemic both have a relationship with the term system. Let us say, the two terms come from the same root, system. Sometimes they are difficult to separate and even interchangeable. Systematic seems to be more a generic term, more well-known to non-experts than systemic.

The different approaches of the two terms in the field of ISD

- A. Systematic design of instruction (Dick and Carey, 1990)
Dick and Carey (p. 2-11) generally discuss the systematic approach model for designing instruction. They begin with an explanation of the relationship between a heating/cooling system (a sort of hard system) and an instructional process in terms of systems concept. They insist that the purpose of their work is to describe a systems approach model for the design, development, implementation, and evaluation of instruction. They define their approach as a procedural system, a series of steps, each of which receives input from the preceding steps and provides output for the next steps.
- B. System design of education (Banathy, 1991)
Banathy talks about the importance of the systemic viewpoint as a more fundamental approach to solving problems in educational situations. As an important aspect of the systemic approach, he stresses that the design of education should be more open and adaptive to the larger societal system. He is explicit in his criticism of the systematic approach without considering systemic aspect in educational reform.

The ship of education is sailing on troubled waters. There is an ever-increasing realization that unless we change the course, the ship will sink. But people are still trying to "rearrange the chairs" (systematic) on the deck of the sinking ship(p.6).

Distinction based on Hard systems Vs. Soft systems

We also assume that there might be some typical tasks (hard systems, step-by-step procedures, etc.) related with the systematic approach, some typical events (heuristic problems, soft systems, etc.) related with the systemic approach and other combinational events needing both approaches (most of the tasks in real situations might be these cases).

- A. Systematic approach rooted in hard systems perspective
Systematic approaches from systems engineering were translated into instructional systems design for military application (Settler, 1990). As a result, , hard systems thinking prevails overwhelmingly in ID practice. Saettler (1990) summarizes how a systems approach based on the hard tradition is practical in the instructional design process:

Instructional goals and objectives were precisely defined, various alternative were analyzed, instructional resources were identified and /or developed, a plan of action was devised, and results were continuously evaluated for possible modification of the program (p. 350).

His statement implies that an instructional outcome can be achieved through "a series of steps activities" (systematic approach) carried out in some predetermined sequence.

- B. Systemic approach rooted in soft system perspective
The systemic ID process embedded in soft systems thinking must go through an iterative cycle as new experiences and insight, such as knowledge resulting from one design episode are gained. Through this iterative design process, relationships among the systems that surround an instructional enterprise will be better understood and instructional solutions refined. Therefore, the design process will become as ongoing learning process in flux.

Systemic thinking provides ID with “the dynamics of process” for dealing with complex real-world instructional problems. Instructional development grounded in soft systems thinking aims to be practiced as a social process. Thus, this approach represents a collaborative act where stakeholders engage in an interpretive understanding of instructional development through dialogue. It thus seeks accommodation among conflicting interests (Checkland, 1985, p. 764).

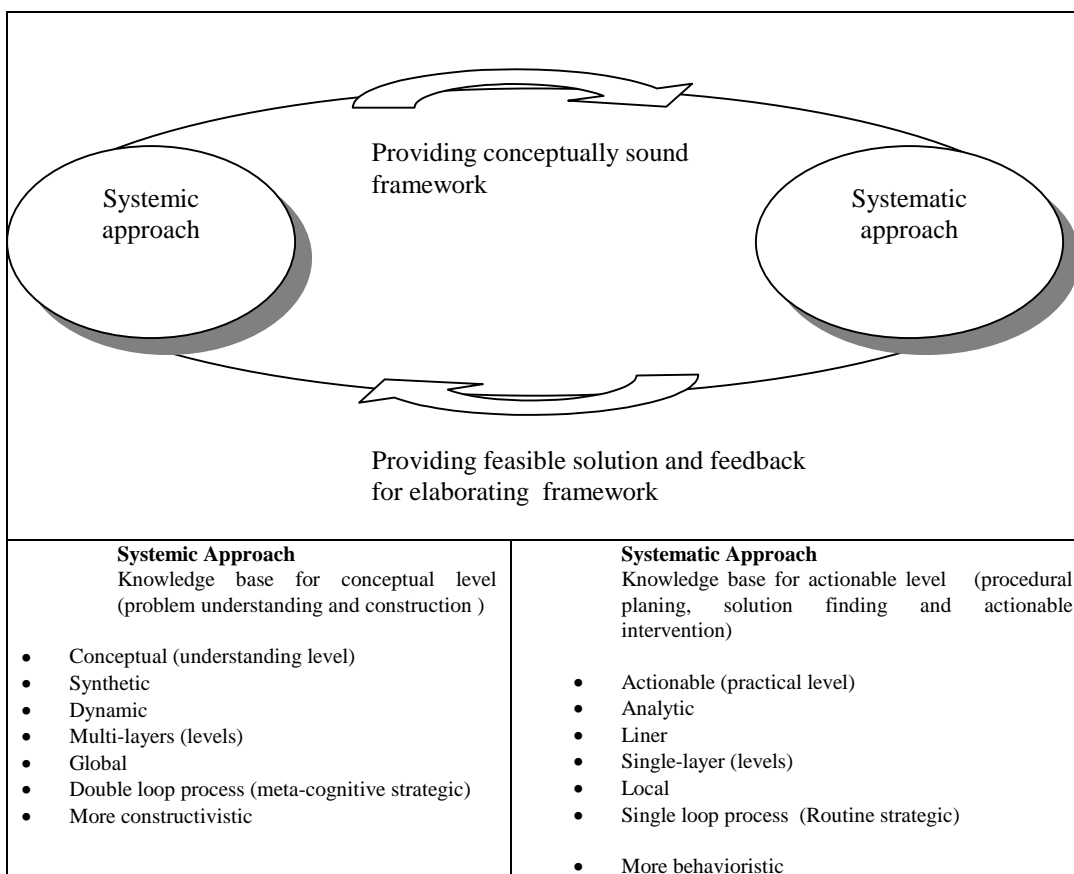
Instructional development is a part of larger systems, such as the school system, the community system, or the total social system. Thus, ID must see the design process as linked with the instructional program, the community, the human performance system in which skills or knowledge gained from an instructional intervention will be used, and the surrounding social system, all concurrently.

In most cases, the total set of problems of ID practice in educational and business contexts cannot be understood clearly. ID practitioners often face many complex situations in which multiple actors (e.g., teachers, students, and subject matter experts) and goals interact intermittently. This implies that practitioners in the field of instructional development need to develop flexible interventions capable of adapting to emerging objectives, needs, and problems (e.g., instructional constraints). In so doing, the design process becomes embedded in a context, and takes the form of iterative, collaborative inquiry. It might be necessary for ID to develop more systemic thinking skills.

The conceptual model of dual structured instructional systems

In our dual structured instructional systems, Systemic and systematic are not longer conflicting approaches any more. These two approaches provide complementary necessary knowledge bases. A more detailed conceptual model is shown in *Figure 1*.

Figure 1. Visual model of dual structured instructional systems



Some guidelines for increasing systemic thinking

Now, we do not want to give guidelines for systematic thinking because most of the IDs are already familiar with that skill. We want to categorize systemic thinking as several sub-abilities and develop some guidelines to increase systemic thinking skill:

- Ability to see the problem as holistic.
The designer needs to study systems theory as a disciplines. The designer should be familiar with visual data like graphics, images, charts, drawings, etc. To obtain a holistic, imagery and intuitive point of view, visual literacy might be better than verbal literacy because verbal expression is subject to logical and linear thinking.
- Ability to set goals in given problem solving situation.
Given a problem situation, the designer should be able to change the problem into a goal. This ability can be raised by need analysis because the goal setting phase is part of the analysis. Finding goal activities leads the designer to develop his/her purpose seeking sense in a broader area. Systematic thinking also might deal with goal finding activities. However, in this case, the activities deal with simply changing problems into goals without any holistic perspective.
- Ability to link possible resources in terms of goals in a given problem situation.
To do so, the designer should be familiar with a multi-disciplinary approach. It might make possible resources meaningful and useful for solving the problem. Only when a designer sees all the resources available as interdependent in terms of the goal, it is possible that creative solutions can be developed.
- Ability to drive a tentative result (changes in system in terms of time and space) in a given condition through test.
There might be several kinds of methods to make the designer think systemically.
 1. One method is to conduct the actual experiment in terms of models (models for solving problems). When a project is longitudinal and tasks are complex, it might be a very time consuming and costly approach.
 2. Secondly, using computer simulation might be more cost efficient than conducting an actual experiment. If the designer chooses several options among lots of input values, the computer quickly presents items corresponding to the selected option.
 3. Thirdly, through the various case studies containing real situation problems, the designer also learn how to think systemically. In this case, the problem solving approach should be systemic. There might be several guidelines given to increase systemic thinking ability.
 4. Fourth, thought experiment might be the most time-cost efficient method because human thought can go anywhere at anytime. But it is very difficult to get a valid result after administrating thought experiment. So follow-up activities through which the designer can find existing data from similar cases or scientific results should be involved. Also, the activities should be based upon theory or models. Some practical tips can be obtained from other fields like physics (Indeed, Albert Einstein used this method).

The benefits of Dual Structured Systems Approach.

There might be several benefits of Dual Structured Systems Approach, including:

- First of all, it can eliminate confusion between two aspects (systematic/systemic) because this approach incorporates the two.
- This approach can drive further study because the mental model still needs to be improved and elaborated.
- There might be some possibility that IDs can know when and where one aspect should be more dominant than the other during the instructional design process. For example, If the task is simple and procedural, then the designer may use systematic thinking like logical and step-by-step analytic ability. On the contrary, if the task is complex and heuristic like soft knowledge, then the designer may use systemic (synthetic) thinking; let us say, the ability to see the problem as holistic and to have a birds-eye perspective, which lead to find out some principles or relationship among several factors. Thus, in this case, the designer might be requested to handle a lot of factors needed to solve the problem. Perhaps, the factors might be appeared, at a glance, as unrelated things in the sight of the systematic oriented designer.
- Finally, IDs might know the meaning of “think globally (systemic), act locally (systematic).” Let us say, IDs could gain the ability to design in a more broader societal domain and to apply more systematic methods.

Conclusion

HD TV which was made in Japan, was a kind of innovation that has finally been proven as a failure because the developing group did not think of the systemic aspect, let us say, because environmental change (societal trends) go to digitized but they did not agree with that. So, if we design an innovation, we have to think about the systematic approach based upon a systemic viewpoint because it reduces the probability of failure.

As another example, before we build a building, we need to think about the outside of the system (building) like the quality of ground, strength of wind, etc. So, it is very important to think about the systemic point of view before we design a system to permit the system to develop safely and soundly.

On the contrary, when we start to do something in terms of performance level, it might be more practical and efficient to have a systematic viewpoint.

We need both systemic and systematic approaches for instructional design. Also, we have to know when or where systematic and systemic approaches are useful. So further study is needed to figure out these aspects.

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THE EFFECTS OF METACOGNITIVE TRAINING ON PERFORMANCE AND USE OF METACOGNITIVE SKILLS IN SELF-DIRECTED LEARNING SITUATIONS

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Abstract

This study intended to determine the effects of teaching metacognitive strategies on performance in a self-directed learning situation. All participants, 60 university students enrolled in a beginning photography course for non-art majors, were subject to the same conditions. The treatment was embedded instruction and practice in reflection, planning and evaluation. Metacognitive awareness was measured prior to and after the treatment. The use of metacognitive strategies was measured by a self-reflection survey, following the first and last assignment. These assignments were identical and provided for the assessment of performance. Results indicated that the treatment had a positive effect on learning. The change in metacognitive awareness led the researchers to conclude that instructional strategies which teach students to practice metacognitive skills while learning course content improves the use and awareness of these skills as well as performance.

Introduction

Metacognition is the ability to reflect, control and understand, in a self-aware mode, one's own learning and cognition (Schraw and Dennison, 1994). Philosophers for ages have been intrigued by the self-reflective nature of human thought. For some, it is the behavior that is the basis of our humanity. Metacognitive strategies as defined by Flavell (as cited in Lin, 1994, p. 489-490) are understanding and regulating one's own cognitive processes in order to monitor, direct and control them. Metacognitive skills include perception of oneself as a learner, an awareness of the nature of a task's components, and knowledge of when and how to use effective strategies. These factors combine to determine which tasks learners find worthwhile and how they choose to engage them (Paris & Winograd as cited in Lin, 1994, p. 490).

Metacognition becomes increasingly important in situations of heightened learner self-direction, where learners are asked to decide what, how and when to explore (Lin, 1994). Examples of such instructional situations are computer-based hypermedia simulations, web-based instruction, and asynchronous, distance learning environments. These environments have an extended complexity and a lack of structure that impose increased responsibilities and cognitive processing requirements on users. A lack of the metacognitive abilities to self-reflect, plan, monitor, evaluate, and adjust one's own cognitive strategies hinders learning under these conditions (Horak, 1991; Blakey and Spence, 1990; Ridley, Schutz, and Glanz, 1992; Lin, 1994).

Today the application of metacognitive research has become useful beyond theoretical models. The results are metacognitive strategies that students can be taught. Guided practice in managing their own experience allows students to develop the metacognitive strategies needed to continue to direct their own learning. (Metcalf and Shimamura, 1994). Strategies include connecting new information to former knowledge, deliberating on how to select what to learn, planning the activity, and evaluating what is learned. Research suggests that making students aware of these strategies may be useful, that students can develop strategies on their own, and that their use increases learning and performance (Blakey, 1990). Research in metacognition has followed two paths, one details how it develops naturally throughout life and the second concentrates on the training potential of metacognitive strategies (Lin, 1994). Most previous research on metacognition describes the phenomena in the assimilation of complex information rather than tasks which are intended to produce personal or novel products. This study was situated in a studio art class and was different than most research and provided a unique context for metacognitive strategies training.

This study focused on training students in the use of metacognitive strategies and the effect on their use of metacognitive processes or activities in self-directed learning. The training was designed into the instructor-led lessons, which focused students' attention on planning, reflection and evaluation.

The long range goals of this research are to find what effect training metacognitive strategies will have on performance and future use of metacognitive processes, as well as to identify a method of training metacognitive strategies that is highly effective. Indicators of effect will be the performance on the comparison between students' first attempt and final attempt at an open assignment.

The primary expectation of this study was that students who have or develop, and then use metacognitive strategies would improve performance in making photographs. Regardless of the source of the student's metacognitive skills, whether gained prior to or during the course, it was expected that using strategies to monitor

what they know would increase the depth of their knowledge and determination to make images which were better than earlier attempts. We hope that such determination supported by metacognitive ability would continue beyond the course as students develop into life long learners.

Demands that are put on students to be self-reflective and creative also require them to be aware of their own conceptual underpinnings. It is the context of complex learning situations that puts pressure on students to develop an awareness of metacognition. Since the course content was complex and demanded constant improvement over previous work, it was expected that post treatment surveys would show significant differences to prior condition surveys of metacognitive awareness.

Method

Participants

During the fall term of 1998, 60 students in a sophomore photography class for non-art majors at a state university made up a sample of convenience for this study. There were 22 males and 38 females. There were no graduate students and all but 4 students were under 25. Participants were present for at least 80% of all classes. The research conformed to the guidelines set forth by the human subjects committee of the university.

Measures

The first item, a Metacognitive Awareness Inventory (MAI) (Appendix A), was used twice as a before and after comparison. It was administered the first time in the second week and a second time 10 weeks later. The MAI survey, designed and tested by Schraw and Dennison (1994), provided a reliable test of metacognitive awareness. The research conducted by Schraw was similar to our testing group in age and demographics. The survey has 52 statements which participants reacted to by marking a Likert scale with numbers from 0 (never true) to 10 (always true). The statements represented two component categories of metacognition, knowledge and regulation. Within the knowledge component were statements of declarative knowledge (knowledge about self and about strategies), procedural knowledge (knowledge about how to use strategies), and conditional knowledge (knowledge about when and why to use strategies). The regulation component covered planning (goal setting), information management (organizing), monitoring (assessment of one's learning and strategy), debugging (strategies used to correct errors) and evaluation (analysis of performance and strategy effectiveness after a learning episode).

A self-report survey (Appendix A) was administered twice: first, after students completed the first assignment; the second time after the last assignment. The survey was designed to capture the degree and type of planning and self-reflection students did before and during the preparation of the work. The survey reflects the strategies we used to embed training in context. The survey questions were written to gather data and to be a learning activity. This activity shows students the questions they should be asking themselves to become metacognitively aware in terms of planning and making photographs.

The third measure was a heuristic used to compare the first assignment and the last assignment (Appendix A). It was designed to measure students' performance change from the work done at the beginning of the course to work done at the end of the course. Each participant's work, completed in four categories of subject matter, was evaluated based on technical skill, subject matter, and composition. Two judges were asked to measure the improvement (0-3) from the first assignment to the last on each skill category for each subject matter set of photographs. Zero meant there was no positive difference between the work. A score of one meant slight change; two, noticeable improvement; and three meant significant positive improvement. Students received 12 different scores, totaling a possible 36 points, from each judge.

Materials

Instructional activities and student materials were developed from several sources of research descriptions. Blakley and Spence (1990) identify specific strategies for developing metacognitive behaviors that were helpful in creating definitions and descriptions of metacognition for students as "Knowing what you already know...." as well as developing guided practice self-reflection and interview questions. Their recommendation of social interaction and guided discussion about thinking in context of course content was included in the treatment activities as a necessary condition for the training of reflective processes, as also suggested by Von Wright (1992), Erickson and Simon (1993), and Sitko (1998).

Procedures

Students met for 10 three-hour sessions in which metacognitive training was embedded into the course content. Each meeting presented the content, which had been part of the syllabus for several years. The lessons for this study had been modified to require students to recognize others' use of metacognitive skills while working, and practice the skills themselves. For example:

- Several videotapes of famous artists were shown in class. Participants were asked to actively watch the film while answering questions related to the artist's methods on worksheets during and after the showing. They also were expected to take notes when the tape was stopped to illustrate specific instances when the artist was employing their own metacognitive strategies such as planning, monitoring and knowledge assessment.
- During the midterm critique class, where several students' photos from past classes were shown, questions were posed to practice planning, visualization and self reflection: "Where's the camera?; Where has the photographer placed the viewer?; When you are making a photograph, how do you manipulate the placement of the camera to create this viewpoint?"

The first and last assignments were given 10 weeks apart; they had identical requirements. Students were instructed to make photographs of four subject matter categories: portraits, still life, landscapes, and self-portraits. They were required to submit two examples in each category. Emphasis was put on planning, designing, and making unique images for the rest of the students to enjoy, understand, and as defined in class, "be able to make their own."

Between the first and last assignment, three other assignments were given over a period of five weeks. These assignments were completed in three parts. They gave the students practice in self-reflection, image visualization, planning, and assessing what they knew or needed to know. The first part was a handout instructing the participants to write or sketch some ideas for this new photograph. A week later, students, in a collaborative planning exercise, were interviewed by each other about their ideas for the assignment. The interview was facilitated by a worksheet of guiding questions; notes were taken and returned to the person interviewed. For the third meeting, the photographs that were done for this assignment were brought in for a critique. Every student gave a written critique of someone else's work and received a critique. This 3-step procedure was followed for all three practice assignments.

After students had completed the three specific subject matter practice assignments, they were given the final assignment. They had to repeat the first assignment to demonstrate what they had learned in the course. It was given in the context of a final exam and meant to challenge students to think and plan. The importance of doing the best they could was emphasized. Their evaluation would be based on improvement over the first assignment.

Research Design

The study was designed as a related sample and data was collected for mixed method analyses. No thought was given to using a control group due to the ethical problem of withholding skills training; therefore all participants were given the same treatment. The independent variables are the pre-tested metacognitive awareness MAI scores and a series of metacognitive strategy training sessions. The dependent variables were the performance in making photographs, measured by the change in performance score, and the use and acquisition of metacognitive skills, measured by the post MAI score and self-report surveys.

Descriptive statistics illustrate a difference in the means collected from the MAI survey. Inferential statistical procedures (t test and Wilcoxon signed ranks test) require random samples. Our design, based on a sample of convenience, could not make inferences to populations beyond this classroom. We understand that the best approach, according to Ludbrook and Dudley (1998), would be a permutation test but the time and software required were not available to the researchers. The self-reported data on the use of metacognitive skills in completing assignments at the beginning and the end of the course were used for qualitative analysis. The change-in-performance scores were used to create two performance groups of ten students each, High and Low, as a means of descriptive comparison.

Results

Changes in Total Mean Score.

Figure 1 shows the difference between mean scores for every subject before and after the treatment. Table 1 is the mean and standard deviation of the pre and post MAI scores. We cannot defend the use of statistical tests to draw inferences to a larger population but we do feel that the descriptive statistics support a rational verbal argument that this group was trained in and developed additional metacognitive skills. To understand the effects of metacognitive strategies training on changes in the subjects' performance we must accept the reported increase in the mean of metacognitive use is due to the embedded treatment in the course content. Qualitative analysis of students' changes in attitudes, strategies, and self-reflective reports offer additional evidence that students' thinking and learning strategies for completing this photography were affected by the treatment embedded design of the course content.

Figure 1. Differences in Mean MAI Scores

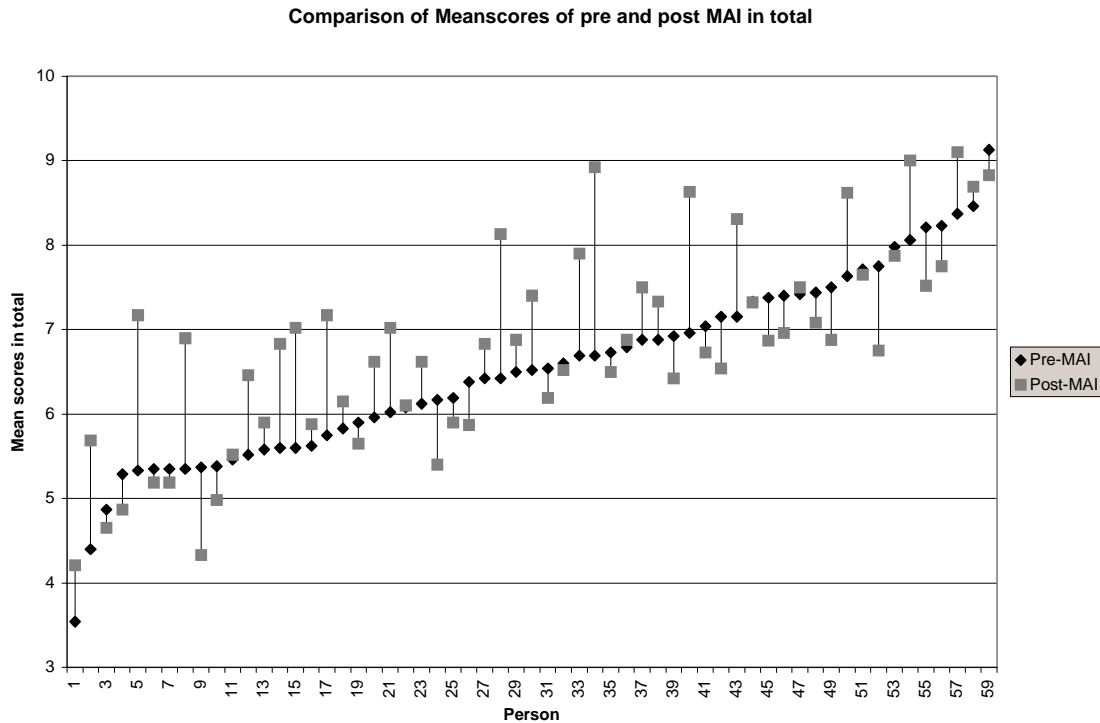


Table 1. Mean and Standard Deviation of Total MAI Scores

N=60	Mean	SD
Pre MAI	6.50	1.12
Post MAI	6.80	1.18

Self-report surveys Comparing Assignments 1 & 8.

Students' self-report surveys were analyzed by first selecting the ten extreme examples of High and Low performing students. The High or Low category reflects the level of change of performance score. The High score represents a change in performance score of 33 or more, while the Low group had scores of 16 or less, from a possible score of 72. These analyzes (Appendix B) compare in two ways the responses of these students to the questions: "What skills were necessary to do good work? ... Did you have them?" and "Describe the steps you took to do the assignment." The first compares the responses on assignment 1 and 8 for each student, showing individual change from the beginning to the end of the course and how this change differs for the Low and High performing students. In the second analysis, responses were coded into metacognitive categories to compare the use of these strategies in the two groups.

The comments of students with high change scores tend to show increased confidence in their work and a gained awareness of the skills and attitudes required to make good photographs. The comments of the lower scoring students tend to reflect little change in the understanding of the skills needed for good photography, or an accurate awareness of their actual ability to make photographs.

For example, when asked "What skills were necessary to do good work?", nine of ten high performing participants used words that addressed their thinking skills rather than just technical information. The descriptors used by these participants for necessary skills included these types of terms:

- manipulating meaning
- determine what was fitting, interesting,
- ability to look at photos critically
- use different perspectives
- remove things to simplify
- have patience, knowledge, creativity

High performing students demonstrated an objective look at their recently acquired skills. In some cases expressing what they had learned and what they still needed to learn. Participant 4 first took photographs intuitively, "doing what I felt" but later described necessary skills as being able to "determine what was fitting, interesting." Participant 65 knew at first that she did not know or have the "skills to do good work" but later describes feeling "more confident" and the "skills necessary to do good work are dedication, acceptance of failure, perseverance, and creative imagery. Another participant (69) used the same words, "patience, knowledge, creativity" to describe skills.

In contrast, the descriptors used by low performing participants for necessary skills included such terms as:

- attention to technical details
- know your f/stops and speeds
- time, patience and money
- a good eye and ability to work the camera

These participants' first comments imply that they consider these skills as things that have not yet been given to them, rather than something to pursue. Six low performing participants, after doing assignment 8, continue to describe necessary skills as technical ability, like "know your f/stops and speeds" and "focus, aperture, shutter speed". High performance students used different terms: "need more awareness of composition"; "tried to visualize pictures I knew were possible"; "take into account the lighting,... removing things from the picture to simplify it." In both groups, the comments illustrated a self-evaluation but the key difference was the characterization of "skills" for technical (psychomotor) goals and thinking (cognition) goals.

When responding to the second self-report prompt "Describe the steps you took to do the assignment." the comments of both groups tended to be more similar. One High group student describes the steps for the first assignment much like the others in both groups "... looked around and took what I thought was interesting." However, that student's description of the last assignment changed to "Decided to photograph things there that have meaning to me." Other comments more evident in the High group's responses for the second assignment relate to photographs being "posed, set up, staged" and many comments from this group also discuss the selection process as part of the steps.

After participants' comments were classified according to metacognitive components, we found both groups made the same comments related to the first assignment in the planning and monitoring categories. In planning, both groups characterized their behavior as "spent a week thinking," "planned in my head," "thought about what I liked." For monitoring, both groups made similar comments, such as "photographed what I liked that applied," "took pictures of places, people, or things that I had been admiring."

The low performing students seemed to repeat their comments from the first assignment when describing assignment 8. Most of their comments were still mentioning "thought about subject matter" and "thought about what would be better." Two participants chose to suspend any planning or monitoring and let chance take its course. They put themselves in situations and relied on intuition to find things interesting enough to photograph.

The difference becomes apparent when high performing students report how it is "interesting to now look at similar subjects in such a different light," Other High participants said "thought about, tried to visualize, pictures," "had ideas for pictures," and "went out, tried to make what I visualized." It is these comments that illustrate a change from their early thoughts about what makes a good picture to using their experience as interpretation.

Discussion

The study found that training students to use metacognitive strategies can affect learning and performance. The results also show that students who improve their level of awareness of metacognition also apply the skills to their problem solving in more direct content specific ways than those who do not change, regardless of the initial level of their awareness. The implication for designers of instruction is that instructional strategies for practice of content should be embedded with exercises that also improve metacognitive skills. Students should be given activities which require them to become aware of what they know, plan what they need to learn, and monitor their strategy choices, so they can be self-directed learners.

One of the most significant findings of this research is the value of the embedded design. Embedded design requires that metacognitive strategies be related directly to course content. For the instructional designer this means developing strategies that deliver course content which also address components of metacognitive awareness. Activities such as presenting examples of experts in the field using self-reflection to solve problems, writing work plans and journals, shared dialog in determining workable solutions to given problems and collaborative critique of work are some examples of embedded metacognitive practice.

As learning strategies and environments become more self-directed in nature, instructional designers must develop ways to bring these theories into practice to help learners be successful. The results found in this study conclude that embedding metacognitive practice in content learning activities helped students become more proficient at guiding their own learning.

Another important observation was that some students who reported high metacognitive awareness did not necessarily report their use in doing coursework. Metacognitive skills need to be practiced like any other skill in order to become effective. Students must be motivated to apply metacognitive strategies, which always require extra time and effort. This implies that designers should embed not only metacognitive practice within content delivery but motivating strategies as well. Future replications of this study will look at motivation as part of the embedded design.

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Appendix A

The measures in this appendix are the Metacognition Awareness Inventory, the student self-report survey for assignment 1, and the heuristic used to measure students' change in performance.

Name _____

Please read the statement and consider how much you agree with it...
then mark the scale to the right. (0) means total *disagreement* 10 means total *agreement*.

	0	10
1. I ask myself periodically if I am meeting my goals. (M)		
2. I consider several alternatives to a problem before I answer.		
3. I try to use strategies that have worked in the past.		
4. I pace myself while learning in order to have enough time.		
5. I understand my intellectual strengths and weaknesses		
6. I think about what I really need to learn before I begin a task.		
7. I know how well I did once I finish a test		
8. I set specific goals before I begin a task		
9. I slow down when I encounter important information		
10. I know what kind of information is most important to learn.		
11. I ask myself if I have considered all options when solving a problem.		
12. I am good at organizing information		
13. I consciously focus my attention on important information.		
14. I have a specific purpose for each strategy I use.		
15. I learn best when I know something about the topic.		
16. I know what the teacher expects me to learn.		
17. I am good at remembering information.		
18. I use different learning strategies depending on the situation.		
19. I ask myself if there was an easier way to do things after I finish a task.		
20. I have control over how well I learn.		
21. I periodically review to help me understand important relationships.		
22. I ask myself questions about the material before I begin.		
23. I think of several ways to solve a problem and choose the best one.		
24. I summarize what I've learned after I finish.		
25. I ask others for help when I don't understand something.		

For this exercise you will review how you did Assignment 1.

Name _____

In order to improve the way you make photographs it is critical that you take time to review and reflect on how you make photographs. Learning how to ask and answer the following questions is as important to improving your work as making photographs.

Doing the Assignment

Describe the assignment in your own words....

Explain the purpose as you understood it....

Thinking back.... did you have all the skills necessary to do good work?

Describe the steps you took to do the assignment...

Planning the Assignment

Did you plan how to make these photographs? Yes / No

Did you write your ideas down Yes / No... or sketch the composition... Yes / No

If you did write or draw your plan, did it help you make the images? Yes / No

As for the technical requirements of the shooting....

Did you have the right supplies? ... Yes / No

Did you take the pictures **all at once** or **over several sessions**?

How many rolls of film did you use? _____

Did you design a photograph that was beyond your skills or expertise?

Yes / No

Recall how Hockney was creating and then designing his “joiner”... he would try things and change his mind and talk to himself—when you were taking your pictures...

Did you change your mind while taking the pictures? ... Yes / No

Did you talk to yourself while planning or taking the photographs? ...Yes / No

Evaluating the Assignment

Most of the time photographs come out different than we expect them.

When you first saw the prints from the processing lab...

Were they what you expected? *Yes or No*

Did they communicate the idea/meaning you had intended? *Yes or No*

Did they give you ideas for new photographs that you want to make?

Yes or No

Did you redo any photographs before turning them in? *Yes or No*

How did your evaluation of what others said about your work affect how you think about doing more work? *In other words, explain how you will use critiques...*

Appendix B**Student ID:** _____

Total Score: _____

Name: _____

Photo Class Assignment: Measuring Change in Performance

		No Change	Some Change	Definite Change	Exceptional Change	Scores
Portrait	Technical	0	1	2	3	
	Composition	0	1	2	3	
	Subject Matter	0	1	2	3	
						Portrait _____
Landscape	Technical	0	1	2	3	
	Composition	0	1	2	3	
	Subject Matter	0	1	2	3	
						Landscape _____
Still Life	Technical	0	1	2	3	
	Composition	0	1	2	3	
	Subject Matter	0	1	2	3	
						Still Life _____
Self Portrait	Technical	0	1	2	3	
	Composition	0	1	2	3	
	Subject Matter	0	1	2	3	
						Self Portrait _____

						Total Score

To determine how metacognitive strategy training differently affected metacognitive processing, the data collected from 40 of the self-reflection reports on the first and eighth assignments were compared in two ways. The first comparison, Table B1 shows each student's responses to two specific questions asked in the two reports. For Table B2, responses were coded into metacognitive categories: declarative knowledge, procedural knowledge, conditional knowledge, planning, managing information, monitoring, debugging, and evaluating strategies.

Table B1. Self-report surveys: Comparing Assignments 1 & 8.

What skills were necessary to do good work? ... Did you have them?

High	Assignment 1	Assignment 8	Low	Assignment 1	Assignment 8
4	Understood requirements, did what I felt	Determine what was fitting, interesting. Shows in my work	1	Definitely Not.	Skills needed were good selection and composition of photos, with attention to technical details. Yes I had them.
5	Knew what I wanted but don't have the experience to manipulate the camera to receive the desired results.	Need understanding of shutter speeds, apertures, and light. I could have used more; light meter would have helped.	8	Yes, after taking several pictures, I remembered how to do things and experimented	A good camera, a camera you're used to, know your f/stops and speeds.
7	I haven't mastered aperture and speed, so used automatic settings. Decent showing of ideas & style.	Knowledge of manipulating shutter speed, f-stop, color temp, meaning. Yes.	10	Yes, but it depends what good work is. It was fine for my second project but far from a gallery.	It was very important that you had a good idea, of how to work your camera. This involves items such as focus, aperture, shutter speed, etc. Yes, I feel I have a good understanding of the skills needed for this assignment.
13	Fair job. First time with adjustable camera.	Using depth of field, speed, lighting contrast knowing what to leave in, what to keep out. I feel I was better at using these skills at the end of the semester.	11	Yes. I seemed to manage taking the photos. I think I am pretty good at taking pictures.	To do good work, one must be able to see a situation in a photograph and make it look excellent and yes, I did have them.
19	I need more awareness of composition. I concentrated every subject square in the middle of the field.	Ability to look at photos critically and objectively to design photographs that were better. Yes.	25	No. I don't have any skill with a manual camera and I don't quite know how to use it.	Time, patience, money, a need to do better. I had some of these... others I lacked in.
51	To take pictures in a way that the surroundings in the picture is interesting. I think I had them.	The skills in the class that I learned... the different perspectives of things that I could photograph enabled me to do good work.	29	Yes. The only thing I lacked was time! After my first roll of film got exposed I had little time to retake photos.	The only skills needed are a good eye for a subject and ability to work the camera. I'm not great at picking subjects but I can work the camera well.
53	I had basic knowledge of how to use my camera for "snapshots". No idea what type/genre of photography I preferred and/or was more skilled at	I knew more than I did at the start but still need practice	45	Creativity	No speed skills.
56	I tried to visualize pictures I knew were possible, while still being something that I wanted.	I needed to take into account the lighting, any special effects I might try, removing things from the picture to simplify it, etc. I had some idea of these skills before, but not to the depth I have now.	46	Yes, I had already acquired the basic knowledge needed to do the assignment.	In order to do this, I needed to be able to quickly determine the camera settings and also be able to figure out what made good composition - I got better.
65	I did not have all the necessary skills to do good work.	Skills necessary to good work are dedication, acceptance of failure, perseverance, and creative imagery. I didn't possess all this skills when I first came into this class but now I feel more confident that I do possess them.	64	No, I don't think I had all the skills to do good work. I had just gotten my 1 st manual camera & was very unsure of it & my ability to use it. I spent an entire day taking pictures all over town & when I went to pick up the developed film it turned out I had loaded the film wrong & didn't get a single picture.	Creativity, an understanding of your camera's functions, an understanding of light, space, and your subject. Deciding what you are trying to capture 1st.
69	In general my photographs were good work, visually pleasing, for beginning photos.	Patience, knowledge, creativity, work. Yes.	76	For the most part, some pictures came out better than others, while others came out not as I expected.	To plan, see, know what I wanted and the ability to create images. - Sometimes.

Describe the steps you took to do the assignment

Low			High		
	Assignment 1	Assignment 8		Assignment 1	Assignment 8
1	Some forethought about who and what I considered photo material - personal choices. Waited for a trip to New Orleans to capture one of the scenes	Most of the photos were taken on a trip to Busch Gardens. I took many rolls with this assignment in mind	4	I thought of a few pictures in my head, but besides those, I just kept my eyes open and searched for subjects.	See things not obvious to regular viewers. Sometimes I just got lucky with what came off the roll of film.
8	I looked for things that intrigued me. Took a shot of it. Experimented with the same shot. Picked the best. Studied the ones messed up.	Drove out to Lake Jackson, several different parks. Walked the trails, looking for something that caught my eye.	5	Figured out who I wanted the portraits to be of. Just looked around and thought what I thought was interesting. Ponder what I liked so I could then know what I wanted to shoot.	Went home. Decided to photograph things there that have meaning to me. Walked around with the camera, capturing some things by accident. Others I posed, set up.
10	Tried to picture a scene that would be easy to produce. Picked a person and a location. Began taking pictures	Planned what I wanted to photograph. Made a short list. Went about photographing.	7	I went out to Lake Jackson for things to photograph. Took an old friend out and took a couple photos of her around town, home.	Went to scenic areas. Took shots I had thought about. The objects just came to me when I was around them.
11	Read the assignment. Photographed what I liked that applied	I kept in mind what the assignment was. Tried to find it. Took the picture, developed, and mounted it.	13	Took pictures of places, people, or things that I had been admiring for some time. The self-portrait was more thought out.	Wandered, exploring, looking, thinking about compositions. Watched for good lighting opportunities. Staged portrait. Cat was opportunity.
25	Took my camera everywhere until I found exactly what I wanted	Looked at what I had done before. Thought about what would be better. Attempted to do it.	19	I thought about what I would like. Made a list of possible subjects. Took far more than necessary to insure acceptable photos.	Over a month's time, I'd have an idea and set it up. Made repeated trips to Lake Ella for candid shots. Took more than necessary. Selected the best examples.
29	Thought about things that would reflect myself. Took the photos. Developed them. Chose the best	I did not plan the subjects. I enjoy just taking pictures when I see an opportunity. Many of the photos were spontaneous.	51	Thought of what kind of areas I wanted. Took a trip to Tampa and found those types. Some things I just took pictures as I went. Selected the most interesting.	Thought about the assignment. Through the weeks, came across situations.
45	Spent a week thinking. One day to snap a roll	When I was free, I just grabbed my camera bag, went outside, and took pictures. Most of my images are seen every day by everyone.	53	Made sure I understood the assignment. Went over possibilities in my mind. Took several photos. Made a photographing trip around town and campus. Chose photographs that fit.	Looked back at 1 st assignment to see what to do differently. Looked over other assignments to find preferences. Thought out possible ideas. Took pictures based on the ideas. Other things seen while photographing. Picked those that worked best.
46	Planned places, people or things. Lighted, distanced, focused them	Brought my camera everywhere I went for a month. Began to go places solely for the purpose of taking the pictures	56	Thought about what would be available to me: lighting, subject, etc. I went out, set it up, shot a couple, trying to get the angle, shadows, etc. that I wanted.	Thought about, tried to visualize pictures. Went out, tried to make what I visualized. Experimented while doing this.
64	Think about my subjects. Drove around with camera. Got them developed. Chose which pictures	Looked at my old work to decide what could make it better. Decided on subjects, began to get ideas	65	Planned the pictures in my head. Tried to take those and others. Took more random pictures than planned. Re-took some.	Reevaluated my own work, deciding what I liked, disliked. Interesting to now look at similar subjects in such a different light. Fully understanding that snapshots are not photographs.
76	Planned in my head. Pictured what & where	Thought about subject matter. Created atmosphere if controllable. Took pictures.	69	Went out around town. Took various pictures from the categories. Went out another time at night. Picked out the ones I liked.	Had ideas for pictures. Created and shot them. Others I just saw and wanted to photograph.

Table B2. Metacognitive evidences of Assignments 1 and 8 for both groups

Component	Description	Low Performance Group		High Performance Group	
		Observed Evidence (Assignment 1)	Observed Evidence (Assignment 8)	Observed Evidence (Assignment 1)	Observed Evidence (Assignment 8)
Declarative Knowledge	Knowledge about self and about strategies. "I know..."	<ul style="list-style-type: none"> after taking several pictures, I remembered how to do things and experimented I seemed to manage taking the photos. I think I am pretty good at taking pictures. I had already acquired the basic knowledge needed to do the assignment. 	<ul style="list-style-type: none"> Skills needed were good selection and composition of photos, with attention to technical details. Time, patience, money, a need to do better 	<ul style="list-style-type: none"> Understood requirements, did what I felt Knew what I wanted but don't have the experience to manipulate the camera to receive the desired results. I haven't mastered aperture and speed, so used automatic settings. Decent showing of ideas & style. I need more awareness of composition. To take pictures in a way that the surroundings in the picture is interesting. 	<ul style="list-style-type: none"> Need understanding of shutterspeeds , Apertures, and light. Knowledge of manipulating shutter speed, F-stop, color temp, meaning. I knew more than I did at the start but still need practice I needed to take into account the lighting, any special effects I might try, removing things from the picture to simplify it, etc. I had some idea of these skills before, but not to the depth I have now. Skills necessary to good work are dedication, acceptance of failure, perseverance, and creative imagery. Patience, knowledge, creativity, work.

Procedural Knowledge	Knowledge about how to use strategies. "First, ... then..."	<ul style="list-style-type: none"> I don't think I had all the skills to do good work. I had just gotten my 1st manual camera & was very unsure of it & my ability to use it. I spent an entire day taking pictures all over town & when I went to pick up the developed film it turned out I had loaded the film wrong & didn't get a single picture. 	<ul style="list-style-type: none"> Created atmosphere if controllable. It was very important that you had a good idea, of how to work your camera. This involves items such as focus, aperture, shutter speed, etc. To do good work, one must be able to see a situation in a photograph and make it look excellent The only skills needed are a good eye for a subject and ability to work the camera. I'm not great at picking subjects but I can work the camera well. In order to do this, I needed to be able to quickly determine the camera settings and also be able to figure out what made good composition Creativity, an understanding of your cameras functions, an understanding of light, space, and your subject. Deciding what you are trying to capture 1st. 	<ul style="list-style-type: none"> I had basic knowledge of how to use my camera for "snapshots". No idea what type/genre of photography I preferred and/or was more skilled at I tried to visualize pictures I <u>knew</u> were possible, while still being something that I wanted. 	<ul style="list-style-type: none"> Using depth of field, speed, lighting contrast knowing what to leave in, what to keep out. I feel I was better at using these skills at the end of the semester. Ability to look at photos critically and objectively to design photographs that were better The skills in the class that I learned... the different perspectives of things that I could photograph enabled me to do good work.
Conditional Knowledge	Knowledge about when & why to use strategies "If..., then "				

Planning	Goal setting "I want... ; here's how..."	<ul style="list-style-type: none"> Some forethought about who and what I considered photo material - personal choices. Tried to picture a scene that would be easy to produce Thought about things that would reflect myself Spent a week thinking. Planned places, people or things Think about my subjects Planned in my head Took my camera everywhere until I found exactly what I wanted 	<ul style="list-style-type: none"> To plan, see, know what I wanted and the ability to create images. Planned what I wanted to photograph. Thought about what would be better. Decided on subjects, began to get ideas Thought about subject matter. Began to go places solely for the purpose of taking the pictures 	<ul style="list-style-type: none"> Figured out who I wanted the portraits to be of. I thought about what I would like. Thought of what kind of areas I wanted. Thought about what would be available to me: lighting, subject, etc. Planned the pictures in my head. 	<ul style="list-style-type: none"> Decided to photograph things there that have meaning to me. Wandered, exploring, looking, thinking about compositions. Over a month's time, I'd have an idea and set it up. Thought about the assignment. Thought about, tried to visualize pictures. Had ideas for pictures.
Managing Information	Organizing "Make a list..."			<ul style="list-style-type: none"> Made a list of possible subjects. 	
Monitoring	Assessment of one's learning and strategy "How am I doing?"	<ul style="list-style-type: none"> Read the assignment and photographed what I liked that applied Lighted, distanced, focused them 	<ul style="list-style-type: none"> I kept in mind what the assignment was and tried to find it and took the picture, developed, and mounted it. Looked at what I had done before. I did not plan the subjects but I enjoy just taking pictures when I see an opportunity. Many of the photos were spontaneous. 	<ul style="list-style-type: none"> I thought of a few pictures in my head, but besides those, I just kept my eyes open and searched for subjects. Took pictures of places, people, or things that I had been admiring for some time. I went out, set it up, shot a couple, trying to get the angle, shadows, etc. that I wanted Took more random pictures than planned. 	<ul style="list-style-type: none"> Walked around with the camera, capturing some things by accident. Took shots I had thought about. Watched for good lighting opportunities. Took more than necessary. Through the weeks, came across situations. Went out, tried to make what I visualized. Interesting to now look at similar subjects in such a different light.
Monitoring					

Debugging	<p>Strategies used to correct errors</p> <p>"What needs changing?"</p>	<ul style="list-style-type: none"> • Experimented with the same shot. • Studied the ones messed up. 	<ul style="list-style-type: none"> • I took many rolls with this assignment in mind • Attempted to do it. • Looked at my old work to decide what could make it better. 	<ul style="list-style-type: none"> • Re-took some. 	<ul style="list-style-type: none"> • Made repeated trips to Lake Ella for candid shots. • Experimented while doing this. • Reevaluated my own work, deciding what I liked, disliked.
Evaluating	<p>Analysis of performance and strategy effectiveness after the learning episode</p> <p>"How did I do, compared to before and others?"</p>	<ul style="list-style-type: none"> • Picked the best • Chose the best 			<ul style="list-style-type: none"> • Sometimes I just got lucky with what came off the roll of film. • Selected the best examples. • Fully understanding that snapshots are not photographs.

EVALUATING NARRATIVE SIMULATION AS INSTRUCTIONAL DESIGN FOR POTENTIAL TO IMPACT BIAS AND DISCRIMINATION

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Abstract

Simulation exercise as instruction has a long history in skill development involving performance tasks. Traditionally physical simulators have been used in diverse fields such as military flight instruction and industrial training. More recently paper & pencil simulation exercises have employed narrative in instruction aimed at solutions to work place problems, such as sexual harassment. This evolution has led to a refinement of principles of simulation exercise design, as well as evidence for specific problem characteristics that indicate potential effectiveness in use of simulations. Issues such as racism, anti-Semitism, sexism, disability, and homophobia present instructional challenges due to the covert and rigid nature of some attitudes and beliefs. This paper reports on the development, design, and initial field testing of a narrative simulation focused on homophobia and adolescent suicide. Desired learning outcomes that focus on attitudes, beliefs, and biases may lend themselves to further evolution of narrative simulation in creating contexts in which to examine deeply held beliefs.

Narrative Simulation as an Instructional Design Strategy

Simulation exercise as instruction has a long history in skill development involving performance tasks. Traditionally physical simulators have been used in military flight instruction, industrial training, and an array of other performance-based instructional problems. More recently paper & pencil simulation exercises have employed narrative in instruction aimed at accident prevention, farm safety, and solutions to work place problems, such as sexual harassment. This evolution has led to a refinement of principles of simulation exercise design, as well as evidence for specific problem characteristics, which indicate potential effectiveness in use of simulations. Issues such as racism, sexism, anti-Semitism, disability, and homophobia present instructional challenges due to the covert and rigid nature of some attitudes and beliefs. Group discussion is one powerful way of beginning to examine beliefs and synthesize new information regarding biases. Narrative simulation has the potential to initiate such discourse by providing less threatening contexts in which to think about and express deeply held beliefs. As a result it provides exposure to alternative ways of thinking. Desired learning outcomes that relate to attitudes, beliefs, and biases may well lend themselves to further evolution of narrative simulation as an instructional design strategy.

Based on the work of Bruner (1986), Cole (1994), Howard (1991), Sarbin (1986), and others, this simulation exercise was developed as instructional material for presenting content on homophobia related to adolescent sexual orientation. *"This just is!"* Jeff's Story uses a narrative approach to engender discourse and to inform regarding this difficult and prohibitive topic. It specifically deals with adolescent sexual orientation, homophobia, and potential suicide. It is a powerful contemporary culture tale that offers opportunity for situated presentation of information (Lave and Wenger, 1991, Schell and Black, 1997, Young, 1993). The purpose of this paper is to describe the design and preliminary evaluation of this innovative narrative simulation. The evaluation utilizes data obtained through expert feedback, exercise field tests, individual and focus group interviews, and observation as basis for informing continued development of this design.

"This just is" Jeff's Story is a narrative simulation designed for target groups of parents, helping professionals, and adolescents. The story centers on a fourteen-year-old boy discovering his own homosexuality and struggling with problems of discrimination, violence, and suicidal thinking. This true story was adapted from a web page, developed by a parent who was faced with these issues. The title *"This just is"* was adopted from a statement found in her son's journal after his suicide.²

The grand scheme was to explore instructional possibilities relative to constructivist theory. Narrative simulation provides opportunity to teach through problem-solving practice in real world environments (Duffy and Cunningham in Jonassen Ed., 1996). The overall intent was concerned with exploring instruction designed to impact socially constructed attitudes, creative problem solving, and independent thinking skills. Simulation exercise with its imperatives for "real world" learning, veracity, and practice before the fact, as opposed to retrospective methods such as case study (Cole, 1997), seemed an appropriate place to begin. The narrative simulation approach increasingly involves the user in the story by virtue of question & answer decision points embedded throughout.

² http://members.tripod.com/~claytoly/Bill's_Story

We began this project with a broad question regarding whether instruction can be effectively designed to decrease bias and discrimination. Questions regarding bias, stereotyping, and attitudinal change appear to be some of the most challenging issues faced by contemporary educators (Boyer, 1995, Vitz, 1990). An initial single focus on homophobia was chosen because discrimination towards gays is so pervasive in contemporary American culture (Helminiak, 1994). Open expression of homophobia has been painfully demonstrated in the most recent well-publicized case of Matthew Shepard, who was brutally beaten and hung on a fence to die, solely because of his homosexuality (Barrett, 1998). Furthermore, discrimination towards homosexuals, in most cases, is still legally condoned in this country (Plaster, 1998, Stachelberg, 1998). Relative to public education, Sandra Prettyman writes, "Creating a forum for discussion and an awareness of the issue [homophobia] will help promote student safety in schools and will help students begin to recognize and critique the oppression that many different groups of people face in our country today (1997, p. 93)." The long-range goal for this project is to develop a series of narrative simulation exercises that will impact various kinds of discrimination, both in pencil/paper and multimedia formats.

Promoting Tolerance and Inclusion through Instruction

While tolerance and inclusion are often recognized as priority issues in various instructional contexts (schools, business and industry, and the military), problems regarding how to promote sensitivity to difference with regard to race, culture, religion, gender, disability, and sexual orientation persist. Most trainers and educators realize that addressing these issues in general, rather than personal terms, has proved to be a superficial and ineffective approach to problems that have serious legal and moral consequences. It has been particularly difficult to address these issues in engaging and meaningful instructional ways. This has been partly due to the fact that instructional materials and approaches, designed to engender personal reflection and discourse on these difficult topics, are limited, often nonexistent (Prettyman, 1997).

However, there is an emerging body of qualitative literature that seeks to address these issues. The 1998 journal of *Qualitative Studies in Education* 11(2) provides an editor's introduction that signals "strong support of lesbian and gay scholars and scholarship." The editors say "...we feel that all educators need to make known publicly their support of lesbians and gays in order to aid this group in their struggles (which really should be *our* struggle, too) to gain basic human rights." William Tierney, author of the book, *Academic outlaws: Queer theory and cultural studies in the academy*, says, in the process of studying a faculty member who died of AIDS, he began to understand "...the intense dilemmas that individuals face in coming to accept those parts of themselves that society most vociferously aims to deny...I struggle to develop pedagogies that enable students to develop their own voice rather than speak with one voice (Tierney, 1998, p. 133)." Robert Rhoads recently completed a "two-year ethnographic study designed to better understand the coming-out experiences of gay and bisexual college men (Rhoads, 1997, p.8)." Chasnoff and Cohen have published an instructional film, *It's elementary: Talking about gay issues in school* (NewDay Films, 1997), which is reviewed by Prettyman in *Educational Studies* (1997, pp. 92-98). Catherine Raissiguier (1997) offers a study of 13 self-identified homosexual university students. Raissiguier (1997) notes that while earlier studies explored the "anomaly" of homosexual attraction and behavior it is relatively recent that homosexual youth have been studied as members of a collective group (pp.34-35). These studies, related articles, reviews, and editor's notes provide a base for the development of instructional materials and media designed to promote a deeper, and hopefully, richer understanding of all types of difference, particularly that of sexual orientation.

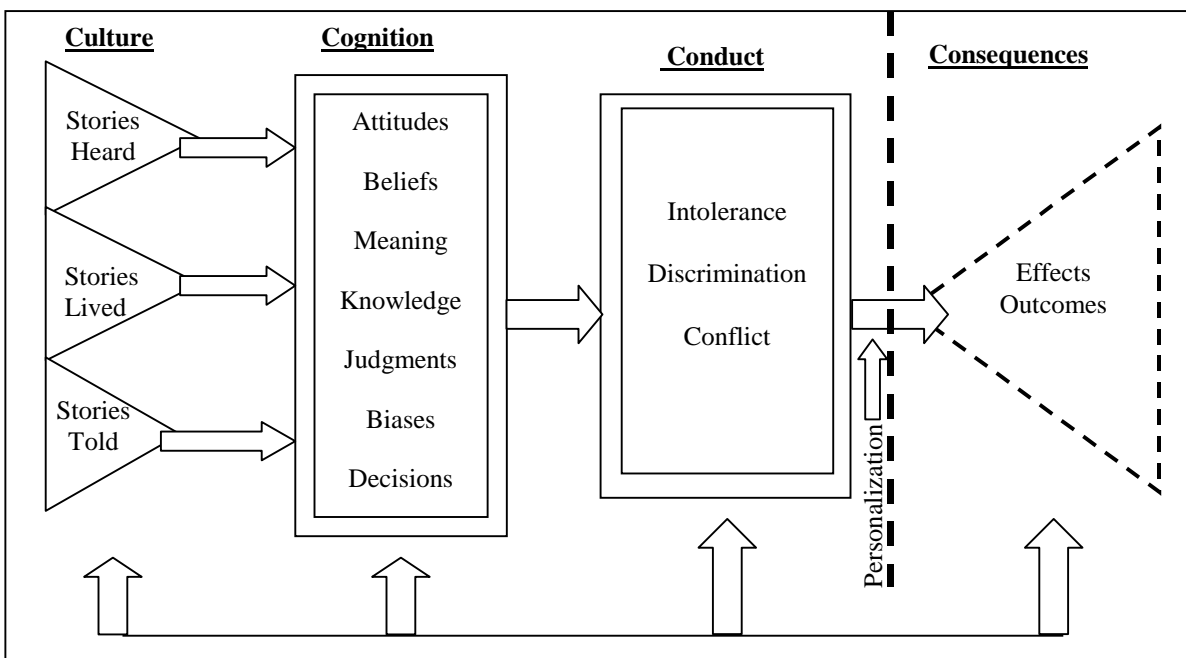
Affecting Beliefs and Behavior through Narrative

Walter Fisher (1995) offers well-articulated foundation for use of narrative to integrate the didactic and non-didactic (affective) aspects of instruction. "Narration (as paradigm) respects reason...as including metaphor as well as argument, as inextricably bound to values, and as historical and contextual (p.173)." Fisher reminds us that objectivist thinking is rooted in concepts, methods, and hypotheses, which are historically grounded in myths. He adds, "objectivist thinking and discourse cannot advance without recourse to imagination (p.174)". The implications, for purposes of this project are to design instruction, which fills the space beyond--the gapping hole--as it were, left by the singular focus of classical science. That is, instruction designed with a primary focus on values in the context of contemporary culture. Instructional narrative that combines didactic information and narrative may be especially powerful with regard to the affective domain (Vitz, 1990).

Henry Cole (1997) has organized and articulated issues regarding instructional narrative simulation through his efforts in farming and mining safety. While emphasizing seemingly traditional performance outcomes, Cole has also provided important clarity on the issue of impacting learner attitudes and beliefs. Cole constructs solid theoretical foundation for use of narrative simulation in education. He states: "The robustness of the life stories people live, observe, and communicate about cannot be captured in a meaningful way with only the abstract principles of paradigmatic thinking (p.332)." One important contribution Cole makes is a narrative conceptual model, which he describes as "a cultural, cognitive, and behavioral model...of beliefs and...behavior (p.333)". In this model culture (stories heard, stories lived, and stories told) contributes to cognition (attitudes, beliefs, meaning,

and knowledge), which in-turn contributes to conduct (behaviors, actions) that results in consequences (effects, outcomes). While the process is linear, insights gained through it often fold back into an interplay of the whole. Cole's model illustrates the relationship between narrative, cognition, behavior, and consequence. One point that he stresses is that narrative simulation can be an effective means to vicariously experience consequences and may even have power to change behavior before the fact. In Cole's original model consequences necessarily follow from narrative, cognition, and behavior. This model is pertinent to this development project with one exception. That is, we would add some indication that only when the social is made personal do consequences necessarily result from this process (see figure 1). This is an effort to move Cole's model a step further for specific consideration of issues of social values such as discriminatory behavior. This is to say that unless the cultural collective consequences are made personal through experience (vicarious or real); they may have no impact, behaviorally speaking, on individual attitudes and beliefs underlying discrimination. "Bruner (1986, 1990a) notes that a universal problem in education is the matter of translating socially relevant information into information that is personally relevant for the individual (Cole, 1997, p.334)." Narrative form has the power to make the socially relevant more personal for the learner (Bruner, 1986, Cole, 1997, Vitz, 1990).

Figure 1. Cultural, Cognitive, and Behavioral Model of Bias and Discrimination



"The kind of meaning the narrative conveys about human existence requires the use of discourse, which can be differentiated from mere collection of words or sentences. A discourse is an integration of sentences that produces a global meaning that is more than that contained in the sentences...(Polkinghorne, 1988, p. 31)." In addition to personalizing dilemmas and decisions, narrative also has important potential to stimulate group discussion. Bruner (1996) writes "...we form a representation of the world as much from what we learn about it through others as from responding to events in the world directly (p.165)." This concept provides an important frame for instruction aimed at impacting the affective domain. We often develop attitudes, beliefs, and biases based on what we learn from others (individually and collectively) rather than actual experienced events. This is especially true with regard to homophobia and racism. Usually personal experience with those discriminated against is limited. Moreover, even when we have opportunities for such experiences, these experiences are filtered through pre-existing cultural and personal belief systems. Isolated experiences serve to either confirm pre-existing notions or stand as rare exceptions. Rarely do these exceptions impact deeply held beliefs. However, since experiences that result in bias are developed and conveyed largely through the vehicle of narrative, it is quite appropriate to look to forms of instructional narrative to change such beliefs. Sarbin (1986) contends that as human beings we make moral decisions according to narrative structures. As such, the use of stories has an enduring, if not prevailing, history as instructional practice.

Combining Narrative Structure and Simulation

Some important findings have emerged from research with narrative simulation exercises. Stories, when used in this manner, provide opportunity for critical thinking and decision making. As narrative simulation stories unfold, dilemmas develop which engage the learner in real world problems and relative solutions. The narrative

exercise requires gathering information, interpreting data, making choices, remembering and utilizing relevant information, and actually interacting with the plot of the story (Cole 1997, Howard 1991, Orner 1996, Schell and Black 1997, Vitz 1990, Young 1993). The learner literally becomes a character in an unfolding tale. As such, he or she is more likely to discuss beliefs, attitudes, and biases, otherwise considered taboo. Most would agree that bias and discrimination are serious problems, which tend to arrest individual and cultural growth and development. However, the tendency of human nature is to view these issues as other people's problems (Bennett, 1998). As an instructional strategy, situated cognition has been used to relate subject matter to the concerns of learners (Shor, 1987). Situated learning involves immersing learners in activities and environments that facilitate ability to make meaning (Lave and Wenger, 1991). Situated learning typically involves four guiding principles: (1) learning is grounded in everyday activities; (2) knowledge is acquired situationally and transfers to similar situations; (3) learning is the result of a social process involving certain ways of thinking, perceiving, problem solving, and interacting; and (4) learning exists in complex social environments made up of actors, actions, and situations (Anderson, Reder, and Simon 1996). Dilemmas rather than content drive this type of learning. Certain problems are presented that serve to challenge the simulation user.

"*This just is*" Jeff's Story combines the aesthetic and affective power of narrative with the situated cognition of simulation by re-creating a real-life situation and utilizing strategically placed decision points. It involves the user as a character in an unfolding story, providing opportunity to think through problems, respond to questions, and resolve dilemmas as the story progresses. Additional information in the form of statistics, news media excerpts, history, and commentary is provided throughout the narrative. These appear at the bottom of each page and are distinguished from the narrative by use of text boxes. Users may choose to read any or all of this additional information.

Development of the Narrative Simulation: "*This just is!*" Jeff's Story

The Search for a Story

The imperatives of veracity and fidelity for simulation effectiveness led to an initial search for a true story. While it is possible to create a narrative with truth-likeness, it seemed that it would be more powerful to use an actual contemporary story. The power of contemporary, true story narrative to support reflection and change has been recently documented (Bliss and Mazur, 1996). Additionally, true story cases combined with facilitated discussion of difficult topics can create conditions for conversation and community (Mazur and Bliss, 1995). While Bruner (1990) and Grossman (1992) suggest that verisimilitude or plausibility is sufficient in narrative, Phillips (1994) argues for the use of true stories "when something important hangs in the balance (p. 17)." Moreover, evidence exists that the true story case provides for intense engagement and personal involvement in the story (Bliss and Mazur, 1995).

Bill's Story appeared in the form of a web page that was dedicated to prevention of teenage suicide and violence towards gays. Bill Clayton's mother developed this web page, after his death. She was contacted and generously agreed to assist with the content and design of this instructional package. Thus, Gabi Clayton is an important collaborator on this project, offering editorial revisions and support along the way. For example, she suggested that the use of the term lifestyle in the original answer choices is a "trigger phrase-lifestyle has been used over and over by people who are homophobic. So has the issue of choice" (Gabi Clayton, 1998, in e-mail reply). Most importantly, she provided crucial input to assure maximum fidelity. Her story seemed appropriate for use in this project for several reasons. It is a well-written account of the struggles of one family to deal with adolescent homosexuality, abuse of and violence towards homosexuals, depression, and teen suicide. More importantly, Bill's Story includes vivid accounts of dilemmas and decisions faced by Bill Clayton and his family. It is a true story in which a family faced problems head-on, made appropriate decisions, and provided more than adequate support. However, Bill's Story is also one that, despite all efforts to intervene, ends in tragedy. This contradiction is the dynamic diagonal in this composition, which is intended to inspire robust discourse.

Adapting the Story to Narrative Simulation

The next issue was development of the true story into a narrative simulation exercise. This required transforming it from a retrospective account to an unfolding and interactive tale. We adapted Cole's (1997) behavioral model, which illustrates the relationship between narrative, cognition, conduct, and consequence. He stresses that narrative simulation can be an effective means to vicariously experience consequences and may even have power to change behavior before the fact. This adaptation goes a step further (indicated by broken lines) to suggest that unless the cultural collective consequences are made personal, they may have no impact, behaviorally speaking, on individual attitudes and beliefs underlying discrimination. [Insert figure 1 about here.]

Following the work of Halpern (1984) and Cole (1997), the first task was to create a qualitatively different instructional environment that would encourage critical forethought (simulation) instead of informed hindsight (case study). The story was condensed and critical decision points were determined. Each decision point or dilemma required developing corresponding questions and answer choices. The initial questions were developed and reviewed

by various experts in the fields of Educational Psychology, Curriculum and Instruction, Instructional Design, and Ethics, as well as both parents and gays. These reviewers assisted by suggesting important editorial revisions.

Using Qualitative Field Study for Content Development

During this initial process of revision it became increasingly apparent that there was a need for the simulation designer (McCrary) to develop a qualitatively unique and deep understanding of the broader issues of bias and discrimination. Various techniques of qualitative field study were employed to broaden the designer's personal understanding and to enrich the final product. The final tasks in development of the instructional components included design of questions and instructional response choices, as well as supplementary explanatory information for an instructor's guide. Due to the fact that homophobia³ persists as an "invisible issue" (Prettyman, 1997, p. 92) in American contemporary culture, understanding a range of possible user characteristics and designing response choices that would be informative and meaningful was a daunting task. Qualitative field study was viewed as an appropriate means to this end. A series of participant observations and interviews were completed, contributing data specifically on homophobia, as well as the larger topic of discrimination, including racism, sexism, anti-Semitism, and disability. Two major reoccurring themes surfaced throughout these formal and informal observations and interviews. Those were religious belief and unwillingness to claim personal bias. From a classical instructional design perspective, religious belief and denial of personal bias might be considered as important entry-level characteristics the target learner.

For purposes of this design effort, religious beliefs may be no less important than preexisting attitudes and beliefs about worker safety or gender related behavior in the workplace. Diana Butler Bass (1998), associate professor of religious studies at Rhodes College, posits that in the cases of African American slavery, the subjugation of women, and anti-Semitism. "Christianity developed elaborate theological systems based on a few biblical texts to keep people subject to the cultural status quo and male authority (D5)". It follows that discrimination towards homosexuals may, in fact, be encouraged by such theological systems. Additionally cultural experience and background may contribute to miseducative experiences regarding race, gender, and minorities. Eisner references John Dewey in describing miseducative experience. "Miseducative experience arrests growth and/or develops dispositions towards a domain of human experience that limit or diminish the probability of growth in that area. (Eisner, 1998, p.99)."

The reoccurring theme of the refusal of those observed and interviewed to claim personal prejudice also raised questions and design considerations. Most informants interviewed were quite comfortable discussing pervasive discrimination in our culture, yet, almost without exception, viewed it as the behavior of others. "But focusing on the prejudices of others leads us down just one path to a hostile and divided culture as each group, blind to its own flaws and vulnerabilities, comes to believe that it holds the moral high ground (Bennett, 1998)." This reiterates the problem in education of social versus personal relevance (Cole, 1997, see figure 1). Discriminatory behavior usually results in immediate and tangible consequences for others, rather than the perpetrators themselves. Therefore, situating the learner as a character in an unfolding tale through the use of engaging questions and frank responses may be the most crucial function of narrative simulation for this type of instructional design effort. "*This just is!*" Jeff's Story employs this function in situating instructional experience in an environment that encourages reflection, empathy, and compassion.

Program Description

"This just is!" Jeff's Story is an instructional program that tells a concise story. It includes an embedded question following each possible decision point in the narrative. After each question several possible answer choices are listed, as well as space for write-in answers. Graphics are included throughout as a means to appeal to aesthetic and sensory ways of understanding and remembering. Each page of narrative includes an isolated text box following the story segment that contains pertinent historical accounts, news media excerpts, and statistical data. A separate answer discussion key is attached, which includes questions and answers from the exercise booklet. Following each possible answer choice is a subjective commentary relative to that particular answer. The answer discussion key, as the name suggests, is designed to stimulate group discussion and individual reflection. Users are asked to compare their answers with those in the answer discussion key and read the accompanying comments. They are then encouraged to discuss individual opinions with the group. Since this instructional package is intended for widely diverse audiences and settings, an instructor's manual is provided. The instructor's manual includes additional information for facilitating participant discussion. It provides suggested focus for discussion and clearly outlined objectives. This manual is designed to prepare and guide facilitators through the instructional process.

2 Homophobia has been defined as "irrational fear and hatred of those who love and sexually desire those of the same sex (Pharr, 1988. P. 1)." Comparisons have been drawn between homophobia, racism, and anti-Semitism in terms of discrimination that includes verbal and physical violence, even death (Pharr, 1988)

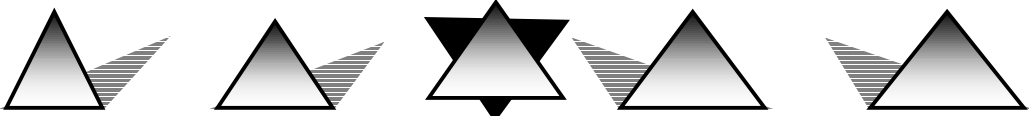
Figure 2. Sample Narrative Page

"This just is!" Jeff's Story Instructional Simulation

<p style="text-align: center;">The Beginning of the End</p> <p>On April 4, 1997, Steven, his girlfriend, Julie, and Jeff were walking near the County High School on their way to Julie's to watch a video they had rented. Four guys from their high school were cruising by the school. They recognized Jeff and followed the three, yelling angry obscenities. "Queers, faggots..."</p> <p>Steven, Julie, and Jeff tried to ignore the insults and threats, deciding to cut through the school grounds to avoid the car following them. The guys in the car parked and proceeded, on foot, to surround Jeff and his friends. They brutally assaulted Steven and Jeff, kicking and beating them unconscious. It was a bright spring afternoon, and all Julie could do was scream at them to stop. When Steven and Jeff regained consciousness, they went with Julie to find the school custodian. He called the police and an ambulance. Both boys were in serious condition with multiple abrasions, bruises, and broken bones.</p>
<p><i>Question F: As Jeff's parent, you are now faced with what to do to help your son. How will you proceed?</i></p> <p><input type="checkbox"/> 41. Get Jeff to a psychiatric hospital immediately.</p> <p><input type="checkbox"/> 42. Tell Jeff that this sexual orientation he has chosen almost got him killed and has brought nothing but trouble.</p> <p><input type="checkbox"/> 43. Call the minister at your church to get his advice.</p> <p><input type="checkbox"/> 44. Tell Jeff you love him and want to help him through this difficult time.</p> <p><input type="checkbox"/> 45. Talk to your friends and try to get their advice.</p> <p><input type="checkbox"/> 46. Try to find Jeff a nice girlfriend.</p> <p><input type="checkbox"/> 47. Make an appointment with a family therapist to get some professional help for you and your son.</p> <p><input type="checkbox"/> 48. Other _____</p>

Figure 3. Sample Didactic Text Box, Graphic, and Original Story Quotation

"This just is!" Jeff's Story Instructional Simulation



<p style="text-align: center;">A Bit of World History</p> <p>"Who belonged in a concentration camp, according to the Gestapo? Above all <i>four groups</i> of people: political adversaries, members of <i>inferior races</i> and <i>inferiors from the standpoint of race biology</i>, criminals, and asocials. ...All groups of prisoners in the concentration camp had to wear external markings which were sewn on their clothing, namely a number and a triangle of a certain color on the left side of the chest as well as the right trouser leg. Red was the color of the political prisoners...The other colors and designations were as follows: Green for criminals... violet for Jehovah's witnesses, black for asocials, pink for homosexuals, at times brown for gypsies... Jews wore an inverted yellow triangle underneath their red, green, black, or other markings, forming a star with six points." (Kogon, 1946, cited from Duberman, 1989, p.376)</p>

[Jeff wrote this in his journal! His brother found it when he was going through Jeff's belongings after the funeral.]

Evaluation of "This just is!" Jeff's Story

Focus of Field Testing

An initial field test of the narrative simulation was conducted with two user groups. These included a graduate class of professionals in the field of Higher Education Student Development at a large southeastern university and a small group of ministers certified as pastoral counselors working in a large urban area in the northeast. Since the simulation will have to be promoted by facilitators or those engaged in raising awareness on the issues addressed in the narrative simulation, these groups of users were selected for initial user tests.

The design features prioritized for field-testing were usability, impact on user attitudes, and relevance of didactic information embedded throughout the exercise. We wanted, first, to determine the overall usability for ease in following instructions, answering questions, and cohesiveness of narrative composition. To this end we used a participant evaluation that was designed to be filled-out immediately after completion of the exercise. Additionally participants were asked to fill-out another very brief evaluation following the review of the answer discussion key and subsequent group discussion. This served to provide specific information about the value of group discussion. Cohesiveness of the composition was determined through careful analysis of participant answer choices, with particular attention to user write-in answers. The next priority was to collect preliminary data on the potential of this exercise to impact user' attitudes regarding homosexuality. This was done through a comparison of initial participant

evaluations with a follow-up evaluation, which was completed at least two weeks after the simulation experience. We considered time for reflection an important factor in attitude change, recognition of impact on beliefs, and ability to articulate such. Finally, we wanted to determine the relevance of the didactic information embedded throughout the narrative simulation. This information, appearing in text boxes, was evaluated through overall analysis of participant answers and comments on various participant evaluations, as well as comments during group discussion.

The higher education development professionals used the simulation exercise during one graduate class period, while the ministers used it during a quarterly ministerial meeting. The narrative simulation packet was distributed and users were instructed to work through the simulation. Immediately following individual use of the simulation packet, users filled out a brief evaluation that included questions regarding usability, veracity, informative aspects, and impact on attitudes and beliefs. The participants then worked in small groups to discuss their responses and the narrative itself. Following the group work, users were asked to respond to several questions specifically regarding the impact of group discussion. Finally, the designer debriefed the users in an open-ended group discussion to elicit any additional feedback not addressed by the evaluation questionnaire. We also attempted to contact users after several weeks in an effort to ascertain residual affects. Although the initial field tests include fourteen users, we were only able to obtain eight returned follow-up evaluations. The follow-up contact occurred at least two weeks after the simulation experience. It includes ten statements similar to those in the initial evaluation.

Formative Evaluation Results

Table 1 summarizes the participant evaluations and includes percentage results for eleven questions regarding the individual experience and four questions relative to the group discussion. These were rated from one to five (5 = highest agreement) on a Likert scale. As part of our analysis, we categorized these statements under six areas: 1) veracity, 2) general usability, 3) the extent to which the user felt the experience was informative, 4) cognitive or the extent to which the exercise provoked thinking, 5) impact on attitude, and 6) the value of group discussion in the exercise process. These findings are summarized and reported in terms of general agreement with specific evaluation questions as indicated by user choice of either number (4) or (5) on the scale, disagreement by choice of number (1) or (2), and those choosing number (3) were viewed as neutral.

Table 1. Initial User Evaluation Results "This just is!" Jeff's Story (n = 14)

Simulation Evaluation Questions	Design Category	Agree (#4,5)	Disagree (#1,2)	Neutral (#3)
I could relate personally to this story.	Veracity	28%	28%	36%
Jeff's Story was realistic.	Veracity	86%	0%	7%
The questions were easy to answer.	Usability	57%	43%	0
The directions in the exercise are easy to follow.	Usability	93%	7%	0
I found the additional information at the bottom of some pages appropriate and informative.	Informative	50%	7%	29%
This story gave me new information about homophobia and discrimination towards gays.	Informative	29%	43%	29%
Prior to working this exercise I had not thought much about discrimination toward gays.	Cognitive	0	100%	0
What I learned from Jeff's Story will help me respond to discrimination towards gay youth.	Cognitive	50%	14%	36%
The questions in this exercise were thought provoking.	Cognitive	93%	7%	0
I found Jeff's Story disturbing.	Attitude	79%	0	21%
This exercise made me feel uncomfortable.	Attitude	21%	64%	21%
The group discussion while reviewing the answer discussion key was helpful.	Collaboration	86%	0	14%
It was useful to hear others viewpoints regarding decision points in the exercise.	Collaboration	93%	0	7%
The group discussion caused me to rethink some of my initial responses.	Collaboration	71%	14%	14%
The group discussion enhanced my experience with this exercise.	Collaboration	86%	0	14%

Usability

Two specific evaluation items related to general usability. Those were statements regarding following the exercise instructions and relative ease of answering the embedded questions throughout the exercise. 93% of users indicated that the instructions were easy to follow, while 57% agreed that the questions were easy to answer. During group discussion it was noted that one reason users said exercise questions were difficult was because they struggled with the dilemmas presented. Written comments regarding general usability were as follows. "Good exercise, very interactive." "It's a wonderful concept and the tool is well designed!" "Excellent investigative tool."

Veracity

Two statements in the participant evaluation related specifically to truth-likeness of the narrative. Although participants were told that this exercise was based on a true story, we wanted to know whether they personally perceived it as believable. Thus one statement concerned the extent to which users could relate personally to the story, while the other simply stated that "*This Just is!*" Jeff's Story was realistic. Only 28% indicated that they could relate personally, with 28% claiming inability to relate and 36% remaining neutral. However, 86% of participants indicated that the simulation was realistic. There were no written comments specific to the category of veracity.

Informative

One evaluative statement relative to the informative nature of the simulation dealt with appropriateness of the additional information provided in text boxes throughout the narrative. A second statement in this category related to whether the story itself provided new information about homophobia and discrimination toward gays. We wanted to know if such a contemporary story was familiar to users, as well as determine whether the history, news media information, and statistics provided was noticed and to what extent it appropriately informed. The participants in these two initial field tests indicated that while the story did not provide new information on homophobia or discrimination (only 29% agreed), the text box information was appropriate and informative for 50% of these users. Two written comments relative to this category were especially helpful in our thinking about further development. One user wrote, "already had experience with homophobia". Another noted that the historical information "seemed one-sided". The debriefing discussion clarified this issue. Users noted that more geographically relevant examples would be pertinent.

Cognitive

The statements in this category pertained to users' sense of their own thinking process with regard to the issues at hand. These were designed to get a sense of whether participants felt they had thought about this topic previously compared to the extent to which this experience would provoke cognitive processing. We also used a statement about whether users' felt that the thinking stimulated through the exercise would impact personal behavior relative to discrimination. The issue of whether participants had previously thought about discrimination towards gays reflected 100% disagreement. That is, all users believed they were aware of this issue before participating in the field test. 50% indicated that this experience would ultimately change their behavior with regard to discrimination towards gays, and 93% said the narrative simulation was thought provoking.

Affective

This category consisted of two statements intended to understand the extent to which this experience was disturbing and made participants feel uncomfortable. Our agenda here was to produce some way to begin to determine optimal balance between necessary discomfort for narrative effectiveness (cognitive dissonance) and residual negative feelings as a result of undue discomfort. Interestingly enough, 79% of users said, "*This Just is!*" Jeff's Story was disturbing and only 21% claimed that it made them feel uncomfortable.

Group Discussion

We felt that one of the most important factors for productive impact of this instructional design would be group discussion. In that spirit, we emphasized collaboration by including four statements regarding group process in this instructional experience. These statements had to do with whether group discussion was helpful, whether it was useful to hear others viewpoints, whether group discussion caused rethinking of initial responses, and whether group discussion provided overall enhancement of the experience. Agreement on these issues was, respectively, 86%, 93%, 71%, and 86%, leaving only a small minority of participants neutral or in disagreement.

Follow-up Evaluation

Table # 2 shows the results of the participant follow-up evaluation. The general themes of these statements reflect issues similar but not identical to the initial instrument. These themes included, broader understanding, stimulation of further discussion of homophobia and discrimination towards gays, utilization of information retained, actual change in behavior, continued thinking on the subject, change in attitude after reflection, lingering disturbance, increased awareness and sensitivity, retention of information gained from group discussion, and overall satisfaction with having had the experience. One striking difference in the follow-up results and those of the initial evaluation was that more respondents indicated a neutral position on many of the statements in the follow-up scale. 63% of participants indicated a broader understanding of homophobia after the simulation experience, 50% said they had discussed these issues further, 88% suggested that the experience continued to be thought provoking, 63% said they still found the exercise disturbing, and 76% were glad they had participated. In disagreement with the statements 63% indicated that they had not yet been able to utilize the information gained from the exercise and 51% said they did not feel differently than they did immediately after the experience.

Table 2. Follow-up User Evaluation Results "This just is!" Jeff's Story (n = 8)

	Design Category	Agree (#4,5)	Disagree (#1,2)	Neutral (#3)
I have already been able to utilize the new information presented in this exercise.	Behavioral	13%	63%	25%
What I learned from Jeff's Story has helped me respond better to discrimination towards gay youth.	Behavioral	38%	25%	38%
I have discussed my thinking on this topic with others since working the exercise.	Cognitive	50%	38%	13%
I find this experience has broadened my understanding of homophobia.	Cognitive	63%	25%	13%
The questions in this exercise continue to be thought provoking for me.	Cognitive	88%	13%	0
After reflection I felt differently about this experience than I did immediately after working the exercise.	Attitude	38%	51%	13%
I am more aware and sensitive to broad issue of discrimination since my experience with Jeff's Story.	Attitude	26%	26%	50%
I am glad I had the experience using this exercise.	Attitude	76%	13%	13%
I still find Jeff's Story disturbing.	Attitude	63%	25%	13%
I remember more from the group discussion than the actual exercise.	Collaboration	25%	38%	38%

Reflections on Instructional Narrative Simulation

What are the implications for the use of narrative simulation to address difficult topics such as bias and discrimination? To what extent can the use of qualitative development strategies and ethnographic field study methodologies inform the design of such instructional materials? The results of preliminary field-tests are encouraging in several areas. First, the transformation of a true story case into an instructional narrative simulation was possible and indeed achieved some of the desired design intentions (character/circumstance identification and user engagement). Secondly, embedding didactic information along with narrative informed and served to further frame the story as contemporary. It appears that the embedded didactic information accomplished these objectives without eroding the flow of the story or the involvement for the majority of users in this group. Third, the combination of the narrative simulation with group discussion appears to have potential to greatly increase the impact of the experience. This is particularly important because it is precisely the lack of public discussion and disclosure of personal belief that appear to be key issues in addressing the so-called "invisible" aspects of homophobia and other forms of discrimination. Fourth, This experience of the simulation appears to have affects beyond the initial use of the exercise, as indicated by responses to the follow-up evaluation. Finally, the results of this initial user test suggest several improvements in the design. Those include the use of more geographically diverse didactic information to promote user identification and revisions to the instructor's manual regarding reaction to user responses.

These results engender a commitment to look carefully at responses to questions on additional tests with other user groups (parents, adolescents, etc.), in order to make informed judgments regarding retaining questions that are never selected or may otherwise detract from the power of the narrative. Lastly, through the design process for the narrative simulation, we have found the use of qualitative methods in the development process has much promise. Such field study immerses the designer in the context of instruction and also provides rich, contemporary insights that can be folded back into the design.

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EVALUATION THEORY IN PROBLEM-BASED LEARNING APPROACH

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Abstract

Student assessment refers to the evaluation of students' performance using appropriate methods. The impact of student assessment on learning is emphasized by many educators. However, not many articles discuss the methodology of assessment in a problem-based learning approach. The purpose of this paper is to review evaluation theories and techniques in both the medical and educational fields and to propose an evaluation theory to explain the condition variables, the method variables, and the outcome variables of student assessment in a problem-based learning approach. A categorization scheme of assessment will be presented, which includes a wide range of evaluation techniques and tools to assess students' behaviors and products in a problem-based learning approach.

Introduction

Evaluation in problem-based learning (PBL) includes student assessment and program evaluation. Student assessment refers to the evaluation of students' performance using appropriate methods. The impact of student assessment on learning is emphasized by many educators. However, not many scholars discuss how professors evaluate students. Swanson, Case, and van der Vleuten (1991) note that "despite recognition of the importance of assessment among problem-based learning advocates, there is little agreement on methodologies for assessment." The purpose of this study is to review evaluation theories and techniques in both the medical and educational fields and to propose an evaluation theory to explain the condition variables, the method variables, and the outcome variables of student assessment in a problem-based learning approach. A categorization scheme of assessment will be presented, which includes a wide range of evaluation techniques and tools. In this paper, PBL will be briefly discussed in respect to its definition, process, and intended learning outcomes. Secondly, the theoretical basis of PBL evaluation and the categorization scheme of assessment will be presented.

Problem-based learning

Problem-based learning is a commonly used instructional approach in today's medical schools in the United States. The advantages of PBL make it a superior way compared to the teacher-centered lecture approach. The traditional approach was criticized as placing too much emphasis on memorization but not enough emphasis on developing thinking skills. Students are passive learners and fail to transfer their knowledge to different environments. Whereas, PBL fosters students' multiple skills and allows them to acquire knowledge in the process of solving problems. In this section, the learning process and intended outcomes of PBL will be reviewed.

The PBL definition and process

Problem based learning is defined as "the learning that results from the process of working toward the understanding or resolution of a problem" (West, 1992). In a PBL approach the students are active learners. Several authors (Gallagher, 1997; Savery and Duffy, 1996; West, 1992) describe students' tasks in the learning process. According to their description, all students in a small group work on the same problem presented by the teacher. They need to internalize and reason through the problem to identify the learning issues and define the objectives. As tasks and work schedule are assigned to each group member, they start to identify resources to gather information related to the learning issues. Each member brings back and reports his findings for the whole group to analyze the data or to shape their learning issues in order to identify the solutions. Once students synthesize and summarize findings into solutions, they need to conduct an assessment to see if all the objectives have been satisfied and to evaluate their performance. Finally, they receive feedback from the facilitator. To summarize, the tasks students need to perform are:

- Defining problem and identifying the issues
- Framing learning objectives
- Determining work schedule
- Gathering and analyzing data
- Presenting and discussing learning findings related to learning issues
- Synthesizing and summarizing findings into solutions
- Justifying solution and evaluating performance

Goals of PBL

PBL approach is intended to foster student's skills in facing their future learning and profession. Students' goals of learning include metacognition skills, self-directed learning skills, critical thinking and problem solving skills, learners' knowledge acquisition and use, collaborative learning, as well as their higher motivation and positive attitude. In this section, these goals will be shortly discussed.

Metacognition

According to Barrow (1988), metacognition is thinking about thinking. It's the "executive function in thinking: pondering, deliberating, or reflecting on the problem or situation; reviewing what is known and remembered about the kind of problem confronted; creating hypotheses, making decisions about what observations, questions or probes need to be made; questioning the meaning of new information obtained from inquiry; reviewing what has been learned, what it all may mean and what needs to be done next, etc." An expert problem solver can monitor and control their thinking process to attain their best effectiveness.

Self-directed learning

Since knowledge changes rapidly, PBL approach fosters students' self-directed learning skills so that they will automatically continue their own learning for the rest of their lives (Barrow, 1988). PBL allows students to determine what and how to learn on their own in order to ensure their lifelong learning skills and the ability to be effective and independent learners.

Critical thinking skills and problem solving skills

According to Scheiman and Dell (1989), the problem solving process has been called the clinical reasoning process, which refers to "the cognitive process that is necessary to evaluate and manage a patient's problem." In a PBL approach, students need to identify learning issues, develop strategies, locate information relevant to the issue, and evaluate their solution. This entire learning process helps to develop their problem solving and thinking skills (Savery and Duffy, 1996).

Knowledge acquisition, retention, and use

Wilderson and Feletti (1989) claim that two types of knowledge learners acquire when they solve problems are concept and procedural knowledge. In other words, they are knowledge of concepts, principles and facts, as well as the procedure for how to use them. Hmelo and Ferrari (1997) note one goal of PBL as the construction of an extensive and flexible knowledge base. They summarize several studies and conclude that students in PBL learn at least as much social-studies and life-science content as students in a traditional classroom.

Collaborative learning

PBL facilitates the development of effective collaborative learning practices. Students working in small groups compare their thoughts to those of others. They develop individual perspectives and recognize those of others. PBL not only provides students with the opportunity to communicate in a social setting but also enables them to cooperatively work with others to understand different views.

Higher motivation and positive attitude

In a PBL program, students are active learners and have the ownership for their learning. Therefore, they express a more positive attitude and higher motivation in learning than do students in traditional programs.

Need for an evaluation theory

As I reviewed the evaluation theories and techniques in several articles, I found that some authors use different terminology to refer to the same concepts. In addition, there are controversies in their view of different evaluation techniques and tools. Some of them present the assessment methods that are only applied in medical schools, while others describe their experience of using PBL in other fields. I synthesized those evaluation techniques and identified gaps or conflicts between them. As a result, I find it is necessary to generate an evaluation theory for a problem-based learning approach that synthesizes these theories and techniques in a more holistic way and provides comprehensive evaluation techniques, assessment circumstance, as well as outcomes to which educators and future researchers can refer. In the following sections I present my theory of student assessment, which is underpinned by several assessment theories and studies, as well as by my personal experience.

Theoretical basis and the philosophy of assessment

PBL was first implemented in medical education in the early 1970's and gradually was applied to other fields. Norman and Schmidt (1992) note that PBL is a learning method based on the rationalist tradition and is strongly influenced by cognitive psychology. According to Schmidt (1993), cognitivists regard prior knowledge as the determinate of the new information to be processed by individuals, and knowledge is structured in memory. The problem presented to students in PBL helps students to activate their prior knowledge and to restructure appropriate semantic networks in order to solve the problem. Based on the epistemology of constructivism, the problem in a PBL program works as a stimulus for authentic activity. Students are expected to reflect on their activities and evaluate their strength and weakness (Duffy and Cunningham, 1996). Duffy and Cunningham consider assessment to be ongoing, rather than just being an end-of-the-semester rating. Therefore, assessment must be in the learning context and can not be separated with the process of learning. They note that "the abilities to self-assess and to provide constructive feedback to team members are explicit learning goals, and this is not only an assessment process but also a learning process." Talking to the teacher's role in assessment, Brooks and Brooks (1993) suggest evaluating students through teaching, participating in interaction, and observing and watching student work with ideas and materials. The teacher can ask questions that challenge students to assess themselves.

The evaluation methods presented in this paper cover those from both cognitivism and constructivism. No matter what epistemology a PBL is based upon, it is important to provide a supportive learning environment so that students are safe to make mistakes and to fail (Bridge and Hallinger, 1995).

Categorization scheme of evaluation

Different taxonomies have been proposed by scholars to classify evaluation methods in PBL. Glasgow (1996) categorizes assessment strategies into three areas of content, process, and outcome. According to him, content assessment is concerned with knowledge students acquired. Process assessment focuses on students' abilities to apply knowledge in solving problems. Outcome assessment deals with the products created by students that may involve original knowledge or a new application of knowledge. Similar to Glasgow's taxonomy, Swanson, Case and Vlerthen (1991) use process and outcome to classify evaluation methods. Their examples of process include communication skills in tutorial groups, acceptance of responsibility for learning, learning to learn, use of learning resources, and development of problem-solving skills, while they use outcome assessment to indirectly measure the quality of the learning process by testing the results of that process after it has been operating for a period of time. Barrow and Tamblyn (1980) also address the classification of process, content, and outcome. Bridge and Hallinger (1995) classify evaluation methods in terms of who structures the assessment and who judges the performance. According to this taxonomy, four evaluation types are described as the instructor-structured and student-judged evaluation, instructor-structured and instructor-judged evaluation, student-structured and instructor-judged evaluation, and student-structured and student-judged evaluation.

In describing the assessment methods I chose process-oriented and outcome-oriented approaches to classify them. The process in my categorization scheme refers to students' behaviors and the outcome to their products. According to Papham (1990), process and outcome can be replaced as behavior and product, and this two-part classification scheme takes care of all examinee responses. Unlike products, which can be subsequently measured, behaviors disappear once they occur. So we must make sure that the behavior is recorded. Popham emphasized the importance of evaluating students' behaviors and notes that "sometimes educators will wish to concentrate on the behaviors used by a student during the early stages of the student's creation of a product," that is, the process. On the other hand, outcome-oriented assessment techniques assess a student's products, such as essays or portfolios. In this study, I regard some product format evaluation tools, for example videotape, as process-oriented assessment tools because they are used to record the student's behavior. Students' behaviors include those in the evaluation process or in the learning process that are evaluated.

According to Reigeluth (1983), the three major components of a theory of instruction are methods, conditions, and outcomes. Methods are "the different ways to achieve different outcomes under different conditions". Conditions are defined as "factors that influence the effects of methods," while outcomes are "the various effects that provide a measure of the value of alternative methods under different conditions." In this section I would like to apply Reigeluth's CMO model to present the condition variables, the process-oriented, and the outcome-oriented assessment methods in a problem-based learning approach. Since a detailed description of learning outcomes is presented earlier in this paper, the intended outcomes of each assessment method will be mentioned shortly in this section.

Condition variables in student evaluation.

The condition variables of student assessment fall into three parts: environment / learner characteristics, subject content, and time constraints. Learner characteristics refer to the attribute each learner possesses, such as the student's prior experience (e.g. use of computers), cognition style, and psychosocial traits, which will influence the learner's learning and interpersonal skills. Environment variables mean the availability of resource materials,

computer facilities, and classroom capacity. In addition, subject content, program goals, depth of problems selected in a PBL course (well-structured vs. ill-structured problems), and available time are important variables that will influence the selection of evaluation methods.

Process-oriented evaluation methods

1. **Tutor, peer ratings:** tutor and peer ratings are common assessment techniques that can be used to assess communication, group cooperation, effect, and self-directed learning skills (Swanson, Case, and Vleuten, 1991). Barrows (1988) describes one task of the tutor as educational diagnosis, in which he monitors the progress of each student in the group and recognizes any learning difficulties. Techniques of peer evaluation are based on the belief that group members are in a good position to evaluate each other during the learning process. In addition, peer evaluation provides a student with the sense of control over the behaviors of his group members before he is confident enough to enter and learn wholeheartedly in the group (Allen, Duch & Groh, 1996). The shortcoming of peer evaluation method is that little information is provided because raters can only give an overall impression of co-workers without precise ratings of distinct skills. The skills to be assessed are listening and communication skills, interpersonal skills, group cooperation, self-directed learning skills, and ownership.
2. **Self-evaluation:** self-evaluation refers to the learners' assessment of themselves, how they review their own work, knowledge, or skills to identify inadequacies (Barrows and Tamblyn, 1980). Wilkerson and Feletti (1989) suggest using PBL to encourage students to assess their own learning through discussion in small groups to compare their answers with those of others, to discover errors in thinking, and to hear correct solutions. Barrows (1988) also suggests students in a small group describing how they did in terms of reasoning through the problem, their self-directed learning skills, and support of the group process. Walton and Matthews (1989) note that as students develop the self-directed learning skills, their self-assessment and criticism should become automatic. Once students acquire the skills of reflection and deliberation, they will become more responsible for their own education. In terms of the evaluation tool, Barrow and Tamblyn present some examples to help students assess themselves as the self-assessment unit, review and comparison of criterion performance, peer review, and review with faculty. The skills to be assessed are self-directed learning skills, problem solving skills, and group-member skills.
3. **Unobtrusive measure:** Swanson, Case, and Vleuten (1991) list some usable tools that can be used to evaluate the student's learning process. They are library records of books and articles that were checked out, computer records of article searches, and students' logs or diaries reviewing their learning activities. This method is better for curriculum evaluation than student assessment because it's hard to standardize all the information that needs to be assessed. The skills to be assessed are skills to locate and use useful resources.
4. **Oral examination:** according to Barrows and Tamblyn (1980), the oral examination "has the advantage of establishing a dialogue or interaction between the student and the examiner." The examiner can explore the student's areas of strength and weakness regarding his knowledge and thinking ability. The examiner can also gain a sense about the student's self-evaluation, personality, and his reaction under pressure. However, low reliability and validity may be a problem due to personal biases. The classic example is the "Triple jump exercise" in which students first discuss possible problems and hypotheses of a given problem with the examiner, locate and review resources, and then discuss the solution of the problem with the oral examiner. This method is used at McMaster University to assess problem solving and self-directed learning (Norman, 1991). The skills to be assessed are problem-solving skills, self-directed learning skills, and knowledge of the content area.
5. **Observation of a patient interview and examination:** the student's interview of a real or simulated patient is observed by the teacher. The observation allows the teacher to estimate the student's abilities to choose appropriate questions, his interview, inquiry and physical examination skills, and use of time. The weaknesses of this method are non-standard criteria of student performance and the bias of examiners. In addition, patients vary in a wide range and cause uncontrolled variables.
6. **Patient problem simulations:** Barrows and Tamblyn (1980) discuss patient problem simulations as an evaluation method that is based on the simulation of the patient problem. Simulated situations are provided in several formats for students to react to and interact with. Students' behaviors are recorded or observed for evaluation. Examples of this are scenarios that deal with sequential management problems, portable patient problem packs, simulated patients, mechanical mannequins, and use of models.

- (1) **Sequential management problems:** an opening statement about the patient is presented to a student so that he can to describe the possible problems of the patient and the actions to take next. Skills assessed include the perception and interpretation of data, problem formulation, generation of hypotheses, and inquiry strategies.
 - (2) **Portable patient problem pack:** using this method represents a patient problem in playing-card format that gives a student the opening picture of the patient's problem. The student can choose any actions in any sequence. After he chooses an action, he can get correct information by reading the back of the card. His inquiry path is recorded by the sequence of card he chooses. Skills assessed include cognitive process, data perception and interpretation, hypothesis generation, problem formulation, inquiry strategy, and diagnostic decision-making.
 - (3) **Simulated patients:** this method is the same as "observation of student interview and examination" mentioned before.
 - (4) **Mechanical mannequins:** the assessment is based on students' observation or evaluation of mechanical simulations of the human body or portions of the human body. It is an excellent way for complex medical skills to be learned at no risk to patients. Computers are used to simulate patient symptoms and to record the various actions of students. At the end of the exercise, the computer will print out the record of performance, time used, dosage of medicines, and other steps. Skills evaluated include the execution of complex skills in observation, physical examination, and medical intervention.
 - (5) **Models:** students manipulate and evaluate mock-ups of the various parts of the body represented with plastic, plaster, metal, and wood dummies. Motor skills are evaluated.
7. **Review of case record:** review of case record is a technique that belongs to both process-oriented and outcome-oriented assessment methods. Teachers directly score students' case records. Case reports and patient's reports are used as evaluation tools. According to Barrows and Tamblyn (1980), the case report provides information that cannot be evaluated during the encounter; the patient's report evaluates student's ability to communicate in writing. Audit record is another tool used to collect information about what a student really did in his work with patients. The skills to be assessed are the ability to recognize important data, interpret that data, formulate hypotheses, make decisions, write diagnoses, and give treatment (The last three skills are products).
 8. **Authentic assessment:** Herman, Aschbacher, and Winters (1992) note the characteristics of authentic assessment as relevance and meaningfulness to students. It uses contextualized problems to evaluate students' complex skills. There is no single correct answer in the authentic assessment. Since students know public standards in advance and the evaluation focus on individual pacing and growth, it creates a fear free evaluation environment. Authentic assessment should be a part of the learning process, for Barrows (1994) regards authentic assessment as a natural component of authentic learning.
 9. **Performance assessment:** according to Barrows and Myers (1993), a wide variety of performances that can be evaluated in a PBL program include oral presentations, written presentations, audiovisual presentations, dramatic presentations, other fine arts presentations, illustrations, graphs, mathematical analyses, and portfolios. Students demonstrate their knowledge as they report their thinking and problem-solving process. The skills to be assessed are creativity and communication skills.

Outcome-oriented evaluation methods

1. **Review of case record:** see assessment method number 7 in the process-oriented evaluation methods.
2. **Student-judged evaluation:** in Bridge and Hallinger's (1995) book, they present several evaluation methods applied in a project-based curriculum. The five student-judged evaluation techniques are integrative essay, protocols, models or examples, knowledge review exercise, and probe questions.
 - (1) **Integrative essay:** Bridges and Hallinger describe a problem-based curriculum for which the basic unit of instruction is a project and students use class time to meet in the project teams. Students prepare an integrative essay following each project. The structures of this integrative essay are based on two procedures: students discuss what they have learned and how they might use the knowledge; a list of questions is given for the students to choose and discuss.
 - (2) **Protocols:** the elements in a protocol include instructions, guidelines, or checklists for students to guide their performance. In the example mentioned by the authors, students use protocols to judge their memos that are written during the learning process.
 - (3) **Models or examples:** students produce products in the project-based curriculum. Models or examples are instances of products provided by teachers for students to contrast with their own products for self-evaluation.
 - (4) **Knowledge-review exercises:** knowledge-review exercises are distributed at the beginning of each project. Students may use them as pretests or posttests or both.
 - (5) **Probe questions:** the skills to be assessed are A set of key questions is given to students at the conclusion of some projects that stimulate their thinking about their final products or performances.
3. **Multiple-choice examinations:** this format has been developed into a sophisticated method to assess recall of content knowledge, intellectual skills, or attitudinal dispositions. It has the advantage of presenting a large number of questions, which can be answered by students in a short time. However, Swanson, Case, and Vleuten (1991) claim that this method is often rejected in a PBL program because it can only assess factual knowledge. This format is argued by some educators to provide cues to the examinees and leads to suggestions of right answers.
4. **Short-answer or word-completion examinations:** this method is particularly suitable for measuring simple types of learning outcomes, like recall of factual information. It has the advantage of not cueing the student to the right answer. But it does not evaluate inquiry strategies or interpersonal skills.

5. **Essay examinations:** according to Swanson, Case, and Vleuten (1991), this format can provide an in-depth assessment of problem-solving skills and encourage students to integrate their insight into a systematic framework. In addition, students' creativity and the abilities of organizing and expressing ideas can be evaluated. The essay question can be used to ask students to justify their decisions or explain relevant underlying principles. With good design of exam questions, this method can evaluate students' abilities to use knowledge in solving important problems. It can measure complex as well as simple types of learning outcomes. But it has the problem of poor generalizability of scores, which its reliability somewhat problematic.
6. **Patient problem simulations**
 - (1) **Audiovisual examination:** there are a variety of ways that audiovisual media are used in place of clinical skill exams. It can measure students' abilities to make observations and interpret data but it cannot be used to evaluate other important clinical competencies, such as inquiry strategies and interpersonal skills (Barrows & Tamblyn, 1980).
 - (2) **Computer-based clinical simulations:** in this simulation, the student is presented with an "opening scenario" that provides a description of a patient problem and then is given a set of options to choose from (Swanson, Case, & Vleuten, 1991). Additional information is gathered when the student proceeds through a series of scenes. The computer challenges the student's data perception and interpretation skills, the ability to intervene with a patient problem, and inquiry strategy.
7. **Portfolio assessment:** Herman, Aschbacher, and Winters (1992) describe recent trends in assessment and suggest using portfolio review as the basis for assessment by the teacher, students, and parents. They define portfolios as "collections of student work that are reviewed against criteria in order to judge an individual student or a program." The types of student works could be essays, videotapes, art, journal entries, and so on. In order to evaluate students using portfolio assessment, the teacher should define the assessment purpose, set methods for determining what to include in the portfolio by whom and when, and define the criteria for sample selection and judgment. Two skills in the example proposed by the authors are problem-solving and communication skills.

Conclusion

By reviewing articles in student assessment, one notices that assessment methods have changed, with their underpinning epistemology shifting from behaviorism to cognitivism to constructivism. There are more emphases on the importance of self-reflection and assessment in the learning context in recent years. Different evaluation methods are applied based on these epistemologies to better capture significant and enduring learning outcomes. Many evaluation methods described in this paper are applied in medical schools to assess students' clinical abilities. On the other hand, some techniques are used to evaluate students' problem-solving skills and various competencies in different fields. Techniques used for process-oriented evaluation have beneficial effects on student learning, while outcome-evaluation techniques have the advantages of ease of scoring and conducting. When making decisions in choosing appropriate evaluation methods, it is important to take the condition variables and desired outcome variables into consideration.

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EQUIVALENCY THEORY AND DISTANCE EDUCATION

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"Theory helps us bear our ignorance of fact"
G. Santayana, 1896

In the rapidly changing and diverse environment in which distance education is practiced, many questions remain unanswered. In this environment it is difficult to arrive at one approach to guide the practice of distance education. New technologies and new ideas about student learning challenge the traditional techniques for the practice of distance education. This theme of change is evident in the discussions of distance education and its definitions and theories.

Numerous definitions for distance education have been proposed, and most include the separation of teacher and learner, the influence of an educational organization, the use of media to unite teacher and learner, the necessity for two-way communication, and the potential for individualized learning. The classical, European definitions of distance education concentrate on teaching and learning taking place at different times and in different places, while recent definitions enabled by new interactive technologies emphasize educational experiences occurring at the *same* time in different locations.

Many cringe at the thought of a discussion of theory. This need not be the case. Theory is important to the study of distance education because it directly affects the practice of the field. Traditionally, theories of distance education have come from sources external to the USA. Recently, the field in the United States has matured to the point where indigenous definitions and theories have begun to emerge; most notably theories based on the American system of education. Local control of the curriculum, elected school governing boards, small classes, rapport between teacher and students, community-based funding, and highly personalized instruction are important characteristics of the American system of education. Many educators are now advocating the need for forms of distance education that retain traditional aspects of American education while taking advantage of the opportunities of telecommunications systems. In this environment, equivalency theory has emerged.

The Need for Theory

Keegan (1986) reaffirmed the continued need for a theory of distance education when he said:

Lack of accepted theory has weakened distance education; there has been a lack of identity, a sense of belonging to the periphery and the lack of a touchstone against which decisions on methods, on media, on financing, on student support, when they have to be made, can be made with confidence. (p. 63)

Keegan (1995) has noted that a theory is something that eventually can be reduced to a phrase, a sentence or a paragraph, and which while subsuming the practical research, gives the foundation on which the structures of need, purpose, and administration can be erected.

Holmberg (1985) defined theory as:

A systematic ordering of ideas about the phenomenon of a field of inquiry, and an overarching logical structure of reasoned suppositions which can generate testable hypotheses (p. 4).

Holmberg suggested that distance education has been characterized by a trial and error approach with little consideration being given to a theoretical basis for decision-making, and that the theoretical underpinnings of distance education are fragile. Most efforts in this field have been practical or mechanical and have concentrated on the logistics of the enterprise.

In his landmark work, *The Foundations of Distance Education*, Keegan classified theories of distance education into three groups: theories of independence and autonomy, theory of industrialization of teaching, and the theory of interaction and communication.

Theories of Independent Study

#1 - Wedemeyer

For Wedemeyer (Keegan, 1986), the essence of distance education was the independence of the student. This was reflected in Wedemeyer's preference for the term "independent study" for distance education at the college or university level. Wedemeyer was critical of contemporary patterns of higher education and believed that outdated

concepts of learning and teaching were being employed. It was felt that universities failed to utilize modern technologies in ways that could alter an institution.

Wedemeyer set forth a system with characteristics emphasizing learner independence and adoption of technology as a way to implement that independence. Wedemeyer noted four elements of every teaching-learning situation: a teacher, a learner or learners, a communications system or mode, and something to be taught or learned. He proposed a reorganization of these elements that would accommodate physical space and allow greater learner freedom. Key to the success of distance education, Wedemeyer believed, was the development of the relationship between student and teacher.

#2 - Moore

Formulated in the early 1970s, Moore's theory of distance education was a classification method for distance education programs. It examined two variables in educational programs: the amount of learner autonomy and the distance between teacher and learner.

For Moore (1994), distance is composed of two elements, each of which can be measured. First is the provision for two-way communication (dialog). Some systems or programs offer greater amounts of two-way communication than others. Second is the extent to which a program is responsive to the needs of the individual learner (structure). Some programs are very structured, while others are very responsive to the needs and goals of the individual student.

In the second part of his theory, Moore addressed learner autonomy. He notes that in traditional school settings learners are very dependent on teachers for guidance, and that in most programs, conventional and distance, the teacher is active, while the student is passive.

In distance education there is a gap between teacher and student, so the student must accept a high degree of responsibility for the conduct of the learning program. The autonomous learner needs little help from the teacher, who may be more of a respondent than a director. Some adult learners, however, require help in formulating their learning objectives and in identifying sources of information and in measuring objectives.

Theory of Industrialization of Teaching

After examining a research base that included an extensive analysis of the distance teaching organizations of the 1960s, Peters (1988) proposed that distance education could be understood and practiced by comparison to the industrial production of goods. Peters stated that from many points of view conventional, oral, group-based education was a pre-industrial form of education. Distance education, on the other hand, permits the incorporation of characteristics of industry, which makes education standardized, widely available, and extremely cost effective. His statements implied that distance teaching could not have existed before the industrial era. Critical to this theory are concepts such as:

- Division of labor - which means that different professionals and paraprofessionals have specific roles in the teaching and learning process.
- Mechanization - which means that machines and devices are a required component of the teaching process.
- Assembly Line - which implies that techniques are used so materials and students move past or are involved at different times with distance education professionals who have specific duties.
- Mass Production - which means that techniques are used to develop large quantities of instructional materials very inexpensively in order to reach large numbers of learners uniformly.
- Standardization - which means the entire instructional process is made standard according to pre-established criteria so that learners receive the same curriculum in uniform ways.
- Concentration and Centralization - this means that a monopoly is instituted so that one organization provides educational experiences to large numbers of students.

Theory of Interaction and Communication

Holmberg's (1989) theory of distance education, which he calls guided didactic conversation, falls into the general category of communication theory. Holmberg noted that his theory had explanatory value in relating teaching effectiveness to the impact of feelings of belonging and cooperation as well as to the actual exchange of questions, answers, and arguments in distance education.

Distance teaching will be successful to the extent it supports student motivation, promote learning pleasure and make study relevant to the individual learner and his/her needs, creating feelings of rapport between the learner and the distance-education institution (its tutors, counselors, etc.), facilitating access to course content, engaging the learner in activities, discussions and decisions and generally catering for helpful real and simulated communication to and from the learner.

Holmberg himself noted that this was admittedly a leaky theory. However, he added, it was not devoid of explanatory power. It did, in fact, indicate essential characteristics of effective distance education.

Equivalency Theory - An Emerging Approach to Distance Education

New telecommunications technologies have impacted significantly on education. Many feel that the availability of powerful telecommunications systems is responsible for the popularity of distance education in the USA. Interactive television systems, such as the Iowa Communications Network (Simonson & Schlosser, 1995), permit distant learners and instructors to see and be seen, hear and be heard, and learn and teach in almost the same manner as they would if everyone was in the local classroom.

Keegan (1995) suggested that electronically linking instructor and students at various locations could create a virtual classroom.

The theoretical analyses of virtual education, however, have not yet been addressed by the literature: Is virtual education (interactive, live televised instruction) a subset of distance education or to be regarded as a separate field of educational endeavor? What are its didactic structures? What is the relationship of its cost effectiveness and of its educational effectiveness to distance education, and to conventional education?

It is in this environment of virtual education that the equivalency theory of distance education has emerged.

Equivalency Theory –

Distance education's appropriate application should provide equivalent learning experiences for all students distant and local – in order for there to be expectations of equivalent outcomes of the educational experience.

Stated another way, this theory is based on research that indicates that learning at a distance and learning locally are *fundamentally* different, even when interactive technologies are used. Equivalency theory advocates the design for distant and local learners of a collection of probably different but ultimately equivalent learning experiences. The objective of the designer of distance education instruction is to provide for appropriate learning experiences for each student that are based on their unique needs, including physical location.

This theory is based on this definition of distance education.

Distance education is a formal and institutionally-based educational system where learners and teachers are separated from one another, and where voice, video, and data interaction occurs using telecommunication systems (Simonson & Schlosser, 1995).

Instructional experiences are essential to learning. It should not be necessary for any group of learners, local or distant, to compensate for different, possibly lesser, instructional experiences. Students should have learning experiences designed and made available to them that are tailored for the environment and situation in which they find themselves. Thus, those developing distance education systems should strive to provide appropriate learning experiences for students no matter how they are linked to the resources or instruction they require.

One key to this theory is the concept of equivalency. Local and distant learners have fundamentally different environments in which they learn. It is the responsibility of the distance educator to design instructional events that provide learning experiences for individuals and groups of students. A triangle and a square that have the same area are considered equivalent even though they are quite different geometrical shapes. Similarly, the experiences of the local learner and the distant learner should have equivalent value even though specific experiences might be quite different.

Also a key to this approach is the concept of learning experience. A learning experience is anything that happens to or with the student that promotes learning, including what is observed, felt, heard, or done. It is likely that students in various locations, learning at different times, may require a different mix of learning experiences. Some will need a greater amount of observing, and others a larger dosage of doing. The goal of instructional planning for distance education is to develop an approach that makes the sum of experiences for each learner equivalent. Instructional design procedures should attempt to anticipate and provide the collection of experiences that will be most suitable for each student or group of students.

A final key to equivalency theory is the idea of telecommunications, which means communicating at a distance. Most often in the USA, telecommunications refers to electronic telecommunications systems such as those using synchronous audio, video, and computer networks. Synchronous interaction need not be the mandatory, however. Various communications systems, including asynchronous ones, can and should be used for distance education, as long as the goal of equivalency of experiences is met.

The equivalency approach is based on core values such as local control and personalized instruction that are held almost sacred in classical American education. If distance education is to be widely accepted and routinely available it must be high quality, easily obtained, and *familiar* to those in need. Powerful, modern telecommunications systems enable the delivery of powerful and recognizable learning experiences to students anytime and any place.

Summary

The changing and diverse environment in which distance education is practiced has inhibited the development of a single theory upon which to base practice and research. A variety of theories have been proposed to describe classical distance education. They include theories that emphasize independence and autonomy of the learner, industrialization of teaching, and interaction and communication. These traditional theories emphasize that distance education is a fundamentally different form of education.

Recent emerging theories based on the capabilities of new interactive audio, video, and computer systems, state that distance education is not a distinct field. These approaches utilize existing educational theory and advocate the creation of equivalent experiences for distant and local learners.

Theory helps guide the practice of a field, and permits a certain "ignorance of fact." Equivalency theory provides a framework for design and production of instructional experience for local and distant learners that need not be the same. The key will be whether equivalent experiences produce equivalent outcomes.

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BEST OF BOTH WORLDS: THE NOVA ITDE MODEL OF DISTANCE EDUCATION

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Friday, 8 p.m.

One by one, the students' faces appear on the computer screen, and with broad smiles greet their classmates in turn. A class of 15, they are participating in the course, Future Trends: Beyond Emerging Technology, from their homes—from California to New York and from Washington to Florida. The students know each other well, having taken classes together for more than two years. On the computer screen, the wide-angle view and the somewhat unsteady motion indicates that compressed video is being used to link the students. But the image is in color and the quality is surprisingly good.

Two others join the videoconference: a program professor greets the students from a studio on the campus of Nova Southeastern University (NSU), in suburban Fort Lauderdale and explains that the course instructor has been delayed, but will join the session shortly. The other participant in the videoconference is the class' cluster coordinator from her home in Florida. Lest there be any doubt about her location, a huge banner, reading Hollywood, is visible on the wall behind her.

Within a few minutes, the course's instructor, an adjunct professor, joins the videoconference, greets the participants, and apologizes for the delay. The videoconferencing equipment is straightforward, but connections from his office, in Rio de Janeiro, are problematic. For several minutes, the instructor discusses the goals of the evening and fields questions from the students about course readings and assignments.

In the following two hours, the students make short presentations based on assigned readings. As each student presents, classmates follow along with the help of handouts that had been distributed via email. The students use a variety of presentation media: there are murmurs of approval as one student uses his camcorder as a document camera, and envious hoots as another student couples a PowerPoint presentation with a live picture-in-picture image of himself.

As the session ends, the instructor discusses the agenda for upcoming videoconferences as well as for the weeklong summer institute to be held in Fort Lauderdale, where the group will gather for intensive instruction the following month.

Introduction

The scenario "Friday, 8 p.m." is drawn from the experiences of Cluster One, whose members became, in February of 1996, the first group of students enrolled in Nova Southeastern University's program in Instructional Technology and Distance Education (ITDE). For this cluster, use of desktop video was an experiment—one of many they had experienced in their graduate program. Over the course of three years, they have been, in the words of a professor, "put through the wringer." But in their use of a wide variety of communications technologies, the students gained a rare and valuable opportunity—hands-on experience coupled with a deeper understanding of these technologies and their use in distance education. Now, after three years, these students are poised to receive their Doctor of Education degrees. It seems appropriate at this time to examine the "Nova ITDE Model," the distinctive multi-mode approach to distance education which the students of Cluster One experienced and helped refine.

The ITDE Program

The ITDE program was established in the spring of 1996 with a single "cluster"—or cohort—of 27. Seven of the students were enrolled in the Master of Science program, the remaining 20 in the Ed.D. program. Three years later, ITDE has 12 clusters, a total of about 250 students, all of whom meet in Fort Lauderdale three times each year. Students in these clusters are mostly from the United States with a sprinkling of students from other countries, including Israel, Germany, and the Netherlands. ITDE is also fostering the development of two "international" clusters—one in Jamaica, the other in Venezuela, whose students will receive the bulk of their instruction in their home countries.

Nova Southeastern University

Founded in 1964, Nova Southeastern University (NSU) is the largest private university in Florida, with an enrollment of about 15,000. Based in suburban Fort Lauderdale, it offers undergraduate and graduate programs

leading to degrees in education, law, psychology, oceanography, osteopathic medicine, dental medicine, pharmacy, and many other fields.

Fischler Graduate School of Education and Human Services

From its 18-acre North Miami Beach campus, the Fischler Graduate School offers courses in six program areas, leading to the master's, educational specialist, and doctoral degrees. Approximately 8,000 students are enrolled in six programs: Graduate Teacher Education, Life Span Care and Administration, Educational Leaders, Higher Education, Communication and Science Disorders, and Education and Technology.

The Nova ITDE Model of Distance Education

The Nova ITDE model of distance education is characterized by a unique combination of pedagogical, structural, and technological attributes. The most important of these attributes are: a uniform course of study offering a single major, the cluster concept, the applied thesis and dissertation, and face-to-face instruction combined with the use of a wide variety of distance education technologies.

The Course of Study

Over the course of their 21-month program, master's students in the ITDE program participate in four study areas, each of which is composed of two courses. The study areas, in the order taken, are:

- Leadership I: Influence of Technology on Leadership and Management
- Research and Evaluation I
- Summer Institute I: Instructional Media
- Instructional Design

Doctoral students take the same courses, plus the following study areas:

- Research and Evaluation II
- Summer Institute II: Instructional Systems
- Management and Human Resources Development
- Summer Institute III: Trends
- Leadership II: Leadership, Technology, and Power

The Cluster Concept

Since the founding of NSU in 1964, the cluster concept has been a strength of the university's graduate education programs. Each cluster in the ITDE program is a group of 20-30 students who live and work in a wide variety of geographic locations and professional settings. Each cluster operates under the direction of a cluster coordinator. The coordinator, who holds a doctorate in education, technology, or a related field from NSU, is a facilitator of numerous administrative details and cluster activities and serves to support and advise students. The coordinator monitors student progress, offers academic advice and encouragement, and facilitates communication that fosters interaction among students who have limited face-to-face contact.

The cluster coordinator is required to be readily accessible via email, to maintain the cluster Web page, to publish Web-based newsletters, and attend online class sessions. In this unique position, the coordinator is a support person for the students, a facilitator for senior faculty and guest lecturers, and a local site administrator/manager for program office staff.

The cluster is the administrative unit that links students throughout the program. Strong bonds develop between the student and the coordinator. Friendship, collegiality, academic support and encouragement develop as students progress through a series of study areas. Student program evaluations consistently indicate that the cluster concept is of extremely high value. The leadership of the coordinator is considered a crucial factor for student success.

The Instruction

ITDE students enroll in three four-month study areas per year, in which most content is delivered through readings and face-to-face instruction. Discussions, student presentations, and interaction with instructors are conducted at a distance. Each study area, led by an NSU program professor or an adjunct supervised by a program professor, consist of three distinct phases.

In the first phase, students are assigned extensive readings, usually including several texts and a collection of journal articles, in addition to the study guide that is a component of all ITDE courses. During this portion of the course, students one or more audioconferences, in which introductions are made and the instructor discusses goals and objectives of the study area, fields questions, and perhaps provides a modest amount of instruction. Finally, students complete a significant assignment based on the readings.

The second phase of the study area, which takes place in Fort Lauderdale, is devoted to intensive face-to-face instruction during an extended weekend (three or four days) or an extended weeklong summer institute. If more than one cluster is taking the course at any given time (as is increasingly the case), the clusters are blended. The instructors (one per cluster) work with each of the students. This arrangement allows students to meet and work with other students in the program, as well as to experience a variety of teaching styles and establish connections with nationally-known instructors. Before the end of the second phase of the study area, learning is assessed, and students begin work on a major final project.

During the third and final phase of the study area, work on the final project continues. Instructor and students continue to communicate via a wide variety of technologies, including audioconference, email, and chat. Students may use these technologies to communicate within formal or informal study groups. Students use the same technologies to present their final projects to the instructor and classmates.

The Applied Thesis and Dissertation

The ITDE applied thesis and dissertation differ from their more traditional cousins in at least three ways. First, they must offer a solution to a problem in the work place. Second, the processes of implementing and reporting are conducting concurrently with coursework, rather than afterward. Third, students are guided, not by a major professor, but by an applied thesis/dissertation adviser, who may be a program professor, but is more likely an expert identified expressly for the purpose.

The Technologies

ITDE instructors and students have used a wide variety of communication technologies. This variety has been the result of technological advances, instructor preferences, specific course needs, and a spirit of experimentation. To a very large degree, the cluster concept has dictated the choice of communication technologies, which must be easily accessible to students and permit student-student interaction, both synchronous and asynchronous. The principal classes of communication technologies include Internet chat, audioconference, videoconference, and Web-based course packages.

Internet Chat

When the ITDE program was inaugurated, in the spring of 1996, Netscape Chat was available as a free download and became the basis for regularly scheduled chat sessions. By the beginning of their third year in the program, Netscape Chat had been replaced by a First Class Internet client. Embanet is now used by four clusters for email, chat, and uploading and downloading of files (assignments, study guides, required forms) in study areas, cluster areas, and workgroups. The advantages of the First Class client include: multiple platform capability; ease of use; sophisticated features and, perhaps most importantly; 24-hour support, online and via telephone, for all registered users, including students.

Audiobridge

The use to the audiobridge continues to be an important element of most ITDE courses. Students meet with instructors via conference call accessed by a toll-free number. NSU uses a commercial provider to set up the calls and provide online support during the call. Advantages of audiobridges include access from virtually anywhere, efficiency (faster than typing), and the ability to make tape recordings of calls. A visual component has been addressed by many ITDE students by adding a second telephone line to their homes so that they may access Web-based materials during the audioconference.

Videoconferencing

Although traditional compressed video has for years been used by NSU programs (including ITDE) to bring guest speakers to students during face-to-face instruction, a trial of desktop videoconferencing has been conducted with Cluster One. The ITDE program provided desktop video boards, cameras, and software to all students and subsidized the lease of ISDN telephone lines in their homes. Desktop video has been used as a medium for the delivery of instruction, for discussions, and for student presentations.

Online Courses

The demand for online courses is undeniably substantial, and growing. The ITDE program has moved toward offering online courses, but slowly and deliberately. Over the course of the first two years of the program, several of the newer online course development packages were evaluated. In the fall of 1998, WebCT was used to deliver an online course. And again, the pioneers were the members of Cluster One, who participated in their final study area, Leadership II, online. Four of the nine study areas will be delivered online in upcoming years.

The Best of Both Worlds

After meeting for several weeks via videoconference, Cluster One gathered in Fort Lauderdale for an extended week of intensive instruction. However, even during this face-to-face phase of the course, videoconferencing technologies were again used, this time to bring guest speakers—leaders in the field of instructional technology—to the students. The presentations were the catalyst for wide-ranging discussions about the status and future field. In the weeks that followed, students and instructor continued to communicate at a distance.

None of the elements of the Nova ITDE Model—the uniform course of study, telecommunicated distance education, intensive face-to-face instruction, the cluster concept, or the applied research project—are, in themselves, innovative. Rather, it is the combination of attributes that is both powerful and noteworthy.

Graduate programs in instructional technology and distance education may be successfully offered face-to-face or at a distance. Tradition, of course, has favored the former, while schools—both established and new—are increasingly offering courses and entire programs at a distance. Both have significant advantages and disadvantages. However, rather than choosing between these two modes of instruction, the Nova ITDE model incorporates both. In so doing, it achieves the best of both worlds through the determination of an appropriate ratio of face-to-face and distance instruction, a balanced set of technologies used to deliver instruction at a distance, and a program structure that builds upon the strengths while overcoming the weaknesses of distance education.

The choice of instructional delivery method is not based merely upon media effectiveness. Clearly, research indicates that students, on average, learn as well at a distance as they do in traditional, face-to-face settings. Further, decades of research have shown that students learn effectively from properly designed instruction delivered via any medium. The Nova ITDE model is based on an understanding that a “best” balance both of face-to-face and distance instruction and of media may be established for a given group of students and instructors. This balance will shift, depending on needs and preferences of the learner, the technological expertise of the instructor, and the available technologies.

In part, the ITDE Model is shaped by the concept of equivalency, which holds that distance education’s appropriate application should provide equivalent learning experiences for all students—distant and local—in order for there to be expectations of equivalent outcomes of the educational experience. In advancing equivalency, the cluster concept provides a practical solution to some of the challenges presented by distance education. Within the cluster friendships are formed, issues are debated, and support is offered. In these and other ways, the cluster simulates the experience of the graduate assistant “bullpen” a not-insignificant element of the graduate school experience offered by traditional programs. Because of their cluster membership, ITDE students are able to overcome isolation, the truly important “distance” of distance education. Further, peer pressure within the cluster encourages students to persist, overcoming one of the historic drawbacks of distance education.

A final, critical element of the ITDE Model is the applied dissertation. Its emphasis on practical application of course content personalizes learning, and in so doing, deepens understanding.

The ITDE program from which Cluster One will graduate is strikingly different from the program in which it began three years ago. Beginning with the goal of achieving the best of both worlds—traditional, face-to-face and distance education—it has undergone numerous and significant modifications. Technologies have been adopted and discarded, courses have been significantly revised, policies have been adjusted, and the program has been strengthened. If the students of Cluster One have, indeed, been “put through the wringer,” they—and the program—are the better for it. For both the institution and the students, it has been a learning process.

INSTRUCTIONAL DESIGN FOR DISTANCE EDUCATION

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Instructional design is critical to distance education and planning for effective teaching is needed for learning to occur. Greater emphasis needs to be placed on the planning process. The instructional design process organizes and systematizes planning. It is essential to consider elements such as the content, the learner, the strategies for teaching, and the means for assessing the learning experience. By following through with this process, the instructor will find that teaching at a distance is an exciting and dynamic experience. One that will be welcomed by both the instructor and the learners.



Adapted from Dick & Carey, *The Systematic Design of Instruction* 1996

The instructional design process considers all aspects of the learning environment, following a well organized procedure that provides guidance to even the novice distance instructor. Viewing the instructional environment as a system, fosters a relationship among and between all the components of that system - the instructor, the learners, the material, and the technology. When this procedure is followed, attention is drawn to considering the components of the system. Especially when planning for distance education, the instructor must make decisions that will affect all aspects of the distant instructional system (Moore & Kearsley, 1996). Focusing on the distant system will help the instructor plan for effective learning experiences and the instructor will have a greater opportunity for developing a balanced distant learning experience.

Principles of Instructional Design Systems

Systematic Process

With the goal of student learning in mind, an instructor can consider the components of a successful learning system (Dick & Carey, 1996). The interaction of the components - learner, content, method/material, and environment - provides results in creating the type of learning experience necessary for student learning. These components must interact both efficiently and effectively to safeguard quality learning experiences. There should be a balance among the components, none can take on a higher precedence over the others. This equal interaction of the system's components safeguards that the instruction will reach the goal of student learning.

Planning for Instruction at a Distance

The planning and organization for a distance education course is multifaceted and must occur well in advance of the scheduled instruction. To eliminate trial and error preparation, distance learning faculty should consider the following:

- Courses previously taught in traditional classrooms may need to be retooled. The focus of the instruction shifts to more visual presentations, engaged learners, and careful timing of presentations of information.
- As traditional classroom materials that have been used during instruction are revised, considerations for illustrating key concepts, or topics, using table, figures and other visual representations need to be made.
- Activities that encourage interactivity need to be incorporated. Planning for interactivity helps learners. Not only does the instructor have to plan for interaction, but students may require training to participate actively in these types of distant interactive activities.
- Activities that allow for student group work need to be well planned. This helps construct a supportive social environment. For example, the instructor could present case studies related to theories and concepts covered in the course, then groups of students, perhaps in different sites, could discuss case study questions and reach consensus on a solution to the problem.
- Technical problems can occur, so alternatives for the class must be considered. If equipment fails, it is important for students to have projects and assignments independent of the instructor and alternative means of communication (e.g., fax, phone, e-mail). Prior discussion of the plan for technology failures with students will eliminate confusion and loss of productive class time (Herring and Smaldino, 1997).

In addition to considerations related to planning for instruction, there is also a need to examine issues associated with the separation of instructor and some or all of the students. Time constraints for class delivery, lack

direct contact, visualization of the materials, and planning for interaction requires a reconsideration of classroom dynamics. Often instructors use visual cues, such as student facial expressions, within the traditional classroom or conversations with students after class to decide quickly to adjust the instructional approach for a course. These cues give instructors insights that help them personalize the instruction for the students and insure a quality learning experience for all. Teaching at a distance eliminates many of these cues. Alternative approaches to on-going evaluation of instruction must be incorporated. If instructors ignore this area of preparation, and plan to teach as they always have, they will feel frustrated. Likewise, students may feel alienated and will begin to “tune out” the instructor. The instructional development process should be based on the unique characteristics and needs of students, meshed with the teaching style of the instructor and the course goals and content. Interaction should be maximized, visual potential of the medium should be explored, and time constraints addressed.

Issues to Address in the Planning Process

Who are the Learners?

Taking the time to learn about the learners in the class yields a more productive learning environment. Along with the general information about the learners, an instructor needs to know more specific information about the students in the class. Factors such as whether the students are from urban or rural areas, age range, grade range, and educational background can have a marked impact on the levels of interaction among students. The instructor may have to plan more carefully for the types and levels of interaction to ensure a quality learning experience for all members of the class.

The cultural, social, and economic backgrounds of the students is also important information for the instructor (Willis, 1994). Educational expectations of learners can also influence the quality of the learning experience. The attitude and interest students bring to the class will impact the learning environment. Thus, an instructor who is interested in creating a quality learning experience for all members of the class, with the ultimate goal of learning as the outcome, will be certain to account for these variables in planning.

Students who are less social may find the distance education environment more comfortable for them. Students may become more expressive because of the perception of privacy and the informative nature of mediated communication. They may perceive the increased and varied interactivity and immediate feedback as a positive input to their interface with the learning experience.

Additionally, students can benefit from a wider range of cognitive, linguistic, cultural, and affective styles they would not encounter in a self-contained classroom. The emphasis should not be on the inherent efficiency of the distance learning, but on the values and services offered to students through their exposure to others (Herring & Smaldino, 1997). Relationships can be fostered, values can be expanded, and a shared purposes or goals can be developed.

To be effective, an understanding of the target audience is necessary. Willis (1994) suggested the following questions be asked prior to development of distance-learning environments:

- What are student ages, cultural backgrounds, interests and educational levels?
- What is the level of familiarity of the students with the instructional methods and technological delivery systems under consideration?
- How will the students apply the knowledge gained in the course, and how is it sequenced with other courses?
- Can the class be categorized into several broad subgroups, each with different characteristics?

What is the Essential Content?

The content of a course needs to reflect articulation within the curriculum. It is essential to examine the nature of the content, as well as the sequence of information. In any distance learning environment, one particular issue, that of time constraints, impacts other planning areas. Time constraints refer to the actual on-line time for delivery, which is often limited and non-flexible. The issue of limited time makes it necessary to closely examine the essential elements of the course content. The instructor needs to balance content with the limited time for learning activities and possibly remove extraneous, nonessential information.

Generally speaking, the scope of the content for a course needs to be sufficient to ensure the entire learning experience will lead to the desired outcomes. Concepts, knowledge, and specific skills need to be identified (Dick & Carey, 1996). Supporting information or knowledge is important to the scope of content analysis. Follow-up and applications of the content should be considered.

It is important to remember that no matter which media are used, the trend is to reduce the “amount” of information delivered and to increase the “interactive value” of the learning experience (Herring & Smaldino, 1997). Thus, the instructor may need to “throw out” content that had been included in a traditional presentation of a course. Or, the instructor may need to reconsider means of “delivery” of the information through alternative means, such as additional reading, booklets designed specifically for the tasks, links to special sites, etc.

What Teaching Strategies and Media to Use?

Successful teaching at a distance places the recipients' needs before organizational convenience and at the center of planning and decision making. The individual needs of the learners are brought to the forefront in education that uses electronic technology, because separation of learners from the instructor requires students to take more responsibility for learning. Consequently, the learner's opinions and needs play a more important role in decision making than is usual in an instructor-centered environment (Macfarlane & Smaldino, 1997).

It is oversimplified to suggest that there is one better way to teach at a distance. In any given content area there are several potential ways of providing a quality learning experience for the students (Heinich, Molenda, Russell, & Smaldino, 1999). What is essential in deciding which strategy or strategies to employ is the issue of engaging the learner. The one thing that has been repeatedly demonstrated through research is that lecture, or the "talking head," approach is the least successful strategy to employ in distance education (Schlosser and Anderson, 1996).

The instructor needs to focus on selecting instructional strategies that engage the learners in active learning. To do this, the instructor may need to de-emphasize the "informative" part of the instruction for more "discovery" of information. The emphasis on keeping the learners engaged in learning ensures that students will be "in tune" with the class.

For the selection of media there are several models often used (Dick & Carey, 1996). One common theme with all of these models is the learning context, which is the content, the intended outcome, and the nature of the students. Practical considerations such as available resources for creating media and the technologies for delivery of instruction also play a hand in the selection process. Mainly, though, goals and objectives should be the primary influence on the selection of media.

McAlpine and Weston (1994) have delineated a set of criteria for selecting media, whether they are commercial media or media developed specifically for a particular course. The first item on the list is to match the medium to the curriculum or content. Also included are related items such as accuracy of information, motivational quality, engagement quality, technical quality, and unbiased nature of material. These should be considered in selecting media in order to match student needs to the strategies employed.

Visuals provide a concrete reference point for students, especially when they are engaged in a non-televised learning experience. Providing visuals, even if they are lists of concepts and ideas, can help students. Visuals also help learners by simplifying information. Diagrams and charts often can make it easier to understand complex ideas. A visual that breaks down a complex idea into its components, can show relationships that might be otherwise confusing to students. Also, preparing visuals that serve as mnemonics can assist student understanding. And, visuals help students in their study. They can use them to prepare for tests and other means of assessing their learning.

Finally, there are two very important additional issues to be raised. First is that of copyright. No matter what technologies are incorporated in the distance environment, the instructor needs to respect the copyright restrictions that might apply. For example, in a televised class, the instructor may not be able to use a video without first obtaining permission to display it to the class. In a Web-based class, the instructor may have to have permission to post a journal article. An instructor needs to be responsible to obtaining copyright permissions where appropriate.

The second issue is that of access. The instructor cannot assume that all students at a distance have equal access to resources. Students may not have the technologies available. Also, students may not have the facilities at hand. The instructor needs to be certain that all students have similar learning experiences, including the materials. For example, if the instructor wishes students to use certain books or journals for outside reading, it is important to check with the local library to be sure these materials are available.

What is the Learning Environment?

Educators are familiar with classroom settings. They are comfortable with using the space available to enable learning to take place. But it is when the classroom shifts into a distance learning setting that the environment becomes a challenge to the instructor. There are several important elements to address within the distance learning environment.

Technology.

The type of setting, be it place or time shifted, will influence planning decisions. Environments that are place-shifted are those that are synchronous but are not in the same location (e.g. a live video-based distance class). Those that are time-shifted are asynchronous, where students access the class at different times. Assessing the use of the technologies in a distant setting is essential. In any distance learning environment the technology becomes the element of most concern for the instructor.

There are several issues associated with technology when teaching in a distance learning mode. First is the basic operation of the equipment. In a televised distance learning setting, switching between sites is usually a simple procedure, but it does require time to acquire the finesse to operate the switching buttons smoothly. Second, using

additional cameras in the classroom can create some concern for the instructor. The overhead camera needs to be focused and materials lined up to ensure that learners in all sites can see the material. Third, the instructor should always consider what the student should be viewing during the lesson. Is it better to see the instructor, the visuals, or other students? When an instructor has had experience with teaching with the equipment, these decisions become automatic, making learning the foundation for the decisions made (Herring & Smaldino, 1997).

In an Internet-based learning environment, the instructor should be concerned with the layout of the courseware and the types of resources available to the students at the distant sites. The instructor needs to be certain materials are designed in a way that is intuitive for the various types of learners. Further the instructor needs to be concerned about student access to the appropriate hardware and software to be successful in connecting to the courseware. And, the instructor should be concerned that the students can complete the tasks expected of them. Finally, the instructor needs to be certain they understand the terminology being used.

It is essential the instructor be prepared with alternatives for each lesson in case of problems. What will the students do during the lesson time if the technology is not operating properly? The instructor and students need to be prepared for times when the entire technology system is not working properly. Pre-planned contingencies should continue the learning process even though the technology is malfunctioning. Alternative lessons must always be ready, but hopefully never needed. And, students need to be prepared to know what to do with those materials. They must be designed to be used without instructor intervention.

Resources

The second element to consider in the instructional environment is the resources available to students. What materials will they have at hand? What materials will be available in libraries and laboratories? Will students have access to resources for easy communication with the instructor?

How to Determine the Quality of the Instruction?

In the instructional design process, formative evaluation becomes an important aspect. Two questions need to be considered. The *first* relates to reflection on the action or activity: "Is this approach going to work?" (Schon, 1987). To be an effective educator, it is important to consider what can happen within an instructional event. All experiences, both those considered to be positive or negative, have some element of surprise. It may be expectations were not achieved; it may be a serendipitous event led to an altogether different, but pleasant, outcome. Whatever the nature of the event, it is essential to reflect upon what has happened.

Reflection may take the form of critical assessment of the events, satisfying curiosity about the nature of those events (Macfarlane & Smaldino, 1997). Reflection may consider the success of the learning situation. It brings the instructor into a state of knowing about the learning event. It is now possible to move into the second question of the formative evaluation process, that of considering how to improve the situation.

The *second* question then is, "How can I make this better?" The instructor needs to examine the instructional event in terms of what worked and what appears to have been a problem. The second phase of the formative evaluation is concerned with helping the instructor ensure a more successful educational experience for students. The instructor needs to consider not only issues such as the learning task, the instructional materials, and the teaching strategies, but also where the technology may have played a role in the instruction.

When examining effective instruction, it is important to look at the role technology plays in instruction. The instructor should consider the elements of technologies and their effect on the students. If a problem occurs with the lesson because of the hardware components of the system, what was the nature of the problem? Was the problem because of a temporary interference with the transmission? Was weather or some other non-controllable issue causing problems with the transmission? Can the hardware be improved? Can things be done to the interactive instructional classroom to aid instruction in the future?

If a problem does not relate to hardware, then what was the problem? Perhaps students needed to be better informed about how to use the equipment. It may be that students needed preparation for the lesson. Perhaps the instructor needed to prepare other types of handouts or manipulatives to ensure that the students could accomplish the tasks. Maybe the instructor needed to select an alternative teaching strategy to improve interactivity and student outcomes.

Because so many different factors effect the interactive learning environment, reflective teaching practices play an even greater role in developing of effective teaching practice. To consider what has transpired and how to change it creates a dynamic educational experience for both the instructor and the learners. Formative evaluation is essential for successful interactive distance learning experiences.

It is important for the instructor to think about handouts within the context of the planning process. The types of handouts will vary according to the age of the students and the content of the course. But, it is important that the instructor realize that when planning a distant course, handouts become an essential communication link with students. Therefore, the instructor needs to invest time and energy in creating quality handouts for students.

Even within a traditional class, the instructor is concerned with getting materials to the students. Often papers and books are distributed at the beginning of the class period. But, when teaching at a distance, this is not as easy as it might seem. Often the majority of the class is at a distance and distribution of materials becomes a logistical nightmare.

An instructor needs to consider: (a) getting the materials to the distant sites on time. A distribution network must be established for getting tests and other materials to those remote sites. The technology can be useful in transferring materials; (b) communicating with the students. The effect of separating instructor and students does affect this communication; (c) time delays in material transfer. Students may have to wait a longer time than normally expected to receive written feedback. Instructors may elect to use other forms of telecommunications with students to facilitate this feedback.

Summary

The instructional design process provides the framework for planning. It is essential that the instructor take the time to plan and organize the learning experience prior to implementation when engaged in teaching at a distance. The instruction will be at a standard that is acceptable in all venues. The students will be engaged and the instructor will be satisfied. Planning makes the difference in a successful learning environment.

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USING MULTIMEDIA TO COUNTER STEREOTYPES IN SCIENCE CLASSROOMS: NEW PERCEPTIONS OF WHO BECOMES A SCIENTIST

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Abstract

Despite gains in many areas, minorities remain underrepresented as scientists and science students. One of the reasons for this absence may be the presence of a common stereotype of scientists as white males. I argue in this paper that recent research in cognitive and social psychology shows that stereotypic processes are not automatic, and that stereotypes can be reversed through the use of multimedia software in the science curriculum which includes graphic images with specific occupation and background information about ethnic groups. Community college students who used the counterstereotypic version showed less negative stereotypic attitudes afterwards, compared with students using the same software without the counterstereotypic images, when used within a course context which included discussion of cultural differences. Based on the quantitative stereotypic attitude changes seen here I propose a two-step model for implementing changes in classroom curriculum which could influence student stereotypes about who becomes a scientist and perhaps lead to an increase in the number of minorities studying and practicing science.

Introduction

Despite 2 decades of federal programs and funding to increase the representation of women and minorities in science, there have been few changes in the percentages of underrepresented groups in science....and efforts to raise the numbers of minority scientists show no appreciable gains.... Eisenhart, Finkel and Marion, 1996.

"Mami, cuando crezca quiero ser biologo de moleculas, even though we don't know anyone who does that job." The number of African-Americans, Latino/Hispanics, and Native Americans studying and practicing science makes it difficult for children in some communities to envision themselves in certain careers. For example, in 1988 only 3% of scientists were Latino/Hispanic although that ethnic group comprised 7% of the labor force (National Science Foundation, NSF, 1990) while African-Americans were even more underrepresented as 3% of the scientists and 10% of the work force. Five years later, the percentage of African-American and Latino/Hispanic scientists remained the same, although both groups increased in the general population¹ (NSF, 1996).

All levels of school seem to play an important role in the formation of who decides to become a scientist. A recent analysis of 8th and 10th grade students' performance in science using a national, longitudinal database (NELS:88) found that schools themselves may be a major cause for the absence of women from science (Burkham, Lee and Smerdon, 1997).

"...it is discouraging for us to report that girls are still learning less science than boys. It is even more discouraging to find that the gender gap favoring boys appears to increase as students move through the educational system. This suggests that schools have an active role in gender stratification, rather than simply reflecting societal influences related to gender" (p. 321).

Schools have also been shown to play an active role in the underrepresentation of ethnic groups in science (Harding, 1993; Solorzano, 1994).

A second main factor which contributes to the underrepresentation of minorities is the image held by students about who becomes a scientist and about ethnic groups. Nelkin (1987) highlighted how the mass media portrays scientists as overwhelmingly white. In the past three decades researchers have linked the white male stereotype to school children (Krause, 1977; Chambers, 1983). Recent data from a study of elementary student drawings of "a scientist doing science" confirms the continued existence of certain student stereotypes about who becomes a scientist (Barman, 1997). The most obvious feature of the 1,504 drawings was the prevalence of white males as depicted in 69% of the K-2 drawings, 80% of 3rd-5th grade drawings and 74% of the 6th-8th grade drawings. Scientists in the 1997 drawings, however, looked like "everyday" people instead of like the fictional "alien" creatures which were common to earlier studies. Barman correlated this change with curriculum reform in science that emphasized "activity-oriented science."

Others argue that holding certain stereotypes influences social judgments about future behavior (Jussim, Fleming, Coleman and Kohberger, 1996). For example, Banaji, Hardin, and Rothman, (1993) illustrated how implicit stereotyping ("effects attributed to unreportable residues of prior experience") occurred by incidental exposure to stereotypic information and they argue that this type of stereotyping unconsciously influences judgment. One consequence of implicit stereotyping is its effect on minority students. Some research has shown that stereotypes influence academic performance, including a report that African Americans receive lower grades than whites at all levels due to a negative stereotype that they are not as intelligent or able to succeed as whites (Wolfe

and Spencer, 1996). This is not a recent occurrence. Three studies in the 1980's (Lockheed, 1985) looked at science performance for 9-year-olds and 13-year-olds and each found whites outperformed African-Americans by at least 15 percent.

Despite Barman's findings that elementary and middle school curriculum changes can affect the kinds of stereotypes that students use to predict who will become scientists, and despite the research that stereotypes contribute to minority underrepresentation in science, few researchers have looked at specific curriculum changes which could effectively counter existing stereotypes about scientists and minorities so as to provide encouragement for more minorities to study and succeed in science.

In this paper, I suggest that multimedia software which includes counterstereotypic clip art can be used to change students' images of who becomes a scientist. The first section reviews recent results in cognitive and social psychology which contradicted the prevailing view of stereotypes as an automatic, individuated response and which reveal ways that stereotypes can be reversed. I then illustrate how other psychology experiments have found content about occupation and socio-economic background to be effective in countering racial stereotypes. Next I describe how those findings informed the design of a multimedia software program about genetics as an attempt to counter existing stereotypes about African-Americans. Based on data from the use of such a program in a community college introductory biology class for non-majors I show how the addition of that software to the science curriculum contributed to changes in both students' stereotypic attitudes and their biology knowledge, within certain pedagogical contexts. Finally, I explore how instructional and curriculum designers can build upon these results and suggest a two-step non-linear model for implementation of curriculum changes.

Automatic and controlled processes in stereotyping

For many years, psychologists have assumed (and persuaded the rest of us) that stereotyping is an "automatic" brain activity. This implied that both encoding (Banaji, Hardin and Rothman, 1993) and retrieval were unintentional, involuntary, effortless, autonomous and occurring outside of awareness (Bargh, 1989). To investigate these processes psychologists rely on providing different lengths of time for the brain to respond. Giving an experimental participant less than 350 ms to respond assumes an "automatic" cognitive activity while longer times are assumed to indicate more "intentional" processes and more control.

The original distinction between automatic and intentional was refined to include activation of a stereotype (by situational cues such as skin color) and application (where the perceiver uses the activated stereotypic information in a judgment). Until 1996, these two were seen as sequential and activation was considered to be an automatic process while application was viewed as a controlled (or controllable) process. This implied that many responses which disadvantaged one ethnic group over another were automatic and beyond the individual's control.

In 1996, Irene Blair and Mahzarin Banaji published their findings about ways that perceivers might moderate the automatic processes. First, they found evidence that confirmed the automaticity of some responses and then they investigated the nature of automaticity itself. They used a complicated psychology research technique called "semantic priming" which is based on the belief that people respond faster to a target word if it is paired with a second word that is semantically associated with the first word. For example, people would respond faster to "nurse" if it is paired with "doctor" than if it is paired with "tree." Psychology researchers use this concept and measure the time it takes people to react to the second word (target word) of paired concepts. When two words are stereotypically associated, such as "dependent" with "Jane", a faster reaction time indicates a stronger stereotype by indicating a stronger association between the two words.³

After establishing automatic responses to stereotypes using semantic priming Blair and Banaji changed the instructions given to participants so as to moderate the priming. Some subjects were given a stereotypic strategy by being told to expect an associated second word, i.e. "Jane" would follow "petite". Others were instructed with a counterstereotypic strategy by being told the opposite, i.e. to expect that "Jack" would follow "petite." They did the experiments at both 350 ms and 2000 ms intervals. The most startling result was that the counterstereotypic instructions reversed the priming within the 2000 ms interval but not within 350 ms.

If the brain acted so quickly that an automatic response was presumed, it followed instructions when they matched the priming; it gave faster response times to stereotypic pairs when it was given stereotype instructions and it gave faster responses to counterstereotypic pairs when given counterstereotypic instructions. However, when allowed a longer time to respond (2000 ms), so as to include intentional processes and more control, the brain also followed counterstereotypic instructions with stereotypic pairs and gave slower response times with those pairs and faster response times with counterstereotypic pairs--in direct contradiction of the automatic aspects of the stereotyping process. In other words, when the cognitive processes were more controlled, participants were able to modify the automaticity of the stereotyping process.

If one accepts the results of Blair and her colleagues that environmental information can contribute to encoded stereotypes but that this information is controllable and changeable, the question then becomes what kind of information could be used to counter existing negative stereotypes. Social psychology research within two well-

accepted theories (complexity-extremity theory and assumed characteristics or trait attribution theory) sheds additional insight to begin to answer that question.⁴

Theories on the influence of stereotypes

Complexity-extremity theory suggests that people have more information about their own group than about other groups and that the more information they have, the less extreme their evaluation will be. Patricia Linville and Edward Jones (1980) did a series of experiments which looked at how members of one cultural group (the “in-group”) evaluated members of another cultural group (the “out-group”). In one experiment, male subjects were given a packet of 40 cards which each contained a personality trait which had been pre-tested to reflect traits of both black and white undergraduates. They were told to sort the 40 traits into groups. Some subjects were told to think about White male undergraduates while sorting and other participants were told to think about black male undergraduates while sorting. Their all-white participants formed significantly more groups when thinking about whites than about blacks and scored higher on a conceptual complexity index test.⁵

These results suggested that whites had greater schematic complexity regarding in-group members than out-group members. The extremity of an evaluation is theorized to depend upon the richness (greater schematic complexity) of one’s conception of the “other’s” social group, that is, richer information results in a less stereotypic attitude. Variations in schematic complexity are also important because they suggest differential influences for new information since a simple and impoverished schematic about out-group members is likely to be heavily impacted by a small amount of new information.

Trait-attribution theory (also called assumed-characteristics theory) proposes that a person with information about only a few traits will use broad complexes which include many traits to evaluate another person. For example, information about skin color leads people with limited information about the other individual to make assumptions about socio-economic status, personality traits, or values.

One line of trait-attribution studies looked at racial stereotypes in light of information about background and occupation. Jack Feldman (1972) had college students generate descriptive adjectives for four categories: “Negro”, “white”, “professional” and “working class”. Other college students then selected a percentage for each adjective which represented the number of people from each of the four categories that would, in their opinion, exhibit that trait. A comparison of white and black categories showed that the occupational stereotype was much stronger and more differentiated than racial stereotypes. Professional background and working-class occupation were rated significantly higher on the black stereotype than were other adjectives. In other words, “professional blacks” were more professional than comparable “professional whites.”

Feldman argued that professionals are accorded more traits and rated higher on those traits than are working class people. He concluded that the black stereotype is “in reality, a *lower-class* black stereotype, and that when contradictory information is presented, it takes precedence over race” (1972, p. 338).

If complexity-extremity theory underscores how small amounts of new information about out-group members can be influential and if trait-attribution theory offers information about occupation and background as effective influences, the question becomes, what kind of information about occupation and background should be provided? Alice Eagly & Valerie Steffen (1984) have shown that the new information can be extremely general. In their experiment, they read a short sentence to participants about a person (e.g., “Phil Moore is about 35 years old and has been employed for a number of years by a supermarket. He is one of the managers”). All descriptions included being employed by either a bank, a supermarket, a medical clinic or a university department of biology. Occupational status was conveyed by job title. “Vice-president,” “manager,” “physician” and “professor” were used to indicate high-status while “teller,” “cashier,” “x-ray technician” and “lab technician” indicated low-status. Participants then rated each person on personal attributes indicating communal (selflessness and concern with others) and agentic (self-assertion and urge to master) qualities which were selected to reflect gender stereotypes. The results indicated that the extremely general information about employment status caused participants to revise their estimates of women’s and men’s communal and agentic qualities away from existing gender stereotypes.

These studies suggest that prejudiced responses and behavior based on negative stereotypes need not be viewed as inevitable, that incidental exposure to stereotypic knowledge can unconsciously and selectively influence judgment but that exposure to counterstereotypic information can moderate the effect of the stereotype. They also imply that providing information about a member of another group can lessen the effect of already-held stereotypic knowledge, especially if the new information contains a counterstereotypic occupation or background.

Can a similar inference be made about the effectiveness of including certain specific attributes in a curriculum as a way to counter the effects of implicit stereotypic knowledge? The psychology studies all involved experimental laboratory conditions where the information was specifically presented to the brain in ways that ensured that certain cognitive processes would occur and where it was highly likely that each participant would absorb the counterstereotypic information. For educators to benefit from this work they have to find ways to incorporate counterstereotypic information into the curriculum under conditions that encourage a similar absorption.

To begin to answer that question, the next section looks at two studies where teachers successfully integrated counterstereotypic information into the classroom curriculum.

Lessons from the classroom

Lorie Strech (1994) looked at existing racial stereotypes with third-graders in California before and after they completed a social studies unit which focused on the school's diverse community. One section of the curriculum included activities to compare their community from the past to the present. A second part of the unit included literature which focused on the concept of communities and a third component was aimed at dispelling stereotypes by having students observe the kinds of occupations present in their neighborhood and the kinds of people holding those jobs. Students reported their data to the class as part of a discussion on stereotypes involving jobs. An African-American female psychologist also visited the class as a role model.

Students were given a pre- and post-test which measured their association between certain ethnic groups (described through photos of African-Americans, Hispanic-Americans, Asian-Americans and European-Americans). The curriculum unit was found to moderate stereotypes with 13% more post-unit responses falling in "neutral" categories than in negative or positive ones. For example, the number describing "janitor" as the occupation for African-Americans fell from 60% in the pre-unit test to 27% on the post-unit test (to be replaced by "football player" at 60%). A similar shift appeared for stereotypes of Asian-Americans. While 77% of the pre-unit responses were "gardener", that changed to 17% after the unit, and "teacher" became the most prevalent with 57%.⁶

In another study Richard Johnson and Joseph Tobin (1992) used a videodisk module in a University of Hawaii education class to help pre-service teachers understand stereotypes underlying classroom discipline. The software included interviews with a Samoan social worker, a Chinese high school student and a Japanese-American professor which illustrated a variety of perspectives about how different cultural groups are stereotypically treated in the classroom. The authors' conclusions, based on qualitative analysis of student responses and critiques, suggest that the education students changed some of their stereotypes after viewing the program. The change in stereotyping information came about when pre-service teachers were provided rich information about three varied ethnic groups.

While these two projects support the effectiveness of a small curriculum modification for influencing the use of stereotypic information, they concerned social studies and education courses where the content could naturally include a focus on culture. In science, the adoption of strategies designed to narrow the gender gap in science (i.e., increasing student confidence, student performance and student interest in science, as suggested by Burkham, Lee and Smerdon, 1997) has failed to change the fundamental perception by students about who becomes a scientist, as seen in the 1997 study of elementary school drawings. While the importance of these programs should not be discounted, it appears that we also need to find another way to introduce counterstereotypic information into science (and other) classrooms.

One of the obvious possibilities is to use pictures since they have previously been shown to enhance learning in certain contexts and they can quickly convey large amounts of detailed information.⁷ Here, in contrast to the issue usually facing instructional designers of which picture to use, we know the information that should be included, and can rely upon the established principle that pictures, when used appropriately, effectively enhance learning. The Johnson and Tobin videodisk relied heavily on images through the use of video for capturing interviews with three people so their comments could be available for student reflection outside classtime. Although the presence of role models and the in-class appearance of experts might be preferable, the Johnson and Tobin study shows certain advantages of technological presentation of images and counterstereotypic information for science classrooms. Digital resources are not dependent upon a teacher's personal knowledge, cultural experiences or contacts in diverse communities. Science is also especially receptive since it is one of the subjects where success requires familiarity and mastery of technology (Songer, 1989).

The technology used by Johnson on the videodisk included a wide variety of elements which would generally qualify as "multimedia", a term for software programs that combine text, graphics, animation, audio, video and interactivity (Lopuck, 1996). Classroom multimedia can provide students with opportunities for independent learning, problem-solving, communication and self-assessment (Platt, Obenshain, and Friedman, 1994). The use of a multimedia program which included counterstereotypic images would allow a student to absorb counterstereotypic information at her or his own pace and comfort level.

Successful use of multimedia in the curriculum has been shown for anchored instruction (Bransford, et. al., 1990), as part of cognitive flexibility (Spiro, et. al., 1992) and within a cultural constructive perspective (Peters and O'Brien, 1996). The multisensory elements have been shown to address a diversity of learning styles (Dunn, 1990) and to attract students' attention and keep them engaged. Static computer graphics have been shown to facilitate learning (Alesandrini, 1987) and research on the movement of graphics (animation) has also shown direct connections to enhancing learning (Enyedy, 1997; Windschitl and Andres, 1998).

Perhaps more importantly for the purpose of conveying information, multimedia typically includes a lot of graphics. Graphics are used to illustrate ideas in multimedia, as part of animations, as interactivity button icons and to communicate navigation (e.g., left-pointing arrow means "go back"). This expectation provides a myriad of

unobtrusive opportunities for including counterstereotypic images. In short, multimedia appears to provide a potential curriculum resource which can easily include counterstereotypic images which convey occupation and background information. Could the use of such software change attitudes of students toward members of an out-group?

Methodology

Software

To investigate this question three versions were created of a multimedia software program. All versions were designed to be used as a review for a unit test which included Mendelian inheritance genetics by helping students check their own comprehension in a game format. Each had the same content, divided into five sections and accessed from a main menu. The content was designed to be easier at the beginning, with the first section containing vocabulary words. The next four sections were alphabetically labeled with questions on monohybrid crosses, dihybrid crosses, x-linked genes and multiple alleles. There were five questions for each section plus a bonus. All versions included a total of 30 questions.

The software was made with a multimedia authoring program (ToolBook by Asymetrix, Inc.) which uses the metaphor of a book. The information on each screen appears as a “page” which remains until the user navigates (usually by clicking a button) to the next “page” or screen. The software is also object-oriented, so information is presented using static objects such as text fields, created within the program, or by importing graphic, audio or video files. All objects can be sized or moved to create animation. The software is also event-driven, so that user actions such as moving the mouse on top of a screen object, clicking an object or entering a “page” causes other actions to occur, such as a text field appearing (i.e., to provide feedback) or a circle moving (i.e., to look like a bouncing ball).

The versions differed in the basic way they presented the information. The first version (hereafter called the Web-page based version) included only multiple choice questions created by the textbook publisher. The first 18 questions were copied, word-for-word, from the publisher’s Web page. Once a student selected an answer, one of two text fields appeared: “Your answer to question #1 was correct” or “Your answer to question #1 was incorrect. Please refer to page 239 in [name of textbook author].” The last 12 questions were taken, also word-for-word, from the back of the textbook chapter and showed the question along with a button which accessed the answer.

The second version of the software was a “game” (hereafter called plain multimedia version) where students scored points by answering questions. A wrong answer triggered an audio file of a dog howling along with the appearance of a text field as immediate feedback which included the correct answer and a short explanation. A correct answer brought applause and access to a “game” which included either archery, bowling, pool, basketball or darts, depending on the content section. Points accumulated and a running total was shown on subsequent pages.

The third version (hereafter called the counterstereotypic version) included ethnocentric clip art and had two differences from the plain multimedia version. It included five images taken from a commercial “Afrocentric” clip art collection where the characters were all African-Americans. Images were selected which showed high-status occupation and background information or could be modified to include such information. Afrocentric clip art was chosen to correspond with the stereotype measure questions which asked participants about “Blacks.” For example, identification as a doctor or holding a Ph.D. was designed to convey a high status occupation or background.⁸ Each image was positioned around the question, usually on the left, so as to be seen when the student read the question. A second difference was that a popular Mexican game similar to Anglo-Saxon Tarot cards was used instead of archery in one section and Wari, a common African game was substituted for bowling in another section.

Classroom Setting

The study was conducted with two sections of a 4-credit course for non-majors at an urban community college in a major city of the Southwest. Students take this course to fulfill their general science requirement for an Associate of Arts or Associate of General Studies degree. Most had graduated from high school but some earned G.E.D.s; the youngest was 19 years old and the oldest was in her 40’s. The campus is notable for the diversity of student ethnic backgrounds and in this study, there were 14 whites (self-identified), 13 Hispanics, 2 Native Americans, 7 African-Americans, 2 Africans, one Thai and 4 Asians. One class met in the evenings and included older, “second-career” students while the other section was an afternoon class with more younger students.

Forty students in two class sections, including one that I taught, used the software individually in a computer lab as part of a regular class laboratory exercise. While each section dealt with genetics at different times in the semester, both spent the same number of class periods and both used the software as a review during the week before a unit test. Prior to entering the computer lab, students were orally informed of their rights concerning consent and participation and completed two surveys, one on computer attitudes (Kay, 1989) and a second one on stereotypes. The stereotype scale had been created with 10 pro-Black and 10 anti-Black statements and previously validated with 174 white students at Brooklyn College and Lehman College (New York City) using principal-components factor analysis with varimax rotation (Katz and Hass, 1988). An example of a pro-Black statement is “Black people do not have the same employment opportunities that Whites do” and an example of an anti-Black item

would be “On the whole, Black people don't stress education and training.” Four items (two of each type) were keyed in reverse.⁹

After completing the questionnaires, the students moved to a computer lab, started the program, entered a code number,¹⁰ selected their gender and answered the question “Briefly describe your cultural background by typing in the gray box”. The next five screens displayed five genetics problems, with multiple choice answers, which functioned as the biology knowledge pre-test. Leaving the last question triggered a random assignment to one of the three versions, based on the time in seconds. Upon completion of the review portion, each student took a post-test with five different genetics problems, exited the software and again completed the attitude toward computers and stereotypic attitude questionnaires (in the computer lab). The software also created a “log” for each student which recorded the time and content of events such as entering a page or typing an answer.¹¹

Results

The pre- and post-software attitude measures were converted from Likert scale to numeric values such that higher scores indicated more positive attitudes toward a member of an out-group or toward computers. Initially, a 3x2x4X2 factorial design was used to analyze the data using SPSS 8.0 for Windows with a four-factor analysis of variance (ANOVA) with multiple variables including all three dependent variables (stereotypic attitude, computer attitude and biology knowledge) and with software version (3 levels), gender (2 levels), ethnicity (4 levels: white, Hispanic, black, Asian), and class section (2 levels) as independent variables. However, since there were no significant results for ethnicity as a factor (or for interactions involving ethnicity) a second ANOVA was used with the same three dependent variables but with only software version (TX) and gender as fixed factors. The two-factor ANOVA is shown in Table 1. It provides a more accurate description of this study because the sample size is small compared with the number of cells and the two-factor ANOVA eliminated the zero frequency cells without losing any significant information.

Table 1: Analysis of Variance with Only Software and Gender as Independent Variables

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	CAMDIFF	.636 ^a	7	9.084E-02	.215	.97
	STERDIFF	3.012 ^b	7	.430	3.273	.01
	QDIFF	25.985 ^c	7	3.712	2.727	.03
Intercept	CAMDIFF	1.103E-03	1	1.103E-03	.003	.96
	STERDIFF	.789	1	.789	5.998	.02
	QDIFF	1.293	1	1.293	.950	.34
TX	CAMDIFF	7.345E-02	2	3.673E-02	.087	.91
	STERDIFF	1.013	2	.507	3.854	.03
	QDIFF	2.588	2	1.294	.950	.40
GENDER	CAMDIFF	4.954E-03	1	4.954E-03	.012	.91
	STERDIFF	1.880	1	1.880	14.300	.00
	QDIFF	1.024	1	1.024	.752	.39
CLASS	CAMDIFF	1.132E-02	1	1.132E-02	.027	.87
	STERDIFF	.311	1	.311	2.363	.14
	QDIFF	2.263	1	2.263	1.662	.21
TX* GENDER	CAMDIFF	.266	1	.266	.629	.43
	STERDIFF	.427	1	.427	3.250	.08
	QDIFF	1.347	1	1.347	.990	.33
TX* CLASS	CAMDIFF	8.058E-03	1	8.058E-03	.019	.89
	STERDIFF	2.214E-02	1	2.214E-02	.168	.68
	QDIFF	13.333	1	13.333	9.794	.00
GENDER* CLASS	CAMDIFF	4.011E-04	1	4.011E-04	.001	.97
	STERDIFF	1.089E-02	1	1.089E-02	.083	.77
	QDIFF	2.727	1	2.727	2.003	.17
TX*GENDER*CLASS	CAMDIFF	.000	0			
	STERDIFF	.000	0			
	QDIFF	.000	0			
Error	CAMDIFF	8.036	19	.423		
	STERDIFF	2.498	19	.131		
	QDIFF	25.867	19	1.361		
Total	CAMDIFF	8.674	27			
	STERDIFF	5.511	27			
	QDIFF	52.000	27			
Corrected Total	CAMDIFF	8.672	26			
	STERDIFF	5.510	26			
	QDIFF	51.852	26			

a. R Squared = .073 (Adjusted R Squared = .268)

b. R Squared = .547 (Adjusted R Squared = .380)

The two-factor ANOVA showed significant main effects for both software version and gender at the 95% confidence level for scores on the stereotyping attitudes scale ($F=3.854$, $p=.039$ and $F=14.3$, $p=.001$, respectively) but not for either attitudes toward computers (CAMDIFF, $F=.087$, $p=.917$) or for biology question scores (QDIFF, $F=.950$, $p=.404$). However, there was also a statistically significant interaction between class section and software version ($F= 9.794$, $p=.006$) on the biology scores.

The significant software version differences correlated use of the counterstereotypic version with positive changes in stereotypes. Overall mean scores for those who used the Web-page based software version dropped -.3833 between the pre- and post- results while those using the plain multimedia had mean scores that stayed about the same (a raw score change of +.003). Those using the software with counterstereotypic clip art saw a positive change in their stereotype attitudes of +.1656 on average. These mean scores, however, differed by gender with women generally scoring more positively on all versions and men scoring more negatively.

The significant software version by class interaction on the biology questions showed different trends between the two classes, some of which may be accounted for by the small sample size. For example, no one in my class was randomly assigned to the Web-page based version. For those in my class who used the plain multimedia version, their biology scores dropped an average of -.7778 and those using the counterstereotypic version increased

+1.5 on average (a 30% increase). For the other class, the Web-page based users saw no change in scores, those using plain multimedia saw an increase in post-software scores of +.3 and those using the counterstereotypic version saw a decrease in biology scores of -1.0 (a 20% drop). The graphs in Figure 7 illustrate the class by software version differences. ANOVA post hoc LSD tests showed that the only statistically significant difference was between the Web-page based and the counterstereotypic versions ($p=.042$). Table 3 shows these results.

Both the significance and the pattern were unexpected results since there were only five questions and since it was expected that software designed for review purposes would be used by students who had already mastered most of the material. For example, several students commented at the end of the class period that the software helped point out the material they did not yet know. I had not expected the design to be sensitive enough to detect changes in biology knowledge.

The differential biology content scores make sense in light of the significant class by software version interaction and the overall increase in stereotypic attitude scores. Although the differences between the two classes on stereotype attitudes were not statistically significant ($F=2.363$, $p=.141$) the patterns were very different. The average for all software versions in my class showed no improvement in stereotypic attitudes. In the other class section, however, group means for those using the Web-page based and the plain multimedia versions showed essentially no change in pre- to post-software scores (+.075 and +.065, respectively) but the group using the counterstereotypic version showed a +.3567 improvement. In short, the use of counterstereotypic clip art in my class correlated with an increase in biology knowledge and the use in the other class correlated with a more positive stereotypic attitudinal change. What does that indicate about using counterstereotypic clip art in the classroom?

These classes were selected because they were the only sections offered of this course. Although the research design did not anticipate differences between classes, these results make sense in light of the different ways culture was included in the two classes. The other teacher said she did not discuss culture during classtime because she did not know how to do that. She encouraged students to get to know their classmates, but did not conduct any class activities designed for that purpose. For example, she did not have students introduce themselves to each other on the first day of class. She said she did not think it was feasible considering the number of students in the class and the room arrangement. Instead her first day strategy was to reassure students that she was sympathetic to them and knew what they were going through since she was a student herself. She also told them about things she had done with students during previous semesters which showed how she had gone out of her way to help students succeed.

In contrast, I encouraged student interactions around culture in my class throughout the semester. For example, on the first day of class, I asked students to interview each other, in pairs, and to then introduce their partner to the class. Before we broke into pairs, I had the class brainstorm a list of questions they could ask of each other as “professional students”. I added the last question to the list, “What is your cultural background?” After all the students had introduced their partner, I answered the same questions for them, telling them that my great-great-great-grandmother Butler was a member of the Cherokee nation.

I also included a number of overt discussions throughout the semester which focused on student cultural backgrounds and which tried to value differences. On one occasion, I asked the two students from Africa to tell the class about each of their countries. The student from Thailand told the class about her country on another day and I then related a five-minute version of how the Hmong came from China via Laos and Thailand to the U.S., and that there were 4,000 Hmong currently living in Colorado.

Other conversations were more directly connected to biology. For example, we talked in class about sickle cell anemia which disproportionately affects Africans and African-Americans, about diabetes and its influence on Native Americans, and about the impact of Tay-Sachs on Ashkenazi Jews. One of the African students told the class about malaria in his country. Interviews and observation data from the other class section indicates that they discussed sickle-cell anemia as disproportionately affecting African-Americans and Tay-Sachs as prevalent among certain Jewish groups but failed to relate diabetes to Native Americans.

The differences in class context make it likely that if a student had not previously been exposed to discussions which raised the issue of cultural differences in either an affirmative or value-neutral manner, seeing counterstereotypic images for the first time could be expected to make an immediate impression which could reasonably appear as more positive scores on the post-software stereotype attitude scale, which is what was seen for those in the other class section. The students in that class who used the counterstereotypic version showed the greatest increase in more favorable stereotypic attitudes (group mean rose from 3.94 to 4.3). For students in my class, who had previously discussed cultural differences in a school setting, seeing cosmetic counterstereotypic images caused no dent in their stereotypes, but did contribute to increased success in biology scores.

It is also interesting that ethnicity did not have either a significant main effect or interaction effect, indicating that it operated as an independent factor. In other words, the influence of the counterstereotypic images in the software was similar for all ethnic groups.

Discussion

The class by software version interaction and its possible roots in the context of the course are both consistent with theoretical discussions in educational research of situated cognition (e.g., Brown, Collins, & Duguid, 1989) and situated learning (e.g., Lave & Wenger, 1991). These approaches direct attention to the apparent success of learning that occurs in group activities which extend beyond individual cognitive moments and reinforces the necessity of viewing learning within the social context in which it occurs.

These results are also consistent with research in social psychology around “outcome dependency” which exists when one person depends upon another to reach a goal or desired outcome. These psychologists have studied stereotypes in the social context of two people working toward a common goal and have shown that category-based stereotypes can be undermined by individuating processes of impression formation which occur when two people work toward a common goal. In other words, people working together will use specific information, rather than general information derived from racial categorization, to form an impression of the person with whom she or he is working.¹²

The specific information included in the software used here was cosmetic, with images which were neither integrated with the genetics content nor part of the overt affective learning goals of either class section. Yet, within a context of class discussion of cultural differences, such minor changes appeared to immediately influence the attitudes of students. The idea that class section differences may stem from differences in classroom interactions among students is consistent with trait attribution theory. The less that a student knows about another student who is an out-group member, the more likely they are to automatically make assumptions and rely on stereotypic information. Introducing students to each other, encouraging them to work together, and using counterstereotypic clip art appear to moderate this tendency.

These results have several implications for instructional and curriculum designers. First, science curricula could begin to include images of people of color which portray them in high-status occupations and with upper socio-economic backgrounds as a way of providing students with information which counters existing societal implicit stereotypes. Second, inclusion of cosmetic images is not alone sufficient to create changes in student stereotypes. Other educational reforms, such as class discussions on culture and how it relates to science need to be coupled with the use of such graphics.

Third, while overall results did not include a statistically significant effect of the counterstereotypic software version on biological knowledge, the significant class interaction and the overall changes in group means suggest a tentative model for changing student perceptions of who becomes a scientist. The initial exposure of students to counterstereotypic information impacts their implicit stereotypes. This step was seen with the other class section where exposure to the graphics correlated with more positive student stereotypes. In the second step, additional counterstereotypic information absorbed by a student who had already experienced some counterstereotypic information, such as during class discussions, helps students to be more successful in mastering science content. This step was seen with my class section where a second exposure to counterstereotypic information correlated with an increase in biology scores. This model is not linear, however, as the effect of encoding incidental exposure to stereotypic information present in society probably needs to be continually moderated through exposure to counterstereotypic information. This further supports the necessity of incorporating counterstereotypic information across all disciplines so that changes in stereotypes and success in content matter are given a chance to increase the attractiveness of studying science for minorities, a beginning toward increasing minority representation in the practice of science.

Notes

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1. While 3.5% of scientists were African-American that group comprised 12% of the population. Latino/Hispanics lost ground; they were 2.8% of the science and engineering workforce while growing to 10% of the total population (Committee on Equal Opportunity in Science and Engineering, CEOSE, 1996). That study also found that Blacks and Hispanics each accounted for only 2 percent of those working in science with Ph.D.'s while Native Americans accounted for less than one half of 1 percent.
2. Psychologists who investigate ethnic stereotyping believe that experiments which use gender as the basis for stereotyping are more reliable since they omit the possibility that subjects are reacting emotionally to race issues.
3. There is another significant aspect to Blair's research. The short time period she used (350 ms) is considered by psychologists to be a condition of “high cognitive constraint”, meaning that the person has very few mental resources available for the task at hand. Kim & Baron (1988) suggest that conditions which tax cognitive capacity heighten stereotypic processing. Overload, fatigue, low task confidence, intoxication, drugs, threat, heat, incentives, sensory distraction, lack of structure, temporal constraints, and embarrassment have been shown to exacerbate stereotypic bias.

4. There is a third main theory about how stereotypes influence evaluative judgment, called expectancy-violation theory. This perspective suggests that when one's characteristics violate stereotype-based expectations, the evaluations are extreme in the direction of the violation (away from the stereotype). For example, if a Black has a quality that is more positive than expected, she or he will be rated more favorably than others with similar characteristics. Although the work which led to this theory is consistent with the ideas proposed here, expectancy-violation was rejected as too general and offering too many possibilities to be useful in designing software.
5. Coleman, Jussim and Kelley (1995) established similar responses for blacks.
6. The primary Hispanic-American shift was toward "happy" and "nice" for Hispanic males. On the pre-test, 17% marked "happy" and 20% marked "nice" while 83% marked "happy" and 73% choose "nice" on the post-test.
7. Some of the clip art had to be edited (i.e., a stethoscope was drawn around the neck of a woman since the Afrocentric collection did not include the image of a woman doctor. These are not new ideas. Guidelines from a major publisher in the 1970s ("Guidelines for Creating Positive Sexual and Racial Images in Educational Materials", suggested ways to "avoid racial and minority stereotypes in art" and includes ways to portray African Americans: avoid "skinny geniuses wearing glasses", show some African shirts, show luxury apartments for urban blacks, feature blacks as the focus of a picture and represent blacks in all professions, including medicine, law, and business. See also Henriksen and Patton, 1976.
8. Paivio (1971, 1978) argued that the use of two independent, interacting cognitive systems, a verbal one for processing text and an imaging system for processing pictures, explains the increased retention of information in pictures. Building on Paivio's "dual coding theory", Kulhavy, Stock & Kealy (1993) developed the idea of verbal and imagery systems which were interrelated by associative links.
9. The original research on this measurement instrument used only African-American stereotypes and the validation study included only data from white participants on the assumption that attitudes toward a member of one's own group are significantly different from attitudes about members of an "other" group. Here, after reviewing the questions, I created a second questionnaire for African-American students where they answered questions about "Hispanics" on the assumption that the stereotypes applied generally to "others" more than only to African-Americans. By including that data I was using an instrument which had not been validated for such use and more research on measurement instruments is needed.
10. So that students would not think that participation was in any way connected to their grades, a subtle form of coercion that is not acceptable for the study of human subjects, each student was given a set of labels with a 4-digit identification code which they placed on each instrument and used as identification at the beginning of the software program. For the experimental design, this also meant that no data could be collected before or after the day of software use since it would mean that I, as their teacher, knew which data was theirs.
11. The log was used to measure total minutes working with the software, minutes spent on genetics questions, number of pages viewed, number of answers entered, number of correct answers, whether the student "played" the program linearly by choosing sections in alphabetical order, and the number of minutes spent on both pre- and post-software biology questions.
12. One example of this kind of experiment can be seen in the 1987 work of Steven Neuberg and Susan Fiske. They conducted an experiment where subjects were told that they were going to work with a schizophrenic ex-mental hospital patient to design creative games. The schizophrenic label had been previously shown to be affectively negative so it was serving as the negative stereotypic piece of categorical information. Some of the participants were told that the team that designed the most games would win a cash prize (creating and manipulating the outcome dependency). Participants were then given one of two "profiles" of the patient which contained personal information (hobbies, interests, career goals, etc.). Those in the neutral group received a profile which was not consistent with schizophrenic traits while those in the dependency outcome group read a profile that was positive and discrepant to the negative schizophrenic label. This meant that each participant in the study would have to choose how to process the information contained in the profile which was inconsistent with the label of schizophrenic they had previously been given about the patient. Those in the dependency outcome group used individuating impression formation instead of the typical category-based evaluation, resulting in higher evaluations of the patient, while those in the neutral group assessed the patient using category-based processes, as indicated by their relatively low evaluations. This showed that if one is working with another toward a common goal, individuating information that is inconsistent with a stereotype category can undermine the stereotype.

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EVALUATING THE ACCESSIBILITY OF WEB-BASED INSTRUCTION FOR STUDENTS WITH DISABILITIES

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Abstract

The author presents the methods and results of a year-long evaluation study conducted solely for the purpose of determining disability accessibility barriers and potential solutions for those barriers found in four Web-based learning environments. The methods outlined include computer-based analysis tools and computer-facilitated focus groups and focussed individual interviews. Additionally, the paper includes URLs for several Web resources on accessibility, including a site created by the author based on the results of the evaluation study.

Introduction

The recent push toward Web-based distance education has brought with it a promise of “anywhere and anytime” and often also including a companion promise of being “for anyone.” However, the fast-paced coding environment of the Web has the potential to exclude the population that may best benefit from Web-based distance education, students with disabilities, thus tarnishing the “for anyone” promise of these distance education technologies and sparking legal debates centered around the Americans with Disabilities Act’s “Reasonable Accommodations”⁴ for classroom materials (Hinn, 1999). With approximately one in five people in the United States alone having a legally defined disability (Waters, 1997), the opportunity for educational outreach is great.

The idea about creating accessible Web environments for people with disabilities is certainly not a new one. An article that appeared in an issue of *The Chronicle of Higher Education* in May of 1994 tells the story of a then new graphics-based Web browser called Mosaic that helped cut the blind off from the Internet (Wilson, 1994). Before the advent of Mosaic, the first graphical-mode Web browser, the Internet was accessed by a text-mode (command-line) interface without graphics. The barrier faced by blind users was the extreme difficulty that assistive devices, such as screen readers that read aloud on-screen information or translate the information into Braille, have with being able to interpret graphics-based information such as buttons or pictures – a problem that still largely exists today.⁵

However, the inclusion of disability accessibility issues in evaluations of Web-based instructional environments has been extremely uncommon despite the urgings of evaluation theorists such as Ernest House to include the viewpoints of the disadvantaged in evaluations (House, 1993, p. 122). With House’s concept of social justice in evaluation in mind, a year-long evaluation (February 1997-February 1998) of the accessibility of a variety of web-based instructional environments created at the University of Illinois at Urbana-Champaign was conducted by the author (Hinn, 1997; Hinn, 1998a; Hinn, 1998b; Hinn, 1998c).

Evaluation Questions

The primary evaluation questions used to frame the evaluation were:

- Are there any features of the specific Web-based courseware package (learning environment) that are difficult to access by persons with disabilities?

⁴ Reasonable accommodations are “modifications to course materials or activities that serve to enable a qualified student with a disability to have an equal opportunity to attain the same level of performance as a similarly qualified student without a disability. Reasonable accommodations are required by law in accordance with the Americans with Disabilities Act (ADA) of 1990, as well as the Rehabilitation Act of 1973 and the Civil Rights Act of 1964. In the case of Web-based course materials, this may mean providing alternative text-only Web pages or non-Web-based alternatives” (Hinn, 1999).

⁵ The difficulties that graphical information presented (and still presents) for many users with disabilities has a longer history than just the difficulties that were presented by the new graphics-based interface used to access the Internet. The introduction of graphical user interfaces (GUIs) in operating systems, such as the one that 1984’s Apple Macintosh operating system used (and continues to use), brought with them a promise of being easier to use and learn. But GUIs were not well received by the blind. Blind users continued to use command-line interfaces, such as DOS, as blind users could not use the GUI operating system that the Macintosh relies on until software developers created programs that could interpret the on-screen layout for screen readers and Braille-output devices. Eventually, however, GUI operating systems would dominate the market with the advent of GUIs for PC and Unix computers and blind users would find less and less software that would rely on the command-line interfaces, such as the Web browser Mosaic (Wilson, 1994).

- What are the ways in which accessibility might be improved for the Web-based courseware package (learning environment)?
- Are there any standard HTML features of many Web pages in general which are difficult to access by persons with disabilities?
- What tools are available for checking accessibility for future revisions of the Web-based courseware package (learning environment)?

Participants

Eleven university students with disabilities participated in a series of computer-assisted focus groups and individual interviews conducted over the course of the year. The disabilities of the student participants included Attention Deficit Disorder with a Learning Disability (1), Traumatic Brain Injury (1), Severe Visual Impairments (2), Blindness (1), Cerebral Palsy (1), Muscular Dystrophy (3), Quadriplegia with limited arm mobility (1), and Quadriplegia with no arm mobility (1). During the computer-assisted focus groups and individual interviews, the student participants used the assistive technologies that they would normally use while accessing the World Wide Web along with the Web browser of their choice. The assistive technologies used by the students included Braille output devices, keyboard versus mouse navigation, screen magnification software, screen manipulation software, and screen readers. Web browsers used included versions of Lynx (text-mode browser), Microsoft Internet Explorer, and Netscape Navigator.

Methods

There were two primary evaluation methods used in the evaluation. The first, a computer-based method, allowed the evaluator to rapidly analyze the source code of the Web-based evaluands for common accessibility errors. The second, the use of computer-facilitated focus groups and individual interviews, served as a compliment to the source code analysis with feedback from the students with disabilities who participated in the evaluation. The following subsections describe these methods in more detail.

Computer-Based Analysis Tools

An analysis of the source code of the individual Web pages in each of the evaluands was conducted using “Bobby,” a Web-based analysis tool designed to help determine page features that may be inaccessible for person with disabilities. Additionally, each site was also checked using Lynx, the text mode Web browser that many blind students use.

“Bobby” (<http://www.cast.org/bobby>) was developed at the Center for Applied Special Technology (CAST) and is a free, automated Web page analysis tool. There are two versions of Bobby which designers and evaluators of Web-based instructional resources can utilize. The original and perhaps most widely used version is Web-based and allows users to quickly check a single page of a Web site for its accessibility for persons with disabilities. In this Web-based version, a user simply enters the URL of the page into the text-entry box on the Bobby homepage. Bobby then analyzes the HTML source code, returning a list of accessibility errors and suggestions to the user. Additionally, users can also specify a browser version or HTML version that they would also like Bobby to analyze so that it alerts them to code that may be incompatible with that particular browser or HTML version.

The second and newest version of Bobby is a standalone Java application⁶. This is particularly useful for Web site designers as users can download the application and then test entire Web sites on their local machine. In addition to the analysis features of the Web-based version, this version of Bobby provides the user with previews of what the Web pages would look like in Lynx. The ability to view page layout in at least a Lynx simulation helps address one of the limitations of Bobby which is that sometimes it is not clear how pronounced a particular accessibility problem might be. An example of this is the use of tables. Tables cannot be viewed in Lynx and when Lynx encounters a table, it tries to come up with an alternative layout. Sometimes the layout will allow the text in a table to be read in an acceptable format that is easily readable and understood. But many times the layout is easily readable, particularly in data tables such as ones similar to a spreadsheet worksheet. Being able to view these pages in Lynx is an advantage for evaluators and designers alike as the Lynx previews give a visual representation for particularly problematic Web sites that they can share with the evaluation clients.

However, if an evaluator does not have access to the entire site or it's not convenient to download the pages onto their local drives, there are a variety of alternative ways to view a site in Lynx. There are several Web-based Lynx simulations that allow a user to enter a URL in a text-entry box and the page script will return a mock-up of how the page would be viewed to a Lynx user. Two of these simulations include “Lynx-It” available from Salt Lake Community College (<http://www.slcc.edu/webguide/lynxit.html>) and “Lynx-Me” available from the University of Alberta (<http://ugweb.cs.ualberta.ca/~gerald/lynx-me.cgi>). The most ideal way of viewing a site in Lynx is to actually go through the Web site being evaluated using the actual Lynx Web browser, as was done in this evaluation study.

⁶ At the writing of this paper, the Java version of Bobby was in its third phase of beta testing.

The advantage to this is that by working through to site, an evaluator is alerted to features of the site that may not work correctly using Lynx. In this particular evaluation, occasionally a password protection dialog box or a Web-based form used in an online quiz did not work correctly when used with Lynx. If these features had been viewed using a Lynx simulation, these difficulties would not have been evident. Lynx is available from several public telnet sites including one at the University of North Carolina (telnet://public.sunsite.unc.edu – use “lynx” as the login) and one in Maryland (telnet://sailor.lib.md.us/ – use “guest” as the login).

Computer-Facilitated Focus Groups and Individual Focussed Interviews

Several computer-facilitated focus groups and individual focussed interviews with the student participants with disabilities were conducted during the evaluation. There were several purposes for conducting these interviews. The first was to complement the computer-based analysis tools as a way to provide richer, more personalized examples of accessibility issues. A second purpose of the interviews was to help address the limitation of the “Bobby” tool in particular. Since “Bobby” is a source code analysis tool, there are many aspects of accessibility that cannot be automatically checked such as whether or not a background image and text color choices that are used for a Web page provide a sufficient contrast for test readability. Finally, the interviews included student participants with a wide range of disabilities that helped to offset the primary emphasis of the computer-based analysis tools on persons with visual disabilities.

The computer-facilitated focus group is similar to the traditional focus groups in that they involve face-to-face interaction that builds on group discussion (Worthen, Sanders, & Fitzgerald, 1998, p. 382).⁷ However, the computer-facilitated focus group differs in that each focus group member uses a computer throughout the focus group interview. The advantage to conducting a focus group in this manner is that participants can directly demonstrate difficulties with a particular Web-based instructional environment and it also serves as a way to help ensure that each participant understands which particular feature another focus group member or the interviewer is discussing. In this evaluation, each participant used a computer that they were comfortable with and that was equipped with any assistive technologies that they needed in order to access Web-based learning environments.

Another difference between traditional and computer-facilitated focus groups is the size of the groups. Richard Krueger suggests in the second edition of his “Focus Groups” (1994) text that large focus groups of 10 to 12 participants are no longer seen as necessary, especially with complex topics. He suggests that focus groups with 5 to 7 participants are easier to set up and manage, as well as they allow individuals to have more opportunities to speak (p. ix). However, computer-facilitated focus groups may require groups of no more than 5 participants. As previously mentioned, one of the features of computer-facilitated focus groups is that they allow the participant to directly point out various strengths and limitations of the evaluand to the evaluator, an advantage that often requires a greater amount of attention by the evaluator and fellow focus group members. With participants with disabilities, particularly students who have speech impairments and/or require a greater amount of time to access particular features on a Web page with their assistive technologies, conducting smaller focus groups can definitely be more manageable. There is a tendency for participants to move ahead of others when working with Web-based evaluands, especially when there is a participant that requires more time to navigate through the site than the others, creating a potential for chaos in a larger group. So an advantage of conducting small focus groups is that the evaluator can concentrate more fully on each of the participants, as well as reduce the potential for confusion.

However, a few of the participants, were unable to participate in even in a small (2-3 person) computer-facilitated focus group. This was due to highly individualized assistive technology that these participants required to access to Web pages of the evaluands, technologies that were more specialized than in the assistive computer labs on the University campus. In these cases, individual focussed interviews that followed the same interview guide used in the focus groups were conducted. A clear limitation in conducting individual focussed interviews versus focus groups is the lack of idea sharing amongst participants. But as one student participant in this evaluation pointed out, it that it doesn’t make a lot of sense to conduct a computer-facilitated focus group when the participants can’t use the computers in the lab. By using computers and assistive technologies that a student is familiar with, the evaluator can be more certain that a difficult to access Web page feature is due to an access issue alone rather than an access issue and the student’s use of unfamiliar, inappropriate, or no assistive technologies. It should be noted that the cost of constantly updating assistive technologies sometimes prohibit absolute certainty that either the student at their personal workstation or a group of students in an assistive computer lab is using the most ideal assistive technologies to access Web-based learning environments.

There are a number of benefits to conducting participant individual interviews and focus groups facilitated by participant use of the Web-based courseware tool. First, observing the student(s) as they move through each of the Web pages and their corresponding features can reveal strengths and limitation of the environment that may not have been addressed in the original interview guide. These observations can also help shed light on how well certain

⁷ For a more in depth description of traditional focus groups, please refer to Krueger’s book entitled “Focus Groups” (1994).

assistive technologies that the student(s) might be using to interact with the Web-based learning environment, particularly certain components of the environment such as interactive forms or particular graphics. As both participant(s) and interviewer discover certain strengths or limitations of the environment, the focus of the interview questions can delve a bit more deeply into the heart of a specific strength or limitation.

For instance, a student might make a comment that a particular feature, such as the “submit” button for a form on a Web page, does not seem to work. After a closer observation of the participant trying to interact with the feature in question, the evaluator can inquire further about the issue at hand. This can help the evaluator understand whether or not the problem is due to user error of some sort, unclear instruction on the part of the Web-based environment’s developer, or is perhaps due to a difficulty that a particular assistive technology has with interacting with the feature in question. In the focus group, the evaluator can also take this opportunity to check with other participants as to whether or not the feature in question is difficult for them as well. The group can work together to try to determine whether or not the access issue is a global one (e.g., true for all Web pages that contain the feature) or more local one (e.g., true for the feature as implemented on this page in particular but necessarily true across all Web pages containing the feature). An example of this from this evaluation study would be a quiz submission button that was unique to one of the Web-based instructional environments that at first appeared to be a more global issue. When examining another Web-based quiz in a different learning environment that did not present a problem for the same focus group participants, it turned out that the problematic submission button was a problem local to that particular learning environment. Additionally, the uniqueness of a particular access issue can also enter the group discussion where group participants can discuss their feelings about whether the feature being discussed is problematic for students with one type of disability in particular or whether it is also problematic or even an advantage for students with other types of disabilities.

As with this evaluation, it is sometimes the case that in the group discussions, another student will have a solution or work-around for the problem that the student who first made note of the problem was not aware of. This assistive interaction amongst the participants is encouraged, as it is the opinion of the author through observation that this kind of helping environment can be quite beneficial to the participants. Similarly, the evaluator is encouraged to share his or her computer expertise or knowledge of potential solutions to access barriers with the participant.

Results of the Evaluation

The following sections comprise of the more generalizable results from the study. It should be noted that it is not a complete listing of all accessibility issues. For a more complete listing of accessibility issues, please see the World Wide Web Consortium’s Web Accessibility Initiative homepage (<http://www.w3.org/TR/WD-WAI-PAGEAUTH/>).

Limitations

There were several limitations that were identified by the student participants as well as the computer-based analysis tools. The most common limitations and suggested solutions are discussed in the following subsections.

Lack of Alternative Text for Images, Imagemap Hotspots, and Applets

When alternative text (ALT tag) is not included within image tags, for imagemap hotspots, and/or within Java applet tags, users who use text-mode browsers such as Lynx and/or use screen readers will be unable to know whether the item was important or just decorative. In these cases, students who rely on these technologies, such as students who are blind or who have severe dyslexia, will only get placeholders such as [image] or [link] and no way of knowing what the image might have been or what the link might be prior to following it. In this evaluation, this was the most common accessibility issue across all of the four evaluands. However, adding alternative text is probably the easiest evaluation issue to fix. The code to include alternative text for each item appears below:

- Alternative text for graphics: ``
- Alternative text for imagemap hotspots: `<area shape="rect" coords="50,50,300,30" href="file_name.html" alt="description of link">`
- Alternative text for Java applets: `<applet code="applet_name.class" alt="description of what the applet is ">`

However, it should be noted images and applets may need more explanation than just a title and brief description placed in the ALT tag. Therefore it was recommended that, in addition to providing short alternative text descriptions, descriptions, in as much detail as necessary, of the function and interpretation of any complex graphics (such as charts or graphs) and applets should accompany the image or applet in either nearby text or in an accessible alternative on another Web page.

Forms Usage

In each of the Web-based environment examined in the evaluation, each used Web forms for online quizzes as well as chat boards. However, several of the students in the study needed to use an extraordinary amount of physical effort in order to use these features. This was particularly the case for the participant who was blind who could not access a quiz using Lynx and was able to use their screen reader with a graphical-mode browser. When trying to answer quiz questions, being able to read each question and then enter the answer proved to be a difficult proposition. When this student used the tab key to move from question to question, the screen would often scroll past the question. When the student tried to get the screen to scroll back in order to hear the question, the placement of the cursor within the answer entry box was then lost. The student then was required to guess where the entry box was on the screen in order to submit their answer.

Web forms, such as those that might be used for an online quiz or message board, should be designed to facilitate independent keyboard navigation as much as possible. Students who have disabilities that limit their arm mobility, such as those with cerebral palsy and muscular dystrophy, often also rely on keyboard navigation. These students move the cursor using the keyboard accessibility features in their operating system. Despite the usefulness of the keyboard accessibility features, they still require quite a bit of manual dexterity to use for navigating forms, especially when the layout of a form does not facilitate moving from answer entry field to answer entry field. It was recommended to the developers of each site in the study that they test their quizzes using only the keyboard to determine the ease of navigation in this manner. However, because of the difficulties that the participant who was blind had, it was also noted that alternative means for quiz submission should also be supported when needed and course instructors should be made aware of possible accessibility issues with Web-based forms for course planning purposes.

Frames Usage

The use of frames to organize information in Web sites has been a problem for people using browsers that do not support frames. For a long time, people who used the text-mode browser Lynx could not access sites with frames at all. More recent versions of Lynx now support the use of frames by providing a listing of the pages that comprise the framed site for the user to choose from. This has resulted in the unfortunate tendency, as was evidenced in a few of the sites examined in this evaluation, for Web designers to assume that an alternative non-framed site no longer is needed and omitting the <NO FRAMES> instructions altogether or simply including remarks instructing the user to upgrade to a newer version of Internet Explorer or Netscape Navigator within the <NO FRAMES> tag. In one case, the designers of one of the sites used in the evaluation had created a "help" section for their instructional environments, one that contained eight separate frames without a <NO FRAMES> alternative. When the blind participant encountered the help pages, they were presented with the listing of all eight pages, each represented by the frame name assigned in the HTML code as opposed to their specific URL. Unfortunately, the designers had also not taken care to assign a frame name that might be intuitive to the user navigating with a text-mode browser and was presented with eight pages entitled "top," "middle," "right," "logo," et cetera. To make matters worse, several of the pages were further broken down and by the time the student found what they were looking for, they no longer had any idea where they were due to the recursive design of the frames. Had the designer included a <NO FRAMES> page that might have led the user to an annotated set of alternatives links or even used frame names which more intuitive names such as "navigation bar" and "main frame window," much of this students frustration would have been greatly lessened.

Additionally, the Web-based instructional environments that used frames in this study presented unexpected problems for the one participant who was Quadriplegic without any arm mobility. This student, as do many other students with disabilities that affect their arm mobility, used a speech-input device to navigate through each of the Web-based learning environments. However, when this student encountered areas that utilized frames, they needed to try to force a particular frame into focus (e.g. activate one frame over another) so that they follow any of the links using their speech-input device. So while it was possible for this student to access and use the framed site, it provided the student with a few slow and tedious extra steps. By providing users not only with a <NO FRAMES> alternative within the HTML code but also by providing them with a link to this no frames alternative, either from the top of one of the frames or from a lead page that gives the users a choice in which version they wish to browse, this problem also could have been easily avoided.

Graphical Icons

Students with impaired vision without total blindness will often use a graphical-mode browser such as Netscape and Internet Explorer but will raise the font size to an extremely large size, as was the case with several of the participants in this study. However, there were many times where a graphic icon with text labels as a part of the icon were used as a navigational device in a particular learning environment. Since graphic icons cannot be enlarged in the way that text can in a Web browser, these students were either unable to differentiate one icon from another at all or were forced to sit at an extremely close proximity to the screen in an attempt to try to navigate through the site.

On the other hand, these navigational devices were noted as an advantage by the student with a learning disability, noting that the graphical cue helped them more than a simple text listing of the pages contained in the site. With this in mind, it was recommended to the developers of the sites that they include text alternatives for each graphical navigation device (such as a cluster of navigational icons or an image map) in addition to the graphical navigation device.

Tables Usage

The use of tables on Web pages is another accessibility issue that holds an advantage for some users. There are times when the ideal method for visually organizing information is through the use of a table. In fact, the use of tables is sometimes the best organizational layout for students with cognitive disabilities. However, for students who require the use of screen readers, the text will become jumbled, as screen readers will typically read across columns versus one cell at a time. Another issue is for students with impaired vision without total blindness. When these students use graphical-mode browser by raising the font size in their browser, the text in one table cell will often end up overlapping the text in another table cell, returning a confusing layout as was noted by several of the study's participants. It was recommended the site developers that they link to a non-tables version of the information found in each table.

Browser-Specific Code

From time to time, code was included in one of the evaluands that did not work with text-mode browsers. One example of this was where a graphical icon was used for a form submission button versus the traditional gray "submit" button. The code underlying this feature did not work at all for the blind participant who was using Lynx and the code only worked with the latest version, at the time, of Netscape Navigator and Microsoft Internet Explorer. Unfortunately, this was not evident until after the student had completed the entire mock quiz used for the purpose of the student and the student was then unable to submit the quiz.

Another example of browser-specific code usage was when the same student tried to access one another one of the Web-based instructional environments. As with the other environments, this site had a password entry dialog box. However, the coding behind this particular password dialog box was browser-specific and the student was unable to access the site at all – a pretty severe access barrier. It was recommended that the developers try to avoid situations such as these in an actual course situation by testing each essential feature that uses browser-specific code with a variety of browsers and prepare a non-browser specific alternative. Additionally, it was also recommended to the developers that they each prepare a FAQ page that outlines any known accessibility issues related to browser-specific code as well as presents accessible alternatives as well as a person to contact for solutions to any problems that have not yet been noticed and/or addressed.

Strengths

Perhaps the greatest strength found in this evaluation was the simple fact that the environments allowed for the course materials being online. Having course resources available in electronic format can serve as an advantage for many students with mobility and visual disabilities. As one focus group member with Quadriplegia stated: "For me...having things around on the Net is a lot easier to read materials because I don't have any hand movement. So in other words, using a book and so forth to look things up...it's a lot harder. Whereas having it on the computer, I can just sit there and go ahead and work through it and get everything from the page. But I wish that I had a lot more classes that had [materials] on the Net" (Hinn, 1997). For some students, Web-based instruction may be the only way that some students can independently access courses and course-materials – something that is a powerful reminder of the need for accessible online distance education.

Beyond the Evaluation Study

In addition to addressing the needs of students with disabilities in this evaluation in order to increase the utility of the evaluands, the evaluation also was concerned with maximizing the dissemination of the evaluation results to include the greater Web design community. With this in mind, a Web site was created by the evaluator called Access.Edu (<http://lrs.ed.uiuc.edu/access>) as a way to try to reach out to Web designers who may be looking for more information about the creation of Web sites that are accessible to persons with disabilities. In addition to information about some of the more common access issues from this evaluation, the site contains links and information about companies, organizations, and Web accessibility tools. The site also contains a Web site design tutorial called "Considering User Differences" that was designed to help novice Web page designers understand the accessibility issues surrounding a designer's choices of color and backgrounds in Web pages through visual and interactive examples. This tutorial also created by the evaluator, focuses on users with reading disabilities such as dyslexia, color-blindness, and visual impairments.

Due to the academic setting in which this evaluation study was conducted, a luxury existed where the evaluator was free to look solely at disability accessibility issues in the four Web-based learning environments that

were the focus of the evaluation. Certainly most evaluators of Web-based instruction will not find themselves in quite the same circumstances. However, it is hoped that the methods used and results of this evaluation will provide evaluators with a place to begin thinking about the inclusion of disability access issues, as well as access issues in a more general sense, in their own evaluations of Web-based instruction. It is also hoped that the information in this paper will provide designers of Web-based instructional environments with a few ideas for creating more accessible Web-based learning environments in the future.

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THE USE OF AUDIO IN COMPUTER-BASED INSTRUCTION

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Abstract

This study investigated the effects of audio and text density on the achievement, time-in-program, and attitudes of 134 undergraduates. Data concerning the subjects' preexisting computer skills and experience, as well as demographic information, were also collected. The instruction in visual design principles was delivered by computer and included numerous illustrations. Subjects were randomly assigned to one of three presentation versions of the instruction: Text Only, Full Text-Full Audio, or Lean Text-Full Audio. No significant difference in achievement was found for the three treatment groups; however, significant differences in achievement were found for sex (females achieving more than males) and self-ratings of computer skill (subjects with higher self-ratings achieving more than those with lower self-ratings). While overall attitudes towards the instruction were favorable, subjects in the Full Text-Full Audio treatment responded less favorably than their counterparts in the other treatments.

Introduction

Multimedia computer-based instruction (CBI) is increasingly used as an adjunct to instruction in schools and corporations and has typically incorporated text, graphics, and audio. Audio has often been added to CBI as an afterthought, to gain attention and increase motivation. When audio has been added as voiced material, it has often occurred as redundant reading of screen text. Little research has been performed to provide the instructional designer with guidelines for incorporating audio into CBI to promote learning. When guidelines do exist, such as those proposed by Barron (1995), they are frequently general and not always based on research. Indeed, little research exists to support the notion that adding audio to CBI can improve learning.

Most research on the use of audio in instruction has focussed on increasing learning through multichannel delivery and has traditionally investigated the mediums of television, videotape, 35-mm slide/tape, and audiocassette teamed with print. The underlying assumption has been that increasing the number of channels and the redundancy between channels will increase learning. This assumption stems from early research into multichannel communication. Hartman (1961) summarized and evaluated several studies that looked at audio-print and print presentation for instruction. He concluded that redundant audio-print instruction was more effective than either audio or print alone. This result was attributed to the cue summation theory that predicted learning would increase as the number of cues or stimuli are increased.

A competing theory to cue summation holds that only one sensory channel can access the brain at a time; implying that multichannel communication would not increase learning (Broadbent, 1958; Travers, 1964). In support of that view, a number of studies have found no advantage for audio-print over print alone in a variety of conditions with different age groups (Barton & Dwyer, 1987; Furnham, Gunter, & Green, 1990; Nugent, 1982; Van Mondfrans & Travers, 1964).

Most audio-text studies have looked at the use of text redundant audio where the audio is word for word the same as the text and both are presented simultaneously. A study by Barron and Kysilka (1993) and another by Barron and Atkins (1994) included text density as a treatment variable. Neither study found a difference in achievement between full text-no audio and lean text-full audio groups. If lean text with explanatory audio instruction is as effective as full text with no audio instruction, the implications for CBI design are considerable. Screen "real estate" is often at a premium—particularly when simulations or large labeled illustrations or graphics are important for the instruction. Some concepts are difficult to explain in words alone—pictures and illustrations may be necessary for clear understanding by the student.

Studies that have examined illustrations as well as text and audio are relatively scarce. Two studies (Mayer & Anderson, 1991; Mayer & Sims, 1994) looking at animations and narrations for teaching science concepts have found that animations accompanied by simultaneous narrations (audio) increase learning. Mayer and Anderson (1991) and Mayer and Sims (1994) believe that dual coding theory provides an explanation for how words and illustrations can be linked (Paivio, 1986). In Paivio's view, spoken and written language are both classified as verbal information. In dual coding, verbal information is selected and organized into verbal representations while visual information is selected and organized into visual representations. Finally, referential connections are built between the verbal and visual representations. This entire process must occur in short term or working memory.

Other researchers (Mousavi, Low, & Sweller, 1995; Tindall-Ford, Chandler, & Sweller, 1997) have indicated that when integration of diverse elements is crucial for learning (as is often the case for scientific or technical illustrations and accompanying text), audio-text instruction is effective and may decrease the burden on working memory that text only instruction might impose.

The present study examined the effects of audio and text density on achievement in a CBI with content that depended heavily on graphics, illustrations, and visual examples. Data concerning subject demographics, time in the CBI, attitude towards the CBI, and computer experience and skills were gathered.

The study was designed to investigate the following research questions:

- Does presentation version (text only, full text-full audio, and lean text-full audio) in a CBI affect student achievement, time-in-program and/or attitude?
- Does computer experience (years of use, frequency of use, and self-rated computer skills and confidence) affect student achievement and/or attitude in multimedia CBI?
- Does time-in-program affect student achievement and/or attitude?

Method

Subjects

One hundred thirty nine undergraduates (93 female, 46 male) enrolled in a computer literacy course at a large southwestern university participated in this study. The course, offered by the College of Education, fulfilled the university's undergraduate computer literacy requirement. While 35% of the subjects were education majors, the remainder represented a variety of majors ranging from Art to Zoology. The subjects were well distributed amongst freshman, sophomore, junior, and senior class standings (18%, 24%, 39%, and 18%).

Materials

A CBI, *Sending Your Message: Designing for Web and Print*, served as the instructional materials for the study. The CBI, developed by the first author, consisted of three topics: typography, design principles, and color. Each topic included information, examples, practice and feedback, and review. The CBI was primarily linear in nature; however, the subjects could view previous screens within any of the three topics and could choose the sequence in which to view the topics. While the subjects had some sequence choices as they navigated the CBI, all subjects were required to view all instructional and review screens, and to complete all practice items before proceeding to the posttest.

The program was designed in three presentation versions corresponding to the three treatment conditions of the study. The first version was Text Only with some music and sound effects, but no voiced material, accompanying the instruction. The second version was Full Text-Full Audio with a male voice reading the instructional text that appeared on the screen word-for-word. It also contained the same music and sound effects as the Text Only version. The third version was Lean Text-Full Audio with the instructional text reduced to a bulleted outline accompanied by the audio from the Full Text-Full Audio version. Again, this version contained the same music and sound effects as the Text Only version. All three versions contained the same graphics, number of screens, practice items and reviews. All instructional screens included graphics to illustrate the concept or information presented in the text or audio. Both audio versions allowed the subjects to replay the audio.

Procedures

The subjects were randomly assigned to the three presentation versions. Students received instructions from the researcher, filled out a demographic/computer experience survey, worked through the CBI, took a posttest, and filled out an attitude survey. The two surveys were paper-based while the posttest was computer-based. All events occurred within the students' normally scheduled 110-minute laboratory period. All subjects wore headphones while working through the CBI.

Criterion Measures

Achievement was measured with a 30-item posttest administered by computer immediately after the instruction. The posttest consisted of multiple choice, matching and short answer items with each item worth 0 to 5 points depending upon the number of answers required by each item. Posttest items were similar in form and content to the practice items in the CBI. Posttest multiple choice and matching items were scored by computer, while short answer items were scored by the first author. The posttest KR-20 reliability was 0.80.

The attitude survey consisted of nine to eleven Likert scaled (five point scale from Strongly Agree to Strongly Disagree) items and two open-ended items regarding the usefulness, instructional quality and feelings towards the CBI. The number of Likert scaled items varied with the presentation version of the CBI. For the audio versions, two questions concerning the value of the audio were included. For the nine Likert scaled items common to all three CBI versions, the KR-20 reliability was 0.81.

Results

Achievement

Means and standard deviations for the posttest scores are shown in Table 1. The means for the three versions were very similar and the results of an ANOVA run on the posttest means indicated that there was no significant difference in scores for the different CBI versions, $F(2, 131) = 0.725, p > 0.05$.

Table 1. Mean Posttest Scores and Standard Deviations by CBI Version.

Version	N	Mean Score* (M)	Standard Deviation (SD)
Text Only	47	47.23	6.99
Full Text-Full Audio	40	45.75	7.10
Lean Text-Full Audio	47	47.30	5.95
All Versions Combined	134	46.81	6.66

*A maximum score of 63 points was possible on the posttest.

Time-in-Program

Means and standard deviations for the time-in-program are shown in Table 2. A one-way ANOVA indicated that there was a significant difference in the means, $F(2, 131) = 18.50, p < 0.05$. A post hoc Bonferroni test identified the source of the difference. The mean for the Text-Only version was significantly different than the means for the Full Text-Full Audio and the Lean Text-Full versions at the $p < 0.05$ level. There was no significant difference for time-in-program between the Full Text-Full Audio and Lean Text-Full Audio versions.

Table 2. Mean Time-in-Program and Standard Deviations by CBI Version.

Version	N	Mean Time-in-Program (seconds) (M)	Standard Deviation (SD)
Text Only	47	1830	596
Full Text-Full Audio	40	2523	712
Lean Text-Full Audio	47	2515	574
All Versions Combined	134	2277	703

There was no correlation between time-in-program and achievement, $F(1, 132) = 0.447, p > 0.05$ nor were any correlation's between time-in-program and attitude discovered.

Attitudes

The means and standard deviations for the attitude responses are shown in Table 3. A MANOVA for attitude scores indicated no significant difference for the different versions, $F(9, 246) = 1.38, p > 0.05$. Follow-up univariate tests were performed for individual items.

Table 3. Mean Attitude Scores and Standard Deviations by CBI Version and Versions Combined.

Item		Text Only	Full Text-Full Audio	Lean Text-Full Audio	All Versions Combined
1. I liked this program.	Mean SD	3.81 1.04	3.50 0.88	3.83 0.80	3.72 0.92
2. I would recommend this program to other students.	Mean SD	3.72 0.97	3.58 0.96	3.87 0.72	3.73 0.89
3. I preferred learning about design in a computer program rather than in a lecture format.	Mean SD	4.11 1.15	3.65 1.25	3.85 1.09	3.88 1.17
4. This was a good way to learn about design.	Mean SD	4.17 0.99	3.90 0.98	4.13 0.86	4.07 0.94
5. I learned a lot about design.	Mean SD	3.89 0.98	3.50 0.78	3.87 0.93	3.77 0.92
6. I plan to use what I have learned in future work.	Mean SD	3.85 1.02	3.75 0.74	4.22 0.66	3.95 0.85
7. This program was easy.	Mean SD	4.15 0.86	4.03 0.86	4.11 0.71	4.10 0.81
8. I would like to learn more about design.	Mean SD	3.68 1.11	3.48 0.91	3.70 0.81	3.62 0.95
9. I tried hard to do well in this program.	Mean SD	3.66 1.01	3.20 0.97	3.72 0.91	3.54 0.98
10. The audio helped me learn better.	Mean SD		3.18 1.15	3.61 1.14	3.41 1.16
11. I liked having the audio.	Mean SD		3.23 1.10	3.78 1.13	3.52 1.15
12. The amount of practice was	Mean SD	1.11 0.38	1.30 0.56	1.51 0.82	1.30 0.63
13. The amount of text on the screens was	Mean SD	1.19 0.45	1.23 0.42	1.15 0.47	1.19 0.45
Number of Subjects (N)		47	40	47	134

Notes: Items 1-9 were measured on a five-point scale from 1 to 5 (Strongly Disagree to Strongly Agree).
 Items 10-11 were not administered for the Text Only version.
 Items 12-13 were measured on a three point scale from 1 to 3 (About Right, Too Much, Too Little)

Univariate analyses revealed that there were significant differences for four items among the different versions with subjects in the Full Text-Full Audio version responding more negatively to three of these items than their counterparts in another version. Subjects in the Full Text-Full Audio version ($M = 3.75$, $SD = 0.74$) responded more negatively than those in the Lean Text-Full Audio version ($M = 4.22$, $SD = 0.66$) to the statement, "I plan to use what I have learned in future work", $F(2, 130) = 3.89$, $p < 0.05$. A similar pattern was observed for the statement, "I tried hard to do well in this program", with subjects in the Full Text-Full Audio version ($M = 3.20$, $SD = 0.97$) responding more negatively than those in the Lean Text-Full Audio version ($M = 3.72$, $SD = 0.91$), $F(2, 130) = 3.64$, $p < 0.05$. In terms of the amount of practice, subjects in the Lean Text-Full Audio version ($M = 1.51$, $SD = 0.82$) were less inclined to respond that "The amount of practice was about right" than subjects in the Text Only version ($M = 1.11$, $SD = 0.38$), $F(2, 129) = 5.049$, $p < 0.05$. Finally, subjects in the Full Text-Full Audio version ($M = 3.23$, $SD = 1.10$) responded more negatively than those in the Lean Text-Full Audio version ($M = 3.78$, $SD = 1.13$) to the statement, "I liked having the audio", $F(1, 84) = 5.33$, $p < 0.05$.

Overall, the subjects in the Full Text-Full Audio version appeared to respond less favorably to the CBI if responses to items one to nine in Table 3 were averaged (Text Only $M = 3.89$, Full Text-Full Audio $M = 3.62$, Lean Text-Full Audio $M = 3.92$).

Additional Findings

Information about the subjects, demographics, as well as computer experience, was collected prior to starting the CBI. Several questions regarding computer experience were asked including: a self-rating of computer skills, confidence in succeeding at computer tasks, hours per week of computer use, and years of computer use. These variables and two demographic variables (Age and Sex) were examined in conjunction with achievement.

Sex ($r = -0.229$, $p < 0.05$), self-rating of computer skills ($r = 0.252$, $p < 0.05$), hours per week of computer use ($r = 0.186$, $p < 0.05$), years of computer use ($r = 0.210$, $p < 0.05$), and self-rating of confidence in succeeding at computer tasks all showed some correlation with achievement. Not surprisingly, self-rating of computer skills was moderately correlated to confidence, hours per week of computer use, and years of computer use. In summary, females achieved significantly more than males and subjects with higher self-rating of computer skills achieved significantly more than those with lower self-ratings of computer skills.

The status variables were also examined in conjunction with the attitude items. There was a significant correlation between sex and attitudes toward amount of practice with females being more inclined towards stating

that there was enough practice, $F(1,130) = 5.732, p < 0.05$ than males. Sex also correlated with the statement, “I tried hard to do well in this program”, $F(1,131) = 5.570, p < 0.05$ with females indicating more effort than males. The more confident subjects felt when dealing with computers, the more likely they were to agree with the statement, “This program was easy”, $F(1,131) = 6.060, p < 0.05$. Age correlated with the statement, “I would like to learn more about design”, $F(1,131) = 5.297, p < 0.05$ with older subjects more apt to rate the item higher than younger subjects. For the audio versions, self-rating of computer skills correlated with the statement, “The audio helped me learn better”, $F(1,84) = 6.277, p < 0.05$ with more skilled subjects responding more favorably to the audio.

Discussion

The present study examined the effects of varying levels of audio and text density on achievement, time-in-program, and attitudes in a CBI. The computer experience, skills, and demographics of the subjects were also examined. The CBI was designed following instructional design principles and the content required extensive use of graphics for illustrations and visual examples. All instructional screens contained some graphic material that illustrated the concept presented in the text or audio.

Achievement

The CBI was fairly successful at teaching the subjects about basic design, a topic which few had any preexisting knowledge. While the majority of the instructional objectives were knowledge and comprehension objectives, a few were analyze and evaluate. The number of analyze and evaluate items on the posttest were too few to allow for interpretation in a broader context but subjects appeared to score about as well on those as on the knowledge and comprehension items.

There were no significant differences in achievement based on the presentation version of the CBI. Text Only was as effective as Full Text-Full Audio, a result that echoes many other studies (Barron & Kysilka, 1993; Barton & Dwyer, 1987; Furnham, Gunter, and Green, 1990; Nugent, 1982; Rehaag & Szabo, 1995). Again similar to other studies (Barron & Aikens, 1994; Barron & Kysilka, 1993) employing CBI, the lean text version was as effective as a full text version. By shifting part of the verbal portion of instruction to the audio channel, more screen “real estate” may be devoted to detailed graphics, illustrations, visual examples and simulations.

The present results do not appear to provide evidence for the cue summation theory, as there was no difference in achievement between the treatments. Some might argue that the present results provide support for the theory that only one sensory channel has access to the brain at one time (Broadbent, 1958; Travers, 1964); thus predicting no difference in achievement for the three presentation versions. Dual coding theory would view the text and audio as equivalent (verbal information) and processed simultaneously with the graphics (visual information). In this view, the three treatments are equivalent and similar results would be expected for each. Research examining graphics, audio and text (Mayer and Anderson, 1991; Mayer & Sims, 1994; Tindall-Ford, Chandler, & Sweller, 1997) might have predicted that the Lean Text-Full Audio version would do better than the Text Only version and possibly better than the Full Text-Full Audio version.

Time-in-Program

Not unexpectedly, the Text Only version took much less instructional time than either of the audio versions—amounting to a difference of about 10 minutes (total instructional time was 30 minutes for the Text Only version and 40 minutes for the Audio versions). While subjects could have advanced through the program without waiting for the audio to finish, the vast majority of subjects waited for the completion of the audio segment before continuing to the next screen. As time-in-program was more likely a function of the presence or absence of audio, it is not surprising no correlation between time and achievement was discovered. Interestingly, time-in-program was not correlated with attitude. It might have been expected that longer instructional time might have engendered some degree of negative attitude but such was not the case. The present study clearly indicates that significant amounts of audio in CBI will substantially increase the amount of time required for instruction.

Attitudes

While subjects’ general attitudes were favorable ($M = 3.81$ averaged over all subjects, all treatments for items 1-9 in Table 3), subjects in the Full Text-Full Audio version were less enthused than their counterparts in the other versions (Text Only $M = 3.89$, Full Text-Full Audio $M = 3.62$, Lean Text-Full Audio $M = 3.92$). In fact, the mean response for the Full Text-Full Audio version was the least positive of the three treatments on each of the first nine attitude items. The means for the Text Only and Lean Text-Full Audio versions were quite similar for seven of the nine items with the Lean Text-Full Audio usually being the more positive of the two.

Additional Findings

Implications

The present study could have implications for the instructional design of CBI where screen "real estate" is needed for something other than instructional text. This is particularly true for simulations and concepts difficult to explain with text alone. Science and technical material as well as visual arts and design are particularly well served by detailed illustrations, visual examples, animations and simulations. If the screen can contain a graphic or labeled illustration with a minimum of explanatory text while audio supplies the detailed explanation, a major design problem can be overcome.

The current findings also provide support for avoiding redundant audio in most situations as an unnecessary expense that adds considerable instructional time for no apparent learning gain. For some audiences, redundant audio may even decrease positive attitudes towards the instruction. Redundant audio should probably be reserved for situations where the audience includes poor readers or used in brief segments to emphasize critical points or issue warnings.

Generalizability

Caution should be exercised before generalizing results from this study. While the present findings support previous research concerning the effectiveness of Lean Text-Full Audio (Barron & Atkins, 1994; Barron & Kysilka, 1993), much is left unresolved. Both of the Barron studies involved technical material with mostly comprehension and knowledge objectives. The present study involved non-technical material and included a few analyze and evaluate objectives. Three studies with two content areas do not constitute much evidence. More research needs to be done on Lean Text-Full Audio in conjunction with higher level objectives and diverse content areas before guidelines for instructional designers can be promulgated with any certainty. Shifting instructional text to audio may only be effective for certain types of content and objectives. Combinations of content and objectives need to be explored in greater detail.

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WHERE IS MY BRAIN?: DISTRIBUTED COGNITION, ACTIVITY THEORY, AND COGNITIVE TOOLS

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Abstract

This paper provides a general overview of distributed cognition and activity theory in order to provide perspective for a discussion of the computer as a cognitive tool. Both distributed cognition and activity theory enlarge the scope of "cognition" to include the individual's interactions with the environment. Activity theory offers a framework congruent with distributed cognition that addresses some of its concerns. Despite the complexity of its vocabulary and concepts, it offers the potential for increased interdisciplinary exploration of issues related to cognitive tools.

Introduction

Though not in total alignment, a number of current learning theories focus on the interaction of the individual with the environment in gaining and using knowledge, drawing on concepts related to those of Vygotsky, Dewey, and the Gestalt psychologists. Examples include activity theory, situated cognition, and distributed cognition (Carroll, 1997; Cole & Engeström, 1993; Hutchins, 1995; Nardi, 1996; Prawat, 1996). These theories are of increasing interest as computers become an integral part of the environment in which knowledge is gained and used. This paper will provide a general overview of distributed cognition and activity theory in order to provide perspective for a discussion of the computer as a cognitive tool.

Situated cognition, distributed cognition, and activity theory

The terms "situated cognition," "distributed cognition," and "activity theory" share similar concepts, and sometimes overlap in use. Distinctions are not always clear. All move from studying the individual in relative isolation, to studying the larger systems, in which people live and work. In addition to their focus on interactions between the individual and the community, a distinguishing characteristic that these theoretical perspectives have in common is their acknowledgement that a portion of the cognitive power used by an individual resides in artifacts or tools created by the larger society. These tools may be physical, or they may be technologies or concepts, or a combination.

Situated cognition theories (and related concepts such as cognitive apprenticeships) stress that individual development occurs in a realistic environment, and is highly contextual (Brown, Collins, & Duguid, 1989; Collins, 1988; Lave & Wenger, 1991; Wilson, 1993). Criticisms of this theory focus on charges of over-estimating the specificity of knowledge, failing to account for the individual's ability to transfer from context to context, and failing to consider the effects of "persistent structures" and their design (Anderson, Lynn, & Simon, 1996; Nardi, 1996b).

In distributed cognition, the unit of analysis extends beyond the individual to include the context within which the individual operates. Further, cognition is seen as less a function of the individual as much as a function of an overall system that includes groups of individuals and their tools (Hutchins, 1995). Cognition may be distributed socially, across groups of people, or may be distributed across artifacts and tools, or both. Thus, proponents of distributed cognition acknowledge that situational factors such as social processes not only affect individual cognition, but can be treated as integral to the cognitive process (Hutchins, 1995; Lajoie & Derry, 1993; Salomon, 1993a).

Moving the unit of analysis from the individual to the larger system raises uncomfortable questions about the role of the individual relative to the system, particularly when talking about computers (Pea, 1993; Perkins, 1993; Salomon, 1993b). Distributed cognition has been criticized for emphasizing system goals at the expense of individual goals, or, in Nardi's terms, assuming a "conceptually equivalent" relationship between people and artifacts (Nardi, 1996b). However, many proponents of distributed cognition go to great lengths to avoid such an equivalence. For example, Salomon uses the terms "analytic" and "systemic" to draw distinctions between the abilities of the individual and the system, and Pea eschews the term "distributed cognition" in favor of "distributed intelligence" because, in his words, "people... 'do' cognition." (Pea, 1993; Salomon, 1990; Salomon, 1993b; Salomon, Perkins, & Globerson, 1991).

Activity theory, a development of sociocultural theory, offers a flexible framework that addresses many of these concerns, one that some authors already see as merging with or even subsuming the concept of distributed cognition (Carroll, 1997; Nardi, 1996b). Activity theory specifically states that relations between individuals and artifacts are not symmetrical; artifacts may be mediators of human thought and behavior, but human motive and consciousness belong to people, not things (Kaptelinin, 1996b). Conceptually, distributed cognition and activity theory are very closely related; the same collection of articles will often include both perspectives (see, for example, Salomon, 1993a). In many cases, ideas from distributed cognition and from activity theory seem indistinguishable: Pea (1993), writing under the banner of distributed cognition, addresses important themes that are conceptually

equivalent to those in activity theory. Such contributions are of great value, and should not be overlooked. However, activity theory offers a broader and more developed theoretical framework in which to examine questions related to the distribution of cognition.

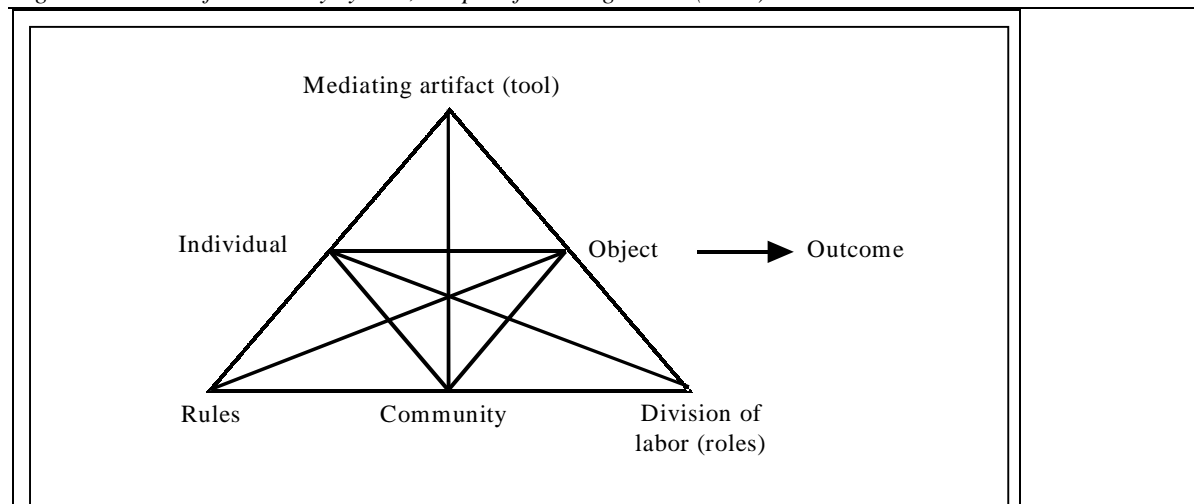
Activity theory

The underlying concepts of activity theory originate in the work of Leont'ev, a follower of Vygotsky (Leont'ev, 1978). Confusingly, “activity theory” now refers to both the original Soviet psychology tradition and to more recently developed theories that extend and develop the original concepts (Cole & Engeström, 1993; Kuutti, 1996). Current contributors are international and interdisciplinary, including representatives from psychology, anthropology, human-computer interaction (HCI), cultural research, and other social sciences. The history and development of activity theory is beyond the scope of this paper, which will sketch only a few key concepts, but numerous references offer more comprehensive discussions (for example, Cole, 1995; Cole, Engeström, & Vasquez, 1997; Nardi, 1996a).

The activity system

Activity theory provides a powerful descriptive framework focused around a “mediated activity system,” which “comprises the individual practitioner, the colleagues and co-workers of the workplace community, the conceptual and practical tools, and the shared objects as a unified dynamic whole” (Engeström, 1992). Figure 1 depicts a general activity system as described by Engeström.

Figure 1. Model of an activity system, adapted from Engeström (1992).



Carroll (1997) describes activity theory as follows:

The object of description in this approach is an “activity system,” the ensemble of technological factors with social factors, and of individual attitudes, experiences and actions with community practices, traditions, and values. Activity theory emphasizes that these ensembles are inherently contingent and changing, that human activities are mediated and transformed by human creations, such as technologies, and that people make themselves through their use of tools.... Activity theory shifts attention from characterizing static and individual competencies toward characterizing how people can negotiate with the social and technological environment to solve problems and learn, which subsumes many of the issues of situated and distributed cognition. (p. 512)

In Engeström’s model of an activity system, the components of the system continually influence and transform one another; the lines in the figure are sometimes even drawn as double-headed arrows, to reflect such mutual influences. At the same time, each system is a node in a network of related activity systems; for example, tools in an activity systems are products of previous activity systems for tool production (Engeström, 1992). Thus, current activity systems are influenced by layers of historical development.

The vocabulary related to activity theory is complex, and requires some patience during initial contact. A few key concepts relating to activity theory are needed for further discussion; however, this overview should be considered as only a preliminary introduction to the topic.

Activities, actions, and operations

Kuuti (1996) provides an excellent description of the hierarchical levels of an activity. At the highest level is an *activity*, which is essentially defined at the level of motives or goals. “An activity is a form of doing directed to an object, and activities are distinguished from one another according to their objects. Transforming the object into

an outcome motivates the existence of an activity” (Kuutti, 1996, p. 27). *Objects* are an important and difficult construct in activity theory, since the term is used both in the sense of “objective,” as in purpose or intention, and in the sense of the “thing” to be transformed (Kuutti, 1996; Nardi, 1996b). Kuutti (1996) observes that the original Russian term for activity carries the connotation of ‘doing in order to transform something,’ which he considers essential (p.41). Thus, while “objective” or goal is probably the easiest English translation for beginners, it is not complete.

Objects can and do evolve and change during an activity system, but are relatively slow to change. *Actions* are shorter-term processes underlying activities, which accomplish goals related to the activity. Actions require the context of an activity to be understood. An activity can be achieved through a variety of actions, and a single action can belong to multiple activities. The example Kuutti offers is the action of making a workplace project report, which might belong to a “project management” activity or to a “competing for promotion” activity.

Below the level of actions are *operations*, “well-defined habitual routines used as answers to conditions faced during the performance of an action.” (Kuutti, 1996, p. 31). Kaptelinin offers this distinction between the three levels:

The criteria for separating these processes are whether the object to which the given process is oriented is impelling in itself or is auxiliary (this criterion differentiates between activities and actions), and whether the given process is automatized (this criterion differentiates between actions and operations). (Kaptelinin, 1996a, p. 108-109).

However, actions can be folded into operations as they become more familiar, and operations can return to the level of actions in response to changing conditions that demand greater attention. The boundaries between actions and activities are equally fluid, and movement is possible in both directions.

Functional organs

Another key concept concerns *functional organs*, or goal-directed combinations of human abilities with tools that improve existing capabilities, or even allow new functions (Kaptelinin, 1996a; Kaptelinin, 1996b; Zinchenko, 1996). These combinations can be seen as belonging to the individual, much as the stick of Bateson’s blind man can be considered as an extension of his senses, and can be quite temporary in nature (Cole & Engeström, 1993; Kaptelinin, 1996b).

Some functional organs extend the *internal plane of action* (IPA), or the capability for mentally representing and transforming external objects (Zinchenko, 1996). This is an important and complex concept: activity theory explicitly attempts to describe interactions between internal consciousness and the external world in a non-dualistic manner. “Context is both internal to people – involving specific objects and goals – and, at the same time, external to people, involving artifacts, other people, specific settings. The crucial point is that in activity theory, external and internal are fused, unified...” (Nardi, 1996b, p.76).

Contradictions

Because activities are affected by related activities, tensions are inevitable. The terms *contradiction* and *breakdown* refer to misfits between different activities, or even among elements in an activity system. Such contradictions are sources of tension, but can also be sources of development (Cole & Engeström, 1993; Kaptelinin, 1996b). According to Cole (1993) “Activity systems are best viewed as complex formations in which equilibrium is an exception and tensions, disturbances, and local innovations are the rule and the engine of change.” (p. 8). Explicitly identifying contradictions within a system can lead to positive changes (for case studies, see Cole & Engeström, 1993; Engeström, 1992; Favorin & Kuutti, 1996).

Artifacts as mediators of human action

Artifacts – tools, symbols, and signs – are the result of previous activity systems. They incorporate “crystallized” knowledge and implicit goals, which can shape the goals of their users (Kaptelinin, 1996b). At the same time, users actively create the meaning of a tool as they interact with it and the environment, and do not merely react to “affordances” (Kaptelinin, 1996b).

An interesting perspective is that artifacts are created by people to provide external support and control. “Artifacts, broadly defined to include instruments, signs, languages and machines, mediate activity and are *created by people to control their own behavior*. Artifacts carry with them a particular culture and history (Kuutti 1991) and are persistent structures that stretch across activities through time and space.” (Nardi, 1996b, p. 75. Emphasis added.) Carroll’s (1996) description of activity theory includes the phrase “people make themselves through their use of tools” (p. 512).

These perspectives on artifacts will contribute to the following discussion of the computer as a cognitive tool.

Current areas of development

Activity theory combines a number of the elements of concern to educational technologists into a powerful descriptive framework. In the United States, two groups have been especially influential in extending and refining activity theory. At the Laboratory of Comparative Human Cognition in San Diego, Cole and Engeström form the center of a group who concentrate on the cultural contexts of learning and work, juxtaposing activity theory with the work of Jean Lave, James Wertsch, Dewey, and various sociocultural anthropologists (Cole et al., 1997). Another core has developed within the field of human-computer interaction (HCI). This group, which includes Nardi, Kuutti, and Kaptelinin, sees activity theory as providing a contextual framework for the consideration of artifacts (especially computers) that connects to previous HCI research directions (Carroll, 1997; Nardi, 1996a). In their explorations of activity theory, these groups draw on overlapping research traditions and integrate previous research with this developing descriptive framework.

Applying activity theory to educational technology

Many current concerns of educational theory, particularly as related to computers, can be discussed using activity theory, which offers a flexible framework that addresses the dynamic and complex nature of educational interactions. For example, the description of activities, actions, and operations can clearly be related both to motivational theories and to cognitive theories about “chunking.” The active role of the individual corresponds to a constructivist viewpoint, while the inclusion of both individual and community goals incorporates the social dimension of knowledge and culture. The conceptualization of artifacts encompasses theories about “affordances,” while acknowledging both the situated nature of artifacts-in-use and the learned responses of the individual user. Though researchers may be interested in exploring specific relationships within an activity system, describing these interactions as part of an overall system maintains an awareness of contextual factors – the “forest” within which the “trees” are rooted.

While the descriptive power of activity theory can most easily be brought to bear on specific cases and situations, applying the framework to describe larger issues can also be profitable. Here is an example of how the vocabulary of activity theory can enrich understanding some of the issues surrounding computers as cognitive tools.

Using activity theory to describe the computer as a cognitive tool

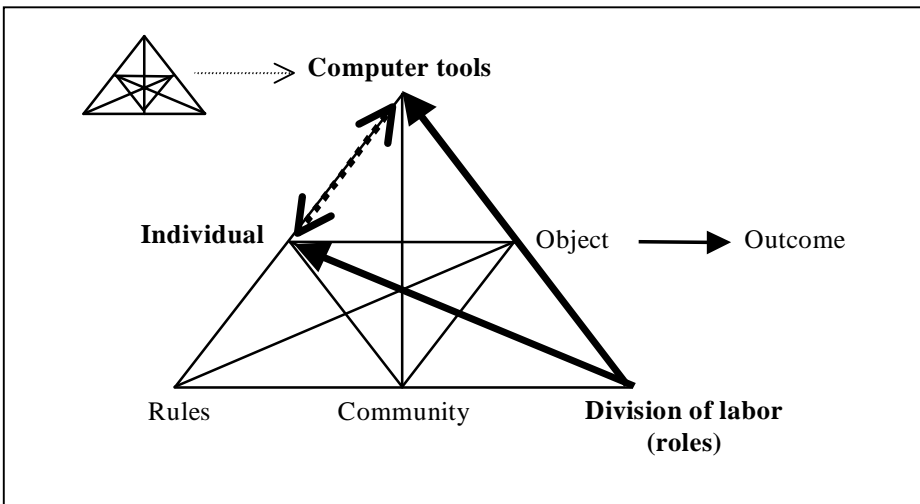
Jonassen and Reeves (1993) offer the following definition of cognitive tools: “Cognitive tools refer to technologies, tangible or intangible, that enhance the cognitive powers of human beings during thinking, problem solving, and learning. Written language, mathematical notation, and most recently, the universal computer are examples of cognitive tools.” (p. 693).

Many authors distinguish using the computer as a cognitive tool from using it as a medium for the delivery of instruction, often linking to constructivist learning principles in which the learner designs with the tool. (Cole & Engeström, 1993; Jonassen & Reeves, 1996; Lajoie, 1993; Pea, 1993; Pea, 1985; Perkins, 1993; Salomon, 1993a; Salomon, 1993b; Salomon, 1993c; Salomon et al., 1991). However, “enhancing cognitive powers” can be interpreted in multiple ways, and affect what one considers a cognitive tool. At one extreme, some limit the term to tools that intentionally develop human capability, however that development is accomplished. At the other extreme, tools that augment human performance (and perhaps make some learning unnecessary) are included. In between are a range of programs such as microworlds, intelligent tutoring systems, expert systems, and the now-commonplace computer applications usually shelved under “productivity programs” – for example, spreadsheets, databases, and word-processing programs.

One of the discussions associated with cognitive tools is their effects on the person using the tool; a particular concern is the inadvertent “de-skilling” of the user. In the context of distributed cognition, Salomon has provided a critical distinction between effects *with* and effects *of* the computer (Salomon, 1990). Effects *with* the computer refer to the efficacy of the total system (the person-plus-computer). In contrast, effects *of* the computer refer to the “cognitive residue” left upon the person, changes evident when operating as a solo performer. Salomon also proposes evaluating human-computer partnerships according to *systemic* and *analytic* criteria. The former looks at the total performance (effects *with*), while the latter specifies the specific contributions of user and system. Pea (1993) acknowledges the distinction between analytic and systemic criteria, but takes issue with the assumption that a low proportion of user contribution is cause for alarm. He persuasively argues Salomon’s approach is overly simplistic, and fails to consider the evolving relationships between the users and tools.

Looking at this discussion through the filter of activity theory clarifies the two separate kinds of interaction under consideration. One involves the role of the computer. There are goals inherent in the design of the computer program in question, which is the outcome of a previous activity system. One way these goals are evidenced is in the division of labor between the individual and the computer in the current activity system, or the role that the computer plays in the system (See Figure 2). The dark solid line indicates that interaction.

Figure 2. Describing computers as cognitive tools within an activity system.



The dotted line indicates the second area of consideration, which are the interactions and transformations between the individual and the program. These include both the “cognitive residue” upon the person and the individual’s adaptation of the tool to his or her own goals (possibly in ways unforeseen by the developers). Like all interactions in an activity system, these two interactions are mutually influenced by one another, and by the other interactions within the system, but focusing on them separately for the moment allows goals and concerns to be more clearly identified for discussion.

Distinguishing between these two types of interactions helps to clarify the issues surrounding cognitive tools, and identify some of the points of tension (contradictions or breakdowns) within the discussion.

The following synthesis draws on the literature specifically discussing cognitive tools (for example, Jonassen & Reeves, 1996; Pea, 1985; Perkins, 1993; Salomon, 1990; Salomon, 1993a; Salomon, 1993b; Salomon, 1993c), from the literature on electronic performance support systems (EPSS's), a type of cognitive tool most commonly used in business (for discussion, see Collis & Verwijs, 1995; Dorsey, Goodrum, & Schwen, 1993; Gery, 1995; Laffey, 1995; Raybould, 1995; Rosenberg, 1995; Scales & Yang, 1993), and from considerations of computer-based learning environments (Cognition and Technology Group at Vanderbilt University, 1991; Hannafin, 1992; Lajoie, 1993; Land & Hannafin, 1996).

In Table 1, the first column addresses the division of labor commonly discussed in relation to computers as cognitive tools. Of course, this division could be conceptualized in multiple ways. In this analysis, the division is considered not in terms of specific tasks, but in terms of the role that the computer plays in respect to the user: expert, intellectual partner, or servant. Such roles are of course fluid, and may be operative at different points during the use of the same program.

Table 1. Considering the “division of labor” between computers and single users as evidenced in computer roles.

COMPUTER ROLES	POTENTIAL INFLUENCES UPON THE INDIVIDUAL		questions (contradictions)
	goals (desirable outcomes)	Concerns (undesirable outcomes)	
<div style="text-align: center;"> Expert ↑ Partner ↓ Servant </div>	<ul style="list-style-type: none"> • teaches user, improving solo performance • creates “zone of proximal development” • scaffolds (as in cognitive apprenticeships) • identifies processes and strategies • provides tools for knowledge representation • provides feedback on decisions • provides situated learning experiences in the context of performance • extends capabilities in a synergistic relationship • allows focus on strengths • allows off-loading of onerous mental tasks • reduces need to learn unnecessary information 	<ul style="list-style-type: none"> • allows successful outcomes without learning • encourages over-reliance on “authority” of the computer. • fails to develop necessary skills • develops “useless” skills • encourages emphasis of form over content • fails to develop reflective skills • extends capabilities for error • obscures critical decision points • reduces human abilities • reduces “executive control” of tasks • reduces command of necessary information 	<ul style="list-style-type: none"> • What are the competencies and skills needed in today’s society? • What balance should exist between process and product? How do we evaluate the two? • How should skills for monitoring, assessment, and reflection be developed? • What information, knowledge, or skills ought people have “in their heads,” as solo performers? Why? • Can software design ensure that users perceive critical information and decision points?

In the “servant” role, the computer primarily supports lower-level cognitive processes in order to free the user to engage in higher level activities, or augments memory. Users may off-load tedious or repetitive tasks, or refer to stored information. They may also create reminders or similar low-level procedural supports.

As the computer offers increased informational access, procedural support, and representational capabilities, its role is more comparable to a partner or expert. The distinction between these roles can be subtle, and may have less to do with the capabilities of the tool than with the nature of the interactions between the user and the computer – specifically, how much of the “goal direction” is assumed by the computer, and how much is consciously retained by the user. In an expert system, the intelligence built into the computer program is responsible for decisions, and the user relies upon it for guidance. Expert systems can encourage learning by modeling problem-solving strategies or working methods, or they may operate in a “black box” fashion.

As a partner, the user and the computer work in an interactive partnership, directed by the user’s intent. The computer not only amplifies but re-organizes mental functioning (Pea, 1985; Perkins, 1985; Perkins, 1993). In this role, the computer most approaches being a *functional organ*, increasing the ability to represent problems and to envision the results of potential decisions.

In the second column of Table 1, the goals and concerns of developers and researchers concerning potential influences on the individual, or “cognitive residues,” are grouped, roughly corresponding to the role of the computer. The division into desirable and undesirable categories reflects the general discussion in the literature, though many items could be debated. These goals and concerns are obviously shaped by historical influences, including the values of the educational community.

From this simple organizational strategy, some interesting questions can be developed, which are presented in the final column of the table. These questions are complex, but by no means exhaustive. They merely illustrate the kinds of underlying tensions that shape the development and assessment of cognitive tools – potential contradictions, in activity theory terminology.

Looking at this portion of this particular type of activity system is only the beginning. A more comprehensive examination of this same interaction would consider not only the computer’s impact on the user, but the *user’s* impact on the *computer*, which might include creating a knowledge base or constructing specialized tools (Laffey, 1995; Lesgold, 1993). Other aspects of the activity system should also be considered, and patterns identified: for example, in discussions of EPSS’s and other workplace computer systems, contradictions between community objectives (the goals of the organization implementing the system) and individual objectives (the goals of

a typical end-user) are gaining increasing attention (Carroll, 1997; Kling & Jewett, 1994; Scales & Yang, 1993). Alan Cooper, speaking from decades of experience as a software developer and interface designer, offers a trenchant description of a typical contrast:

The user's goals are often very different from what we might guess them to be. For example, we might think that an accounting clerk's goal is to process invoices efficiently. This is probably not true. Efficient invoice processing is more likely the goal of the company or the clerk's boss. The clerk is more likely concentrating on goals like:

- Not looking stupid
- Not making any big mistakes
- Getting an adequate amount of work done
- Having fun (or at least not being too bored).

If you think about it, those are pretty common goals. (Cooper, 1995, p. 12).

They are pretty common goals, and seem to be as prevalent in education as in business. Perkins (1985) points out that an individual goal of many student users of computers seems to be "avoiding cognitive load," citing programming examples involving Logo. Obviously, there is a contradiction between this goal and the objectives of the educational community!

Areas for additional research

Writing about cognitive tools for pedagogy, Salomon points out that

No tool is good or bad in and of itself; its effectiveness results from and contributes to the whole configuration of events, activities, contexts, interpersonal processes taking place in the context of which is used....If nothing significant changes in the classroom save the introduction of a tool, few if any important changes can be expected. (Salomon, 1993c, p. 189)

Research confirms that tools like Logo can have widely different effects when used in varying contexts. (Jonassen & Reeves, 1996; Pea, Kurland, & Hawkins, 1987). Salomon (1994) points out in regard to media and cognition studies that there is often a great difference between what *can* be affected and what is *typically* affected; the same is true for any technology, whether the potential is for good or ill (Salomon, 1994). Using perspectives from activity theory to revisit the use of such tools may help to identify contextual factors that influence the widely varying results that have been reported.

The previous example used concepts from activity theory at a fairly abstract level, adopting the framework to summarize an ongoing discussion; a more common and practical approach is to use activity theory to analyze specific systems. While activity theory is descriptive, not prescriptive, it has been used for both analysis and diagnosis (Bødker, 1996; Cole & Engeström, 1993; Engeström, 1992; Engeström & Escalante, 1996; Favorin & Kuutti, 1996). The results of such an analysis can even be used to consciously re-design the activity system, as Cole and Engeström (1993) demonstrate in two different examples (though neither specifically focused on computers).

However, what constitutes a "better" activity system is always open to debate: the answers involve individual and societal goals as much as they involve capabilities of people and tools. Considering the activity system as a whole – and acknowledging the value-laden questions that arise in considering "objects" – is one way to address concerns about the potential consequences for individuals and society as computers become more commonly used as cognitive tools.

Summary

Theoretical perspectives provide both organizing structures and a set of filters. Both distributed cognition and activity theory enlarge the scope of "cognition" to include the individual's interactions with the environment. Activity theory offers a framework congruent with distributed cognition that addresses some of its concerns. This framework has a rich history, and is being extensively developed by disciplines related to educational technology, such as psychology and human-computer interaction. Despite the complexity of its vocabulary and concepts, it offers the potential for increased interdisciplinary exploration of issues related to cognitive tools.

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DISTANCE EDUCATION: LEARNER-TEACHER INTERACTION AND TIME SPENT BY TEACHING FACULTY

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Abstract

This qualitative study examined the structure and interaction in an online course from the meaning-perspectives of the actors involved. Data collected included interviews, observations and messages posted by participants to a virtual classroom environment. Findings suggested that while teachers conceded that they spent more time teaching an online course than a traditional face-to-face course, they believed the online-teaching experience to be a worthwhile endeavor. In the context of an online course, teachers felt that they were more 'present' and available for students than in a traditional course.

Results of the study also suggest that students displayed better commitment to their work in an online course than a traditional course because they have close interaction with the teacher. This close interaction can offset the lack of control the students may feel in a highly structured distance course. The personality, emotions, philosophy and educational background of the teacher determine the structure and design of an online course, including the amount of interaction, and time the teacher spends on online activities.

Introduction

Most early definitions of distance education include a teacher and a student separated by geographical distance or time (McIsaac & Gunawardena, 1996). The learner, teacher, and a medium of communication are the most distinguishing features of distance education. Interactions and relationships between teachers and students in distance education are extremely important and learners usually carry on dialog with instructors across space and time, using communications media. Students work within specified course requirements or structure determined by the teacher in advance. The geographic distance between learner and teacher creates what is termed 'transactional distance' (Moore, 1991).

Course structure and learner-teacher dialog are important elements in transactional distance. Transactional distance is defined by Moore (1991) as a "...[d]istance of understandings and perceptions, caused in part by the geographic distance, that has to be overcome by teachers, learners and educational organizations if effective, deliberate, planned learning is to occur." Moore postulated that high (rigid and inflexible) program structure reduced dialog, and therefore increased transactional distance. Several researchers including Saba and Shearer (1994), Bischoff, Bisconer, Kooker and Woods (1996) have verified and expanded the concept of transactional distance. They elaborated on Moore's work by saying that transactional distance decreases when dialog increases and structure increases. Conversely, increased structure and decreased dialogue increase transactional distance. Students in a distance setting communicate more with their teacher than students in a traditional class format (Bischoff et al, 1996). Communication in distance settings is usually through the medium of electronic mail; however, several courses now employ highly interactive technologies such as two-way video.

Interaction between Teacher and Student

From the student's perspective, interaction with the teacher is a means of obtaining feedback and guidance. Feedback in an online environment may be either synchronous (immediate and in real-time) or asynchronous (delayed). Timely response to questions from students produced relatively good results in online courses (Starr, 1995). This was irrespective of the type of course and the kinds of online activities required by the teacher. Other research findings (Egan, et al., 1991) on the need for interaction have shown that learners value timely feedback regarding course assignments, exams, and projects. Instructors comment that students in an online environment expect more immediate feedback than students in a traditional class. While increased teacher-student interaction is good, it is time-consuming; therefore, it is important to examine whether increased interaction with the teacher affects the quality of student learning. While studies (Harasim, 1990; Waggoner, 1992) show that computer mediated conferencing with student-teacher interaction produces positive results, this is an issue that warrants more research (Kearsley, 1995).

Beginner teachers of online courses feel overwhelmed with the amount of time they spend interacting with each student (Tinker, 1997). The model that is used in designing a particular course is key to determining the time spent on that course. Some teachers expect to communicate with every student individually as they try to replicate

the traditional model of instruction in online teaching. Such a model can make communication with even a small group of students tedious, and can make professors feel as if they are holding unlimited office hours. A less cumbersome and more productive model is the seminar model (Tinker, 1997) in which the teacher structures the virtual classroom by laying out activities and facilitating communication among students. In this model the teacher refrains from having extended individual conversations with students. Instead, the teacher encourages students to communicate with each other, moderates, and guides discussions. The advantage of such a model is that it is more scalable and productive for the teacher. Also, it is more suited for constructivist learning environments, and allows the student to actively construct an internal representation of knowledge by interacting with the material to be learned. Even when implementing a seminar model, a teacher can spend a lot of time on an online course when compared with a traditional face-to-face class.

Time Spent By Teaching Faculty

While students can approach a teacher directly during class in a traditional classroom when they have problems, students in an online course can participate and receive feedback on a daily basis. The onus is therefore on the instructor to sign on to the conferencing system on a daily basis and respond to any waiting questions. Starr (1995) reports that teachers believe that it takes them about 30 minutes to an hour each day to complete this activity depending on the number of students and the extent to which they are involved in the course. The conscientious teacher therefore becomes a "perpetual professor" (Starr, 1995) rather than teaching for a few specific hours in a week. Teachers need to keep abreast of ongoing dialog in different discussion tracks and maintain class web sites (University of Wisconsin, 1996; Creed, 1996). While learners benefit significantly from, and are more motivated if they are in frequent contact with the instructor (Coldeway, et al., 1980); teachers find this a very time-intensive task. Kearsley (1995) also urges distance education programs to make cost/benefit evaluations of interaction in terms of preparation time versus instructional effects. In a case study that focused on a distance education class taught using television, he concludes that the benefit of increased interaction are higher student involvement and satisfaction with courses; however, he is unconvinced that the costs involved in obtaining these results balance out the benefits.

Several researchers have called for further research on teaching an online course from the teacher's perspective. It is important to examine the obstacles and limitations in teaching an online course (Berge, 1997) and examine the distance teacher's perspective of dialog, structure and transactional distance (Bischoff et al, 1996). The present study explores teacher-learner interaction from the perspective of the teacher, and outlines the complex interaction of time spent on teaching an online course in relation to course structure and dialog. The study also examines the area of time spent by teachers of online courses and attempts to further the understanding of how the time is spent and whether teachers consider teaching online a worthwhile investment of their time. Important outcomes of teaching the course such as satisfaction, and a sense of achievement are examined from the perspectives of the actors involved in the particular setting. It is important for us to examine issues faced by faculty related to time, particularly because time is a top priority for most distance education faculty (Sherry, 1996).

Purposes Of the Study

To explore the issues of interaction and time discussed above, the following questions were investigated:

1. What are the responsibilities of an online teacher?
2. How much time does the teacher spend on each of these responsibilities?
3. Does the teacher consider teaching the online course a worthwhile experience?
4. How does the philosophy and background of the teacher affect course design and consequently the amount of interaction and time the teacher spends on an online course?

Method

Setting and Participants

The participants in this study were a teacher and a teaching assistant who taught a graduate course in distance education delivered through the medium of a computer conferencing system during summer 1998. The instructor is a professor who has been teaching courses about distance education. She pioneered the use of online technologies for course delivery at the university for graduate-level courses.

The course was one of the several courses offered by Arizona State University in the distance setting (<http://seamonkey.ed.asu.edu/~mcisaac/disted/>). There were seventeen students in the class that summer. The course employed the World Wide Web and computer conferencing technologies for course delivery and included a combination of face-to-face and online instruction. It was conducted mainly at a distance because teachers and students did not meet face-to-face except for the first three sessions of the class. The class was supported with the help of a text-based computer conferencing software called FirstClass which is a closed environment that only members of the class can access. The system allows students and teachers to engage in both synchronous (chat) and

asynchronous (e-mail, contribution to folders) communication. It also provides file transfer capability and can link directly to the web. This feature enables students to connect to specific web addresses that are included in discussions.

Several folders were created as part of the FirstClass environment. The News folder was available for general discussions between students and any announcements that teachers wanted to make. Students were required to participate in group-discussions each week by posting messages to specific folders. The general area of discussion was predetermined. However, students could choose a specific topic of discussion within the given area. Students were required to act as moderators for at least one discussion (either individually or in groups) in the semester and had to post two questions for each discussion on the weekly topic. Every student had to respond to each question at least once during the week. It was the moderator's responsibility to summarize the results of the discussion and post them online once the discussion was complete.

Teachers and students met face-to-face during the first three days of the course. This was done so that students could familiarize themselves with the conferencing system and the format, requirements, and schedule of the course. The class web site provided information about assignments, schedule, resources to students. The teaching assistant maintained postings of students' work and constantly updated that portion of the web site. After the first three face-to-face meetings, class continued online for five weeks. Then, class met face-to-face one more time at the end of the course.

Data Collection

Qualitative Data

Erickson's (1986) interpretive method was chosen to analyze the qualitative data. Erickson uses the process of analytic induction for data analysis. His approach to qualitative data analysis is holistic. He believes in looking at the data as a whole, rather than splitting up the data into categories. The researcher did not code the data, but read and re-read the data in order to generate assertions from the data. Assertions are generally statements that one can make about the data. They may be statements about relationships observed in the data, hypotheses or propositional statements. Warranting of assertions is important in the Erickson approach. Warranting consists of searching the entire data for confirming and disconfirming evidence for the assertion. On finding disconfirming evidence, the researcher may need to reframe the assertion or modify it. If confirming evidence does not predominate, then an assertion may be dropped. However, sometimes, an assertion may be acceptable even if the amount of confirming evidence is greater than the amount of disconfirming evidence available. Ideally, assertions are warranted by many instances of data from various sources such as interviews, field notes and site documents. This step of warranting assertions is important because it ensures that the researcher is not reacting to rare and dramatic events. Finding these links between the data and the events are crucial for Erickson. The interpretivist notion of validity hinges on coherence. It is vital for the researcher to include a plausible account of the construct. We have attempted to document and warrant assertions in detail in this study.

Qualitative data were collected through interview, online messages and chats. Interviews were audio taped and transcribed later for analysis. Messages that teachers sent out on FirstClass, and chat sessions with peers and students were analyzed. Teachers participated in text-based chat sessions with students and peers, which were saved by them for analysis on a voluntary basis.

Quantitative Data

The quantitative data that were collected was primarily the amount of time that teachers spent in various activities as part of the process of teaching. Data collection was based on self-report because teachers were teaching this course at a distance and direct observation was not possible. Teachers participated in a variety of activities related to the course, such as: planning and preparation, teaching, administration, interaction with peers, interaction with the learning environment (conferencing system) and interaction with students. Quantitative data is reported in a separate study. This paper examines teacher-student interaction from the perspective of the teacher and documents teacher perceptions regarding time spent on teaching the distance class.

Researcher Role, Choices Made and Implications

The researchers were participants in the class setting. One of the researchers was a complete participant and the other researcher occupied a role where she was more of an observer than a participant. Being participants in the setting enabled us to collect data that was rich in detail, particularly in the interview mode. Our familiarity with the participants made it possible for us to obtain intimate details about their background and gain better access to their thoughts during the interviews. Further, both researchers have taught courses using web and conferencing technologies as a medium. Thus, we were naturally interested in this setting, and able to easily obtain access to the setting.

Discussion

As the researchers observed the settings, interviewed the actors, and thought about the data, several issues emerged from the observations and interviews. Researchers reviewed the data obtained from the various sources several times. They identified certain common patterns and themes that emerged from the data. Following are the main themes that most of the data related to:

- *Teaching style in the distance setting:* Teachers teach differently in the distance setting than they do in the traditional setting. Teachers perceive their role to be different in the online setting when compared with their role in the traditional face-to-face setting.
- *Dialog with students:* Dialog is made up of different forms of communication with students. Examples are chat, e-mail, and face-to-face interaction. It was obvious that these forms of communication also were used for a variety of purposes and that what was communicated is just as important as how it was communicated.
- *Time spent on teaching the distance class:* Teachers felt that they spent more time on teaching a distance class than a traditional class. In fact the other two issues outlined here seemed to be directly connected to the time spent on the class.

Since rich data sources were available for assertions concerning teaching style and dialog with students, the present study is focused on these issues. Based on repeated readings of the data obtained from various sources such as interview, observations and text messages from the conferencing system, researchers generated some assertions. Then we proceeded to warrant our assertions by searching the data for confirming and disconfirming instances. These assertions have changed and evolved several times during the process of analysis. We found that these assertions were strong because there was a preponderance of data that supports the assertion rather than data that disconfirms the assertion. Based on this process, some of our preliminary assertions were dropped, and two assertions were strengthened. The first assertion examines the issue of time spent on teaching online courses and the second assertion explores the area of student-teacher dialog. We will now present these two and provide warrant for them.

Assertion 1: While teachers may be required to spend more time when they teach a course in the online format, they believe that it is worthwhile for them to put in the extra effort.

Teachers who teach courses at a distance perceive the need to do a lot of work to put a course online. A teacher needs additional help to start an online course, and then continue teaching it in that format. Teaching in an online or computer mediated environment seems to somehow alter the role of the teacher as well as change the interaction dynamic between teacher and students and between students themselves. In the traditional classroom, the teacher is the source of knowledge and people seem to believe that knowledge flows from the teacher to the student. In the computer mediated classroom, learning requires the student to participate in a variety of activities such as interaction and discussion with other students, interaction with the teacher, reading messages posted in the conferencing system and accessing the class web page for content and resources. The teacher believes that she gets a greater level of commitment with students who participate in the computer-mediated environment. She feels that this may primarily be due to the fact that students can be present in the learning environment only when they are ready to participate and contribute to the learning environment. This viewpoint may be illustrated in the following quotation from my interview with her:

Teacher: And that's what I like about the online courses, is that when someone is there, they are doing something or they are not there. So I think it is a much more individual sense of time and what they are doing. And I like that. I also like the level of commitment and interaction that you get, which I didn't get in a traditional class. I would really struggle sometimes to get somebody to contribute something.

The teacher's perception was that she got a better idea of each individual person's thought process in the online environment whereas it was easier for some students not to participate in a traditional teacher-centered class. She also felt that the mediated environment seems to encourage better interaction because students do not have the traditional distractions that they may have in a face-to-face environment. Students have an opportunity to really think about what they want to say before they post it to the conferencing system, and this seems to enhance the quality of what they have to say. Further, every student has an opportunity to contribute to class discussions in this online environment and they tend to write and communicate freely with the teacher using the medium of chat or e-mail. The teacher mentioned that from past experience, it is only students who are new to the conferencing environment who are usually reluctant to initiate online conversations with her. When questioned, they said that they did not want to interrupt whatever she was doing. She mentioned that she now usually makes it a point to initiate contact with students via chat when they are logged on simultaneously and let them know that she was available if they needed help. This clarified things and encouraged them to communicate with her if they needed help.

In spite of the fact that she needs to put in extra effort, the online course has somehow brought the teacher closer to her students. She is able to relate to the distant students and feel close to them because she can

communicate individually with them and understand problems that they might be having. In the online setting, the teacher has an opportunity to interact with all students in the class unlike her traditional class where only certain students communicated with her. Students also concurred with this viewpoint. The following is an excerpt from an evaluation that one of the students wrote:

Student 1: I think that I learned more in this class than I would have in a traditional setting. In a traditional setting, I would not have interacted with the instructors and students as much as I did. Also, I would not have had as much time to work on the assignments, do research and read, as I did in this class. I often find that the research and reading get pushed aside when I am in a traditional course, but this did not occur in this class.... I would also like to thank the instructors for their timely feedback. I found it very useful to be able to chart my progress and to get such specific feedback.

Students feel very involved with the online class and relate to it in a different manner. An important factor that may contribute to involvement, is course structure. Students were required to participate in group-discussions and collaborate with group members. Requiring students to take responsibility for what happens in the classroom environment and providing close interaction with faculty seems to foster a sense of commitment in the students:

Student 2: I also enjoyed collaborating with group members. I felt more responsible for my participation in the course and felt that I "influenced" the course in some way.

When teachers participated in online discussions and were simply present online, they felt that students were more satisfied and participated actively in the conferencing system. The students felt that the teacher was more 'present' and available for them, and consequently, the teacher was able to get more out of the students. Both teachers and students felt closer to one other and were able to share thoughts and ideas. They contend that while this might also happen in a traditional class for some students, all students in a distance course would have the opportunity to experience this closeness. Another student expressed her thoughts:

Student 3: There were many things I liked about the course. I liked being able to talk to ____ (the teaching assistant) a lot. I found him very reassuring. He helped to alleviate my fears. Whenever, I had a problem, he was always a chat command or e-mail away. He also made sure not only to chat with me about class-related elements, but also about more personal things such as the topic of his dissertation and his future career plans, making me feel like he cared about more than my academic progress. I think this is very important for instructors to do, and I try to do it myself.

The teacher had a teaching assistant who helped her immensely in teaching the course and in administering the conferencing system. This was an important factor because it gave her the opportunity to focus on facilitating the course and spending a good amount of time interacting with students. The teaching assistant helped out with all aspects of the course, particularly in grading assignments and responding to technology related among other things. The teacher and the assistant shared their responsibilities, so that the assistant focused more on administrative, technical functions, while the teacher maintained a general overview and conducted most of the other activities related to the course.

In analyzing the data with regard to time, it is interesting to note that in a traditional course taught in the summer, teachers would have to spend a total of about 75 to 100 hours on the course. In this online course, however, teachers spent two to five times as much time. Another interesting pattern noted was that the teaching assistant spent more than twice the amount of time the teacher spent on the class (377.75 hours versus 98.83 hours spent by the teacher). In fact, looking at the data collected with regard to the amount of time that the teacher spent, 30.83 hours was spent interacting with students. In contrast, the teaching assistant spent 94.16 hours interacting with students. It is obvious that the teaching assistant spent a greater amount of time on the course, even though percentages of time spent look very similar. This could have been partially due to the fact that the assistant was a younger and more inexperienced teacher. Thus, he needed to spend more time teaching and preparing for the class when compared to the experienced teacher. It probably also had something to do with the personality of the teaching assistant. The assistant loved to work online and was logged in even at times when he was not required to be. Thus, when students logged in, they always had an opportunity to interact with him via chat or e-mail. Looking at percentages of time spent in the various activities pertaining to the class, it was interesting to note that both teaching assistant and teacher managed to constantly remain in touch with each other and the students even when they were located physically in different states.

A study of the patterns of time spent indicate that teachers spent more time on administration and planning than in the area of interaction. Further, since the class required to students to participate in online discussions, teachers spent a lot of time reading these discussions and contributing to them. Overall, the online course required at least two teachers for a group of 17 students. They also had an intern who helped in posting assignments on the web. One reason why online courses need so much time may be because of the fact that these courses need to be constantly updated. Teachers noted that online courses need a lot of work even if they had taught the course in a similar format earlier. Teachers required students to use Internet resources for the course and they agreed that

updating online resources was a time-intensive task. Interaction with students and administration also involved a lot of work. In spite of having to spend the extra time on the course, teachers like to teach in this format. One important reason for this was flexibility. Teachers can teach the course from anywhere and they have the ability to reach students asynchronously at any time via e-mail. Thus, they could complete their responsibilities at their convenience. Flexibility was an important factor for students also, as indicated in their course evaluations. Teachers felt that this flexibility enabled students and teachers to experience a better quality of learning and teaching. This viewpoint is evident in the following excerpt from an interview with the teacher:

Teacher: Well, I think it is much more time intensive, but I like the quality of time better. I think that if I compare the two, going to class once a week, and having office hours, I interact with a lot more students individually. The only people who came into office hours were people who were on campus. Most people were not going to make an effort to come to campus to appear at an office hour. So, generally, I got to know some students really well in a face-to-face classroom. But if I had to go back now and teach these courses once a week and that was the only contact I had with the students, I wouldn't be very happy.

Most students liked the course once they got used to the technology and the format. This is evident from another student evaluation:

Student 4: I also think that once you become comfortable with a new environment it is difficult to go back to the traditional learning environment without feeling some dissatisfaction. Once you know and experience other possibilities you tend to want to continue to have those options. Before the experience there was nothing to compare... I would definitely take another distance learning class. In fact, given a choice, I am sure I would choose this format over the traditional classroom environment.

Teachers and students feel that they got to know each other well during the course of the class. This helped students build a rapport with teachers and contributed to their course participation. Considering the pros and cons of teaching in an online environment, teachers perceived that it was worthwhile to put in the extra effort to teach such a course because it afforded them flexibility and brought them closer to their students. This closeness consequently seems to enhance student participation and satisfaction with the course as evaluated based on course evaluations.

Assertion 2: Teaching style, personal philosophy and background of a teacher affect course design and student-teacher interaction in an online course.

Teachers have particular teaching styles and this affects everything they do as teachers. Teachers have various reasons for adopting a particular style of teaching. It was important for the teacher of the course under study to get students involved and actively engaged in the course. Her teaching philosophy directly affected the way she designed the course. Her personal teaching style influenced by her educational experience and background had a profound effect on teaching style.

Teachers have various reasons for adopting a particular style of teaching; even a specific method of using technology as a medium of teaching. The participant in the study did not outline instructional objectives and select appropriate learning experiences systematically at the beginning of the course; nor did she identify a static body of information that she would transmit to students. She took control of the fact that she was having problems with her face-to-face class and decided to re-structure the class so that it was more student-centered. The following excerpt from her interview underscores this feeling:

Teacher: There is something missing with my teaching in face-to-face class. I can go into a classroom and it is really great and I have all these lectures prepared, and I used to do those cooperative learning exercises...I always felt that they were a little contrived. I was always trying to plan how to involve people and get them going and at the end of it, I felt good about the class, but I could see people yawning and nodding off, and not always participating and that always frustrated me; because I thought 'why are they sitting here and not doing something?'

It bothered her when she found that students were not actively involved in the learning process. A socio-cognitive constructivistic approach to learning emphasizes that learning is an active and evolving process. Learners are constantly engaged in integrating new information into existing knowledge structures. Through the on-going interaction between teacher and student, development of meaningful, valid and increasingly complex knowledge structures are encouraged. This demands two-way communication where students attempt to explain their interpretation and listen to others' understanding. The teacher in the study believed that it was important for her to get students involved in the course, and actively engaged in the learning process. She also wanted flexibility in what the students learned as well as how they learned. This fits in with the Deweyan notion that children learn both inside and outside of school (Dewey, 1938). In this situation, students are literally learning outside school. Being physically outside the school, they are able to bring their outside experiences into the classroom.

While the teacher used flexible learning strategies, there is a paradoxical need for her to maintain control of the classroom. From her personal experience, this teacher believed that an organized learning environment was not

necessary for students to learn because students would learn when they found the need to learn something that is of interest to them. Yet, at the same time, the teacher had a personality that wanted to be in control of the learning environment. The teacher provides reasoning for this by providing information about her own educational background. The following is another excerpt from her interview:

Teacher: We moved every year. I went to 13 or 14 different schools and one year we moved in May and I went to another city and another school and I wasn't doing the same work they had done and so they put me back, so I had to do fifth grade again. I was so humiliated. So I repeated fifth grade. Then we went to Switzerland. In sixth grade I did about 2 weeks of school. My mother was supposed to home teach me, but she didn't manage to, and so that was a whole loss of a year and at the end of that year, we moved back to NY and I had 2 weeks of school and again, it was the end of this year, and I was in 6th grade. They just went ahead and put me in 7th grade the next year and I was there for 2 weeks and they put me in 8th grade. So I basically repeated 5th grade twice and the next class I was in was the 8th grade. So I had a very unconventional education and basically felt that whatever I needed to know, I learned, whenever I wanted to learn it. So I felt that organized education was a big waste of time. And I am sure that is what underlies my whole philosophy and why I like this medium. Although it is organized, there is flexibility for the students to work through it...Again, the distance ed. courses that are not successful, are the ones that are not very well structured.

The teacher borders on extreme child-centered learning here. She relates her personal experiences and believes that she learned a lot even without a so-called structured education. She however qualifies her experience and relates it to the new technological environment that she teaches in. She is quick to point out that structure is an important component of the distance education metaphor. She therefore believes that having structure is important in a course, again consistent with the holistic paradigm. Structure, in this context is different from control. Control is determined by a single authority figure, whereas structure can be emergent. This teacher provides flexibility inside an organized environment and underlies the fact that structure is different from chaos. For example, she allowed students to select questions for discussion, given a general topic area to work with. Thus, some of the content of learning is also emergent. Dewey believed that it is miseducational for teachers to impose content on the learner (Dewey, 1938). The teacher also realized this. She wanted students to see the relevance of what they were learning. Yet, she reserved final judgement on what they learned. This is again an important indicator that the teacher's position with regard to content was close to critical democracy (Goodman, 1992).

In warranting the above assertion, the researchers examined the data and found that this teacher believes in providing the students with the ability to learn flexibly. Her epistemological position may be identified as 'phenomenological'. She had structured her course in the transaction position (Miller and Seller, 1985). In the transaction position, the student is seen as rational and capable of intelligent problem solving. Education is viewed as a dialog between the student and the curriculum in which the student reconstructs knowledge through a dialogical process. The historical antecedent is the period of the Enlightenment, and the influential people most closely allied with the transaction position, according to Miller and Seller, are Horace Mann, John Dewey, and Jean Piaget. The teacher provided opportunities for students to collaborate with each other and structured appropriate learning experiences in the form of group discussions conducted through the conferencing system. Further, the teacher encourages (on certain weeks even requires) students to discuss some aspect of the learning content among themselves.

There is a strong emphasis on giving the students an opportunity to interpret what they learn. Meaning-making is again central to the holistic tradition. Dewey believed that the role of the teacher is to 'guide' the educational process, not 'teach' it. This teacher encouraged students to explore topics within the general area of learning. Although she gave students the opportunity to choose what they wanted to learn (negotiation), the negotiation was allowed within the framework of content and structure provided by the teacher. Yet, this teacher thought that her personality was oriented towards being more of a controlling person. She mentioned that although she likes to take control in a traditional class, she made a special effort not to do that in the online class. Therefore, she achieved a delicate balance between control she exerted on the curriculum, and flexibility that she allowed students in the online medium.

The learning experience provided in an online environment is therefore determined by the type of activities encouraged in the class. The teacher determines these activities and other aspects of course structure. The teacher's personality and background have a bearing on her ideas of what learning is and her epistemological position. Consequently, this has influence on the way the teacher designs her course and the activities that she includes in the online learning environment. Again, course structure also has direct bearing on the role the teacher takes on in an online class and the time she spends on it.

Conclusions

The lack of communication between student and teacher in the distance education environment is one of the most debated topics in the field. Although the characteristics of each technology affect the ability of participants to communicate, the choice of the technology to be used in the class was a personal decision made by the teacher of the

course. While a conferencing system provides a means of communication, simply having the means of communication does not mean that effective communication takes place. One needs to assess the type and quality of interaction that does take place using these media. The course that I observed uses computer conferencing as a medium of delivery to ensure that students have an opportunity to interact with the instructor. The success of such a system would depend on the quality of the feedback that the teacher provides, and learning environment the teacher creates for the students. The implementation of such a system does not guarantee a better quality of learning, it at least opens up an avenue of communication between teachers and students. This again underscores the idea that philosophy and personality are definite factors that determine how teachers structure their courses. The teacher's beliefs guided her in the process of course design; therefore, her teaching philosophy affected the way she has designed the course.

A recent naturalistic research study (Annand, 1998) that examined six instructors' experiences with computer conferencing, documented how these instructors understood the educative process in computer conferencing and its relationship to themselves and their students. The findings reveal that instructors' varied personal philosophies of learning were foundational in delineating their relationship with the technology. But other aspects, such as recognition of students' learning styles, the instructors' repertoire of preferred pedagogical strategies, and the discourse patterns privileged by computer mediated communication (CMC), were also important influences in their understanding of students' computer conferencing practices. In the present study, the teacher's philosophy, personality, and technology create a complex interplay of factors that influence how the teacher structures her course. Her beliefs guided her in the process of course design; therefore, her teaching philosophy affected the way she designed the course. The technology she was using to teach the online class also had an undeniable effect on how she taught her distance class.

Teachers who teach the online course perceive the need to do a lot of additional work for such a course. While they could have spent less time teaching the online course, they felt that the amount of time spent contributed to a worthwhile teaching experience. This was mainly because the online metaphor gives students and teachers great flexibility in terms of participation. Also, students were more satisfied with the course and participated actively in the conferencing system because they felt that the teacher was more 'present' and available for them, and consequently, the teacher felt that she was able to get more out of the students.

In conclusion, structure and dialog are inherently related, as pointed out by Moore (1991). Further, teacher personality, emotions and philosophy are factors that affect course structure in an online course. Dialog, of course, relies on the ability of the students to interact with each other and the teacher, but dialog needs to be fostered and nurtured by the teacher. Interaction has to occupy an important place in the design of the course and only the teacher can give it such a status by making it a priority. All decisions she makes with regard to the structure of the course have a direct impact on dialog. It would be interesting to examine the degree to which teacher personality is a factor that determines course success regardless of the limitations and structure imposed by technology and other factors.

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EFFECTS OF FACULTY MOTIVATION IN DISTRIBUTIVE EDUCATION ENVIRONMENTS AT INSTITUTIONS OF HIGHER EDUCATION

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As the distributive education environment (DE) grows and develops many changes in current administrative policy and faculty approaches to instruction will need to evolve to accommodate this method of delivery. Distributive education is a form of instruction that is dynamic, using many modes of delivery. This delivery may be synchronous or asynchronous and takes into account alternative methods available to the faculty (internet, lecture, video, audio, etc.). However, utilizing these alternative methods usually requires a more demanding workload for the faculty. The heavier workload is a result of designing, developing, implementing, and evaluating the materials delivered via DE.

This research will attempt to evaluate three factors that may underlie faculty resistance to distributive education:

1. Difference in motivation in faculty according to career status (junior, senior, departmenthead),
2. Difference in Administrative and faculty perceptions of reward structure, and
3. Difference in motivation to teach via distance (intrinsic and extrinsic).

Research suggests that these themes are recurring in institutions of Higher Education (Blackburn & Lawrence, 1995). Blackburn's findings neither support nor reject themes one and two. Blackburn suggests that faculty call on one or the other reward system depending on factors and circumstances neither theory alone adequately takes into account. Blackburn also suggests that socialization is a recurring, if not continuous, phenomenon. Faculty socialization begins in graduate school and continues throughout their career. Senior faculty, administration, and other cultural factors of the institution indoctrinate faculty. If the faculty changes institutions re-socialization often happen.

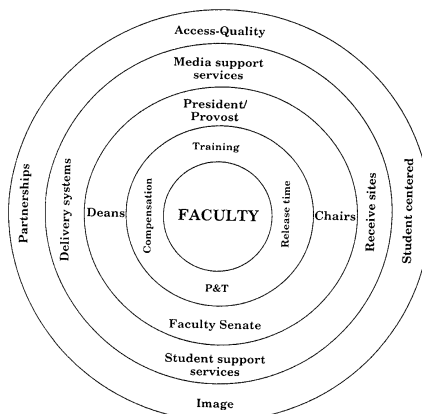
The resources necessary for successful development and implementation of DE are not the focus of this research. This research examines the chief factor underlying effective instruction, the faculty. A primary barrier determining the future of DE may be the faculty's attitudes, perceptions, and willingness to use technology. The intention therefore is to determine if a link exists between motivation and the use of technology. There appears to be a need to increase the intrinsic motivations of faculty to use the technology; therefore, minimizing the cost of extrinsic rewards (Deci, Eghrari, Patrick, & Leone, 1994). Increasing intrinsic motivation and decreasing extrinsic rewards may lead to higher perceived self-efficacy.

"Judgements of one's capabilities can affect rate of skill acquisition, and performance mastery, in turn, can boost self-efficacy in a mutually enhancing process", (Bandura & Schunk, 1981).

Cultivating faculty self-efficacy may produce higher quality instruction and increase faculty and institutional efficacy (Newman & Tuckman, 1997). If this has some truth, then efforts in developing faculty motivation must emphasize the importance of faculty and institutional efficacy. Olcott's research supports this assertion.

Don Olcott's Institutional Support Framework (Olcott & Wright, 1995) examines an institutional faculty support system. The framework consists of structures ranging from evaluation, modes of delivery and support, administrative duties, reward systems, and faculty. The framework has five levels represented by rings.

In this article, the focus is on the three innermost rings of Olcott's framework. The commonality that binds



this structure is their direct effect on faculty motivation. The core of the structure represents the faculty.

The next ring represents promotion and tenure, compensation, training, and release time. The rings described above can be utilized to help the faculty internalize the extrinsic rewards each represents. The internalization can have positive effects on self-efficacy.

The administrative bodies are best able to deal with institutional efficacy. The outermost ring of our focus represents faculty senate, deans, president/provost, and chairs. The outermost rings are bodies that may effect faculty motivation. Once the institution believes that faculty motivation is of critical importance to its growth and development, then the change permeates the institution in a top down approach. This change will be reflected in the second ring of Olcott's framework.

"Despite the recent expansion of distance education programs, many faculty continue to resist participation in distance teaching. We assert that this resistance has been due, in large part, to the lack of an institutional support framework to train, compensate, and reward distance teaching faculty at levels commensurate with those in traditional instructional roles"(Olcott & Wright, 1995).

To maximize faculty participation their personal motivation must be increased to a level of satisfaction. To minimize the cost of externalities (money, time, etc.) the reward structure must lend itself to cultivating intrinsic motivators and internalizing external motivators (Bandura, 1991). A person is intrinsically motivated when no apparent rewards are received except for the activity itself. Intrinsic motivation might be either innate or learned. Education is generally said to be an intrinsically motivated profession. Many primary and secondary educators have been known to work in precarious environments, educating children despite obstacles and adversity. For them, teaching in such conditions is worth it even if only one child leaves more knowledgeable than when they began. Their gratification does not come in the form of salary or benefits; their reward comes from the act of teaching. On the other end of the continuum we have external rewards. External rewards tend to reduce intrinsic motivation (Deci, 1971). In addition, the administrators must take on a significant role in supporting the reward structure with policy and finance.

Faculty motivation is a topic that has re-emerged out of an attempt to restructure the institution of education to fit the non-traditional method of instructional delivery commonly known as distance education (Clark, 1993). Faculty have always been considered an invaluable resource, but often our most precious resources are neglected and taken for granted (Dillon & Walsh, 1992). Findings from a study by Taylor & White (1991) suggest that faculty are generally motivated by intrinsic rewards rather than extrinsic rewards when evaluating the benefits of distance education. They studied an Australian higher education institution, where faculty is required to work in the conventional face to face setting as well as to prepare materials for use by distance education. The findings suggest that faculty derived job satisfaction from teaching via distance education. The following five ratings were consistent in importance in terms of faculty attitudes toward teaching in the distance education mode: quality of interaction with students; working with motivated students; satisfaction from the act of teaching; feeling of personal achievement; and high level of student outcomes (Taylor & White, 1991).

Attitudes of American faculty in higher education institutions are consistent with Australian faculty.

In a study of telecourse faculty at an American university,

"A few faculty will continue to utilize telecommunications to teach students at a distance for a variety of personal reasons, ranging from diversity of experience to an altruism toward the nontraditional learner" (Dillon, 1989).

This quote supports the view that a few faculty members are intrinsically motivated to teach, whether an external reward is provided or not. However, this does not mean that teaching does not require external rewards.

In a survey of 317 faculty, thirty seven percent of faculty expressed a belief that they would not be adequately rewarded for their efforts in distance education (Clark, 1993). A national study of 4,000 full-time, tenure track faculty generally agreed that research is heavily rewarded in merit pay increases, tenure, and promotion decisions (Fairweather, 1993). It also shows faculty believed that adequate teaching is a necessary but not sufficient condition for tenure. Therefore, faculty has a motive to avoid devoting extensive amounts of time to teaching (distance education, lecture, etc.) (Kasten, 1984).

Barriers (lack of time, increase in workload, technical problems) to distance education may contribute to the decline of faculty motivation (Dillon & Walsh, 1992). Faculty may create their own barriers to using distance education; therefore, directing their efforts to other aspects of academia:

"It also appears that faculty career stages do not allow for any adoption to occur, either. For faculty in the early entry and career stabilization stage, the importance of obtaining tenure dramatically outweighs the experimentation with a questionable and little researched teaching innovation. The midlife stage faculty does not accept the thought of style of teaching in front of a classroom that has taken several years to develop and has rewarded them with the necessary tenure and promotions. The senior life stage faculty is no different. The senior professor realizes that a high merit increase closer to retirement is more important than a change of a teaching style" (Koontz, 1989).

It appears that in order to get faculty to incorporate DE into their method of instruction their motives must change. This leads us to explore research in the field of motivation.

To begin we will examine the research surrounding intrinsic motivation and extrinsic rewards. Intrinsic motivation and extrinsic rewards are extremely important in the struggle to overcome the barriers to DE. In order to facilitate the growth and development of DE a balance between the two is needed. The research has shown that offering extrinsic rewards may diminish intrinsic motivation (Deci, 1971). However, research has also shown that extrinsic rewards may also increase intrinsic motivation when linked to goals (Heyman & Dweck, 1992). Goals setting theory states that common human behavior is purposeful; therefore, regulated by an individuals (Latham & Locke, 1991). Goal setting has at least three attributes of motivated action: (1) direction: goals are directed by relevancy of action, (2) intensity: effort is regulated or expended accordingly to difficulty of goal, and (3) duration: goals are effected by time (Latham & Locke, 1991). Goal setting and motivation research shows that proximal (immediate) goals can develop self-efficacy and intrinsic motivation (Bandura & Schunk, 1981). It has also been shown that personally setting distal (distant) goals can have a positive effect on intrinsic motivation (Manderlink & Harackiewicz, 1984). Distal goals can increase institutional efficacy if the leaders provide them to their employee's and use proximal goals as benchmarks (Latham & Locke, 1991). Participant modeling with verbal persuasion can promote self-efficacy and task performance (Newman & Tuckman, 1997).

Methodology

This research utilizes a survey to gather data about faculty motivation towards distance education. Indiana Higher Education Telecommunications System was chosen as the group to sample. Because this group reflected characteristics of the target population of the study which included; 1) people in higher education, 2) that were involved in distributive education environments, 3) and were in both administrative and faculty positions. The sample for the study was selected from a list of statewide technology users (Faculty and Administrators) who subscribe to Indiana Higher Education Telecommunications Services (IHETS) for delivery of instructional services. IHETS services include internet, video down link, and audio-graphics. IHETS maintains a distribution list of administrators and faculty that use their services.

The questionnaire was distributed via E-mail and included both the closed-form which permits limited responses (multiple-choice questions) and open-form. The open form allows any comments that the participant may want to contribute. The survey methodology was chosen because of its usefulness in data collection. It allowed for the distribution of the same instrument (questionnaire) to all of the participants of the study. The questionnaire also aided in the data analysis strategy chosen. A descriptive research strategy was employed to summarize the data collected. The data collection instruments were delivered via electronic mail to an IHETS distribution list of faculty and administrators. Approximately two hundred people subscribe to this distribution list. At the time of the survey, the administrator of the listserve confirmed that only fifty to seventy-five of the two hundred subscribers were active participants. Thirty-two people responded to the survey, of the respondents thirteen were usable. Surveys that were incomplete were not used. Faculty and administrators from eight higher education institutions in the state of Indiana actively contribute to the listserv. This listserv is a place that subscribers can discuss issues surrounding distance education. An invitation to participate (Appendix A) in the study was sent to the distribution list followed by a survey questionnaire (Appendix B).

The survey was created using a couple of strategies. First, a collection of previous surveys and questionnaires were analyzed and then synthesized into an instrument that was then pre-tested with two faculty members. Secondly, the results of the pre-test were taken into consideration and the assistance of a campus research statistical service was employed. The result of which was distributed to the participants of this research.

The collection device (questionnaire) centered around three themes: faculty demographics, job satisfaction, and early socialization. Faculty and administrators were asked to respond to the questions and return them in a relatively short period of time, approximately one week. During that time frame, reminders were sent to expedite the return.

Quantitative methods of data analysis were employed to synthesize results. Statistical Package for Social Science (SPSS) was used to collect and analyze the data. The following statistical functions were used to give an accurate description of the data collected and analyzed frequency distribution, factor analysis, and t-Test. Three statistical procedures were used frequency distribution, factor analysis, and t-Tests respectively. Frequency distribution more commonly known as frequency count recording is defined as the measurement of the number of times that each observation variable occurs during an event (Borg, Gall, Borg page 760). Secondly, in an effort to narrow the scope of variables a statistical procedure called factor analysis was applied. Factor analysis is a statistical procedure for reducing a set of measured variables to a smaller number of variables (called factors or latent variables) by combining variables that are moderately or highly correlated with each other (Gall, Borg, Gall page 759). Third, a t-Test is a test of statistical significance is used to determine whether the null hypothesis that two sample means come from identical populations can be rejected (Gall, Borg, Gall page 772). Statistical significance is evaluated by the power that it holds. The term power refers to the ability of a statistical analysis to reduce Type II errors. Higher power tests are more likely to find statistical relationships when there is one (Vockell & Asher, 1995). We will discuss our views and discoveries resulting the methodology employed.

Discussion and Analysis

Faculty motivation is not a new topic; however, its is an old one that has been rejuvenated in light of distributive education. In order for DE to take a stronghold in education the primary resource (faculty) must adopt it and implement it into their pedagogy. This change creates a need to find the source of faculty motivation. Our restated question is "What effect does DE have on faculty motivation"?

In answering the above question an evaluation of three factors was conducted:

1. Difference in motivation of faculty according to career status (junior, senior, departmenthead),
2. Difference in Administrative and faculty perceptions of reward structure, and
3. Difference in motivation to teach via distance (intrinsic and extrinsic).

Below are distributions that are supportive of the evaluation factors:

Table 1 Rank

RANK	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Non-tenured	3	23.1	25.0	25.0
Tenured	8	61.5	66.7	91.7
Administrative	1	7.7	8.3	100.0
Total	12	92.3	100.0	
Missing System				
Missing	1	7.7		
Total	1	7.7		
Total	13	100.0		

Table 1 shows that 23.1% of the respondents were non-tenured or junior faculty, 61.5% were tenured, and 7.7% were administrators.

Table 2 Motivation

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Intrinsic	8	61.5	66.7	66.7
Extrinsic	4	30.8	33.3	100.0
Total	12	92.3	100.0	
Missing System				
Missing	1	7.7		
Total	1	7.7		
Total	12	100.0		

Table 2 gives us a little more insight in to what their motivations are. Our findings are 61.5% of the respondents say that their source of motivation is personal fulfillment. 30.8% answered that an opportunity to help student learn via DE is their gratification. A total of 92.3% of the respondents provided answers that are in line with our definition of intrinsic motivation. It seems highly likely that the majority of faculty are intrinsically motivated regardless of rank.

In an effort to determine what faculty desired (money, time, assistance, or formal recognition) the most when creating a DE 69.2% responded that time is most desired, followed by assistance, money, and recognition respectively. This supports the idea that faculty are intrinsically motivated. Faculty were also asked, "If you were to leave your job to accept another position, would you want to do more, less, or about the same teaching via distance?", 92.3% responded that they would like to do about the same or more (see Table 3).

Table 3 Amount

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid More	6	46.2	50.0	50.0
Same	6	46.2	50.0	100.0
Less	0	0	0	
Total	12	92.3	100.0	
Missing System				
Missing	1	7.7		
Total	1	7.7		
Total	13	100.0		

Faculty was also asked what were the major support issues that they have encountered at their institution. The majority responded that technical support was the most encountered.

The above frequency distribution analysis gives a foundation upon which we can continue to build our case about faculty motivation.

Factor analysis was used to determine where improvements could be made to the survey questionnaire. Changes were made according to the clusters that were generated using the Principal component analysis extraction method with varimax normalization. Due to the time constraint of the study, the modified survey could not be redistributed to the sample.

Table 4

Rotated Component Matrix ^a			
	Component		
	1	2	3
EXTIME	.761	.125	.234
SFSUP	.747	-.192	-6.65E-02
FASUP	.713	.291	-.297
STSUP	.703	.169	.133
TEREWARD	-.667	6.314E-03	.188
REREWARD	-.615	-.356	-.389
EXASSIST	-.564	.361	.543
ADREWARD	.114	.856	9.282E-02
DEREWARD	-.415	.779	-9.24E-02
TESUP	.233	.677	.143
EXMONEY	-.362	-.628	.533
SEREWARD	.303	.138	.844
EXRECOG	-.165	-.164	.832
MOTIVE	-8.03E-03	-5.57E-02	-.489

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

The Time and Support Factor shows that faculty value support and time in their creation of DE, we can see this factor by analyzing the loads associated with the first six variables. The loads are as follows; .761 (value time to create DE), .747 support (staff support resources), .713 faculty support (major support issue), .703 student support (student support resources), -.667 teaching rewards (institutional reward), -.615 research (institution reward). This information tells us the difference of perception between faculty and the administration. Faculty value and place importance on time and support to create and deliver DE, but the institution rewards research and traditional teaching methods.

The External Reward factor provides us with additional information that shows us the gap that exists between faculty and administration. The loads are as follows; .856 administrative reward (institution rewards), .779 distance education reward (institution rewards), .677 technical support (major support issue), and -.628 money (value most in creating a DE course). Money has a negative load value, this may be interpreted to mean that in regards to other factors the reward of money does not outweigh the reward of factors (time, assistance, and recognition) that support the development of internal motivation.

The loads associated with the Service and Recognition factor are; .844 service reward (institution rewards) and .832 recognition (value most in creating a DE course). These loads show that faculty also value performing service and being recognized for their efforts in DE.

Our analysis of the factors paints a picture that is quite easy to interpret. The reality of the problem is that faculty and administration have different perceptions of what is important to each other. The faculty values time and assistance when working in DE. On the other extreme administrators value things that are institutionally rewarded, such as research and how many students are in the classroom. However, we must not stop here further analysis need to be done to sharpen our focus.

Third, a t-Test was applied to the data to test for significance. Although, t-Tests were conducted no significance was found. This can be attributed to lack of power due to a small data pool. However, this does not mean that the study is not significant. It does mean that further research with a larger data pool must be conducted in order to verify significance. The results from the frequency distribution and factor analysis tests lend credence to a strong possibility of significance. Currently, we can only suggest that with a larger data pool statistical significance would be the result.

It appears that faculty are intrinsically motivated to teach in DE. This finding should not determine the end of Administrator and Policymaker efforts to create a fair and equitable environment for faculty. Administrators and Policymakers should take this opportunity to create an atmosphere that fosters intrinsic motivation. This does not imply that faculty are not concerned with promotion and tenure or other external rewards. The reality is that external rewards are extremely important to their existence, but personal fulfillment is equally as important. Therefore, Administrators and Policymakers must work with faculty to reach a balance between external rewards and intrinsic motivators (Olcott & Wright, 1995).

Motivation theory supplies a foundation upon which faculty socialization to DE can be built. Motivation offers many theories that may help build institutional and self-efficacy; thereby, increasing intrinsic motivation and internalizing external motivators. Theories such as goal setting, participant modeling, and intrinsic motivation can all be used to foster an efficacious environment.

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IMPACT OF INSTRUCTIONAL GROUPING ON NAVIGATION AND STUDENT LEARNING IN A WEB-BASED LEARNING ENVIRONMENT

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Abstract

The development of effective web-based learning environments requires careful assessment of the impact of design variables on student learning. The present study investigates the effects and interactions of web-page design on student navigation and decision making in web-based learning environments. The following research questions are examined via quantitative, qualitative, and exploratory data analysis procedures:

- * Does instructional grouping or web page format effect navigational decisions in an online learning environment?*
- * Are there differences in the number of unique URLs visited with respect to instructional grouping or web page format?*
- * Are there differences in student attitude toward instructional grouping or computer-mediated instruction?*
- * Are there differences in quality of students written language with respect to instructional grouping or web page format?*

Fifty undergraduate students enrolled in an introductory educational survey class at a large southwestern community college served as subjects. Each subject was randomly assigned to one of four groups; cooperative learning with advisement, cooperative learning without advisement, individual learning with advisement, and individual learning without advisement. Subjects participated in computer mediated instruction employing Internet resources (World Wide Web) to gather information and compose an essay. Analysis of Variance and Chi Square procedures were applied to assess the relationship between independent and dependent variables. Significant differences were observed between instructional arrangement with regard to navigation (number of sites contacted and number of returns to the homepage). An interaction between instructional arrangement and homepage design was observed with regard to navigation. No significant differences with respect to attitude and performance were observed. Implications for instruction, navigation, and interface design are detailed. Areas for further research are presented.

Theoretical Framework

The theoretical basis for this comparison is grounded in the literature on cooperative learning, computer-mediated instruction, and learner control within hypertext environments. From a social cognition perspective, when students interact with their peers they are faced with ideas, explanations and information that are inconsistent with, or contradict, their prior knowledge and beliefs. Confronting these inconsistencies and contradictions challenges learners' current point of view, and resolving such cognitive conflicts results in cognitive restructuring (Bearison, 1982). When students receive new information from peers during group work, they presumably add detail to their existing cognitive schemas, explore and correct their misunderstandings, fill in gaps in their knowledge, and/or reorganize their knowledge structures (Bearison, 1982; Piaget, 1963; Vygotsky, 1978). During peer interaction, students are exposed to new strategies, terminology, and ways of thinking about problems; these experiences can restructure their own thinking, which may in turn affect their problem-solving behavior. From a social modeling perspective, peer interaction provides opportunities for imitation of successful problem-solving behavior. Both of these theoretical perspectives can cause changes in students' levels of competence as a result of peer interaction in small groups (Vygotsky, 1978).

Cooperative learning (CL) refers to instructional methods in which students are assigned to work in small, intentionally selected groups in which they are responsible both for their groupmates' learning (interdependent goal structures) as well as their own (individual accountability) (Mainzer, Mainzer, Slavin, Lowery, 1993; Stahl, 1994). One of the basic components of cooperative learning is a common concern or goal shared by the group of students, with each "team" member having a specific objective to be attained in cooperation with other group members. In CL, each member of the team, as well as the total group effort, is assessed in terms of productivity. Group success is typically assessed in terms of the supportive, contributive, and shared efforts of each team member toward the group attainment of a final outcome. CL provides for individual differences by enabling members to help one another to achieve the group goal (Slavin, 1982). Research indicates that students completing CL group tasks tend to have higher academic test scores, higher self-esteem, greater number of positive social skills, and greater comprehension

of the content and skills they are studying, than those in traditional instructional situations (Johnson, Johnson, & Holubec, 1993; Johnson, Johnson & Smith, 1991; Slavin, 1991; Stahl, 1994; Stahl and VanSickle, 1992). In most CL situations, students are working in groups of two or more, mutually searching for understanding, solutions, and meaning, and/or creating a product. This emphasis on academic success/learning for each individual as well as for the group or team as a unit is one feature that distinguishes cooperative learning groups from other group tasks (Slavin, 1991; Stahl, 1994).

Little experimental research has been conducted on the use of cooperative learning in higher education. Dansereau (1988) examined the effect of cooperative learning strategies with university student and found that students gained more from learning in pairs than from working alone. Learning through interaction also transferred to individual achievement. Sherman (1986) used cooperative learning methods with university students enrolled in psychology courses, finding no significant differences on measures of achievement. Students in cooperative settings, however, rated their experiences more highly than those who were not in groups. Davidson (1990) reported similar results with college mathematics students. Frierson (1986) reported that nursing students studying cooperatively achieved higher scores on state nursing exams than a control group studying independently.

At the University of California, Berkeley, enrichment workshops were formed that used cooperative learning techniques for in-coming African-American mathematics and science majors (Treisman, 1985). Grade point averages, retention rate and graduation rates were higher for students in the cooperative learning workshops than for a control group of students. In a meta-analysis of approximately 100 studies conducted with subjects at the college level, Bligh (1979) found that students who had in-class opportunities to actively interact with the instructor and with each other reported significantly higher levels of satisfaction with their learning experience than students in classes taught exclusively by the lecture method. Kulik and Kulik (1979) reported similar findings in their expansive review of the literature, concluding that students involved in classes which made use of discussion groups were more likely to develop positive attitudes toward the subject matter of the course (Cooper et al, 1990).

Although, research addressing the use of CL at the college level is somewhat limited, results to date are very consistent with those reported in pre-college settings (Cooper, Prescott, Cook, Smith, Mueck, & Cuseo, 1990, Johnson & Johnson, 1989; Johnson, Johnson & Smith, 1992). Procedural elements, which are critical to the effectiveness and ultimate success of CL, include:

- positive interdependence of group members (a feeling that the goal cannot be accomplished without everyone's involvement),
- face-to-face promotive interaction (engaging each other in an encouraging, supportive, and useful manner),
- individual accountability and personal responsibility (individual evaluation is contingent on individual performance),
- interpersonal and small group skills (knowledge and ability to perform functional group roles) and group processing (examining the workings of the group relationship) (Cooper et al, 1990; Johnson et al, 1989, 1992; Johnson et al., 1991; Stahl, 1994).

Because of limited access to computers, assigning groups rather than individuals to work at computers has been common practice in classrooms of all grade and academic levels for some time. Becker (1984) found in his national survey of k-12 schools that teachers assigned students to groups to work individually with computers 46% of the time. Several studies addressed group work with computers, finding group activities to facilitate positive peer interactions (Fisher, 1984; Mevarech, Stern, & Levita; Webb, 1984) and encourage social modeling (Johnson & Johnson, 1985). Students completing computer-mediated instruction in cooperative groups perform as well as and often better than students working alone (Carrier & Sales, 1987; Dalton, Hannafin, & Hooper, 1989; Hooper, 1992; Johnson, Johnson, & Stanne, 1985; Mevarech, Silber, & Fine, 1991; Shlechter, 1990). Within the past decade, research in the area of computer-mediated instruction (CMI) has demonstrated the positive effects of this method on achievement, attitudes, and learning (Mevarech, Stern & Levita, 1987). In the early 1980's, Kulik, Bangert, and Williams (1983, 1986) reported that 39 out of 48 studies demonstrated the superiority of CMI programs over traditional instruction at the college and secondary levels of education. As indicated in their meta-analysis, CMI students scored .32 standard deviation higher on achievement tests than non-CMI students.

Cooperative CMI involves the instructional use of the computer combined with cooperative learning groups (Johnson & Johnson, 1986). Research has not extensively investigated the impact of cooperative CMI in small groups on students' social development, especially with adult learners. Studies involving highly structured cooperative learning settings have found that students using cooperative CMI perform better on achievement tests than students using CMI individually (Carrier & Sales, 1987; Johnson & Johnson, 1985). As both computer-assisted instruction and cooperative learning have demonstrated positive effects on student attitude and achievement (Kulik et al, 1983, 1986; Slavin, 1980), the two strategies when combined hold potential for a robust instructional strategy (Kacer, Rocklin, & Weinholtz, 1991).

The presentation of the information in a computer-mediated setting can greatly influence student achievement. Early promoters of hypertext hailed it as a revolution in learning, allowing one to combine linear study with self-exploration and chance discovery. Some researchers believe that the organization of human memory is in

the form of associations between concepts and ideas, much like that of a hypertext document (Beasley & Lister, 1992). The use of hypertext documents may improve comprehension and learning by focusing on the relationship between concepts and ideas instead of isolated facts (Johassen, 1988; Kearsley, 1988). Several studies lend support to this theory by suggesting that comprehension can be improved when the material to be learned is presented in such a way that the learner has some degree of control over its sequence (Friend & Cole, 1990). Due to its flexibility, and the degree to which learners are forced to take an active role in their own learning, hypertext is attractive to educators who view the ideal learner as self-motivated and self-directed (Shin, Schallert & Saveny, 1994). Learner control is a commonly used in reference to instructional design that allows a student to make instructional decisions (Park, 1991; Shin et al., 1994). Reigeluth and Stein (1983) suggested that instructional effectiveness and efficiency improve as learner control increases. Learner control nurtures system independence by encouraging students to select and manipulate instruction according to their needs and stimulating them to invest greater mental effort in a task (Federico, 1980; Salomon, 1983, 1985).

Learner control has not been strongly associated with situations in which students work alone (Carrier, 1984; Hannafin, 1984; Milheim & Martin, 1991; Steinberg, 1977, 1989). Learner control appears to be most effective when prior knowledge is high (Hooper, Temiyakarn, & Williams, 1994). However, as indicated by Carrier (1984), students given learner control may not always make "good" choices. Learner control with advisement has been recommended when designing instruction delivered by computers (Carrier, 1984; Johansen & Tennyson, 1983; Santiago & Okey, 1992).

Several advisement strategies designed for improving students' choices under student control have been identified (Coorough, 1991; Goetzfield & Hannafin, 1985; Holmes, Robson & Steward, 1985; Johansen & Tennyson, 1983; Laurillard, 1984). Studies exploring the effects of advisement on learner control have reported that students who received advisement; a) achieved equal to higher scores on achievement tests when compared to non-advisement control groups (Holmes et al., 1985; Johansen et al., 1983; Tennyson, 1980), b) took longer to complete lessons than students in conventional learner control conditions, (Goetzfried et al, 1985; Johansen, 1983), and c) reported positive responses concerning advisement in learner control conditions (Laurillard, 1984).

The specific effects of learner control in cooperative learning groups remain unknown (Hooper, Temiyakarn & Williams, 1994). Students less knowledgeable of computers may function effectively in learner-controlled environments when paired with students who are more knowledgeable. More able partners will provide a model of effective learning that less knowledgeable students can emulate. Coupled with advisement in the learner control condition, these students will show marked achievement. Alternatively, dominate partners may impose their intentions on the group, which may have a negative effect for other members. In this situation, some students may benefit more from working individually than in groups.

The purpose of the present study is to examine the effects of instructional grouping and internet homepage format on student navigation in a network hypertext environment, attitude, and performance.

Methods and Techniques

Fifty undergraduate students (32 female, 18 male) enrolled in an education survey class at a large southwestern community college served as subjects. Students ranging in age from eighteen to forty-two were randomly assigned to one of four treatment conditions; cooperative computer-mediated instructional groups with navigational advisement, cooperative computer-mediated instructional groups without navigational advisement, individual computer-mediated instruction with navigational advisement, and individual computer-mediated instruction without navigation advisement. All students, regardless of assigned treatment received the same instructional content consisting of a twenty minute introductory lesson/demonstration on the basic elements of navigating through internet-based web sites. Following instruction, each subject was assigned randomly to a treatment condition (advisement or no advisement). The screen design of the initial homepages differed in type of advisement provided (advisement vs. no advisement). In the advisement condition students viewed a homepage with directive advisement (Gleason, 1986), which included written suggestions for the student on how to navigate the lesson and a brief description of the hypertext links contained in the page. The no-advisement condition consisted of a home-page containing a list of hypertext links. The specific links provided on both pages were identical. Both pages were designed using the fundamental design principals and visual factors outlined by Faiola & DeBloomis (1988) concerning fonts, spacing, and basic graphic elements. Students were asked to write a brief essay detailing resources and applications available for students with special needs. They were provided with access to web-based search tools as a means of gathering information in support of their essay. Students' essays were evaluated by teachers enrolled in a post baccalaureate/masters teacher training program. Writing samples were assessed via a rubric adapted from the Arizona Student Assessment Program.

After completion of the task students were asked to complete a questionnaire focusing on their opinions and experiences related to computer-mediated activities (Love, 1969)

Dependent variables were navigation, attitude, and student performance. Navigation was assessed by 1) the number of links accessed by the student or group and 2) the number of times each student returned to the main

homepage. The network interface software recorded all hits and returns to a data file. Attitude was assessed through student responses to an attitude questionnaire. Quality of the written product was indicated by score for quality of writing as assigned by peer evaluators. The independent variables in this study were 1) instructional format and 2) advisement. A two (instructional format: cooperative groups vs. individual instruction) x two (advisement: advisement vs. no-advisement) experimental design was constructed to assess impact of each level of independent variable on the dependent variables.

Results and Conclusions

Educational Importance

Classical statistical procedures were employed to investigate the hypotheses. Analysis of Variance (ANOVA) procedures were applied to each dependent variable across levels of independent variable. All tests of significance were evaluated at the $p=.05$ level. The significant positive results in attitude among subjects in the group condition, and lack of difference found in student performance on the writing task across treatments, is consistent with the literature reviewed. Student indicate that interdependence, and the sharing of a common goal or outcome was present in most groups. Previous research indicates that pairing students based on ability, such as low-ability students paired with high-ability students, will show a greater effect on student achievement outcomes Hooper and Hannafin (1988). In the present study, students were randomly assigned to instructional based merely on chance, and no other factors were involved in the placement. Significant findings of the present study involve student navigational choices in a network hypertext environment. The interaction between the independent variables in regards to the number of unique sites visited indicates that students in cooperative learning groups across both levels of homepage format visited significantly more resource sites than students assigned to individual learning conditions. The results of this study indicate a critical need for research to continue in this area. Curriculum designers need to be aware of the influences different settings have on students working in network hypertext environments, this study lays the ground work for this subject to be addressed.

Discussion

The most intriguing findings of the present study relate to the impact of homepage format and instructional grouping on student navigation in the World Wide Web. The interaction between the levels of independent variables with regard to the number of unique URLs visited indicates that students in cooperative learning groups across both levels of homepage format visited significantly more resource cites than students assigned to individual learning conditions. Research geared towards the question of whether these students acquired more knowledge by viewing more homepages is yet to be adequately addressed. One explanation for this finding could be that students who work individually lose interest in the assignment at a faster rate than students working in groups. Conversely, students working individually may be spending more quality time on each homepage they visit than subjects in the cooperative learning group.

The significant positive results in attitude among subjects in the group condition and lack of difference found in student performance on the writing task across treatments is consistent with previous research. Although no significant differences were observed between groups in performance, cooperative learning groups did not appear to have any educational drawbacks. The high attitude scores indicated by the student questionnaires point to a potential advantage of group learning -- it permits the effective instruction of at least twice as many students as does instruction involving one person assigned to one machine. It is difficult to determine why there was not more of a difference between groups on quality of work. Previous research indicates that pairing students based on ability, such as low-ability students paired with high-ability students, will show a greater effect on student achievement outcomes (Hooper and Hannafin, 1988). In the present study, subjects were randomly assigned to instructional based merely on chance, and no other factors were involved in the placement. If subjects had been assigned to groups containing learners of varying levels of knowledge, perhaps a difference would have been found. Also the fact that writing samples were not first tested for sensitivity towards the measures can be another reason for the failure to find differences in student performance.

Diana and White (1994) suggest by combining three "high impact technologies"; computer supported collaborative (or cooperative) work, computer-based learning, and the use of (multimedia) data bases for educational purposes, a kind of educational "Superinterface" will evolve and, in turn, bring dramatic changes in patterns of knowledge transfer in education. Curriculum designers need to be aware of the influences educational and instructional settings have on learners working in network hypertext environments such as the Internet. Instruction need no longer be restricted to the classroom; it may be extended to the virtual classroom or a virtual environment in which learning can take place. A class is made up a virtual community of learners. Time becomes a variable instead of merely a fifty-minute lecture. In a distributed learning environment, the entry point may vary with student preparation. The exit will change depending on the depth of mastery required. The length of the learning activity adjusts to fit the learner's needs, schedule and educational goals. Successfully achieving a distributed learning

environment requires the use of information technology and networked delivery of instruction through both synchronous and asynchronous communication. To create distributed learning environments, institutions must address both human and technological issues through planning, support from the community as a whole, and innovative architecture. The data on student navigation through the Internet has yet to be examined fully in the literature. The present study establishes ground work for future research targeting specific questions which may provide an empirical basis for development effective learning tools in computer mediated network communication environments.

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WHICH WAY TO JUMP: CONVENTIONAL FROG DISSECTION, CD-TUTORIAL, OR MICROWORLD?

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Abstract

The purpose of this study was to investigate and compare the level of initial and long-term retention of frog internal anatomy among seventh-grade students using an interactive CD tutorial, a desktop microworld, and conventional frog dissection. Students' anxiety toward science was also compared across the three treatment groups and between genders. Additional data on the students' preferred learning style were used to explore possible interaction effects with their respective instructional activity.

Subjects participating in the study were all seventh-grade students in one junior-high school, numbering 280 in total. Classes were randomly assigned to one of three modes of instruction. The conventional treatment was traditional physical dissection using a preserved frog specimen and lab dissection tools. The CD-tutorial treatment was the interactive tutorial Digital Frog from Digital Frog International. The microworld treatment was an environment composed of Operation Frog on CD supplemented with other programs and resources to provide additional avenues for learning. Data collection and testing occurred prior to treatment, one day after treatment, and three months after treatment.

Data analysis showed mixed results for all measures taken. Differences in achievement favoring the conventional treatment from pretest to both posttests appear to have leveled out somewhat over time.

Although anxiety levels declined for both genders after treatment, females reported significantly higher science anxiety than males both before and after treatment. There appears to be a relationship between treatment and gender in terms of effect on science anxiety.

For all three measures taken -- pretest, immediate posttest and delayed posttest -- no significant difference in achievement by learning style was observed. Learning style alone does not appear to be related to achievement in this study. However, the interaction between learning style and treatment was significant in some cases. In looking at achievement defined as gain scores among the three achievement measures, some cases within the microworld treatment proved to be significant.

Introduction

This study was born from the familiar, frustrating scene of physical frog dissection, which occurs annually in school systems everywhere, and in this particular case, a suburban junior high school. The problem facing the biology teachers was to find an alternative means of instructional delivery that would yield substantially the same cognitive knowledge development in the students, help address the declining frog population, address the issue of science anxiety among students at the junior high level, and accommodate the learning styles of the students.

Despite the long history of dissection in biology coursework, it has become controversial (Kinzie, Foss, & Powers, 1993; Langley, 1991; Orlans, 1988; Strauss & Kinzie, 1991). As one result, the Florida legislature passed a bill in 1988 protecting the rights of students who do not wish to participate in dissection.

To explore potential new approaches, it was first necessary to look at the various alternatives available such as anatomical models, charts, laserdiscs, reference books, advanced coloring books, computer programs, and interactive Internet sites. Secondly, it was necessary to select appropriate alternative means of instruction for this grade level and the depth of coverage desired. Although there are many alternatives to dissection, the extent to which computer models, videotapes or other non-animal material can replace dissection entirely in schools remains open to question and appears to have had little impact on animal use.

Many of the alternatives are faulted for their low levels of realism or for limited opportunities for active student participation (Strauss & Kinzie, 1991). Whether or not the alternatives are interactive appears to be an important factor in ensuring success (Strauss & Kinzie, 1994). With this in mind during our search for a suitable alternative to an actual frog dissection, we examined various forms of instructional material involving computers as the delivery medium because of their inherent constructivist and hands-on elements, which should more closely parallel the essence of an actual dissection activity. These materials fell into one or more of the following general categories (Piskurich, 1993): hypertext, hypermedia, simulation, multimedia, virtual reality, and microworld.

It soon became clear that no one delivery system existed that would cover the subject matter needed, at the grade level needed, or with a constructivist hands-on approach to parallel that of an actual dissection. It also became clear that there had been few efforts to evaluate the learning effectiveness of alternatives to dissection (e.g., Langley, 1991).

The team decided to use two alternative forms of frog dissection within this study in order to look at the supposed benefit of a hands-on approach to learning. The selected alternatives were the CD tutorial, *Digital Frog*, and a desktop microworld with *Operation Frog* providing the hands-on element of the dissection process. It became necessary to combine elements of each delivery system category to form a microworld of frog dissection in which to immerse the students. This microworld consisted of the multimedia simulation *Operation Frog* CD, digitized movies of the various stages of frog dissection, 3D movies of frog anatomy and human anatomy, sounds, and digitized still images.

Problem of the Study

With the richness of computer-based microworlds come many questions as to how these environments compare with actual reality. Little work has been done in comparing the two “realities” with regard to comprehension and recall of material; whether all learners or only those with certain learning styles can follow the conceptual model; how the classroom teacher can harness the power of these computer-based environments; and how students and teachers interact with a microworld. Even less work has been done specifically in the areas of alternatives to physical dissection and their impact on cognitive development gains, long-term retention, science anxiety, and differing learning styles.

Related Literature

There have been calls for additional research to identify the educational setting, types of students, and the areas of education that will benefit most from the inclusion of hypermedia (Lamb, 1991; Jonassen, 1989; Spiro & Jehng, 1990). Questions include whether this type of presentation improves comprehension and recall of material, whether all learners or only those with a “hyper-mind” can follow the conceptual model (Maurer, 1993), and how the classroom teacher can harness the power of hypermedia systems (Heller, 1990). In hypermedia, elements of constructivist theory combine to accommodate the evolving nature of knowledge by encouraging students to engage in a continuing search for improved understanding (Resnick, 1989; Bednar, et al., 1991; Black & McClintock, 1995; Lebow, 1993; Wilson, Teslow, & Osman-Jouchoux, 1995; Duffy & Jonassen, 1992; Wilson, et al., 1995; Cunningham, Duffy, & Knuth, 1993). Hypermedia microworlds designed in such a way as to give users exploratory experiences within a carefully controlled range of concepts and principles offer a practical compromise between instructivism and constructivism (Spiro & Jehng, 1990; Papert, 1980; Rieber, 1996).

Contradictions fill the literature concerning the use and effectiveness of computer-based instructional simulations (Carroll, 1982; J. A. Kulik, 1994; Mills, Amend, & Sebert, 1985). More and better simulations might be needed to influence student examination performance. Extensive research is needed on simulation design and use (Thomas & Hooper, 1991).

Students struggle when they try to learn in ways that aren’t natural or easy for them. Effective education depends upon a sound match between characteristics of the student and characteristics of the programs and persons the student encounters (Messick, 1976). Although numerous studies have examined learning style (Helm, 1990; Ewing & Yong, 1992) and numerous others have explored CAI (Wang & Sleeman, 1993; Wise & Okey, 1983), there has been much less research conducted pertaining to the relationships between CAI and learning preferences (Ester, 1994-1995).

Knowledge acquisition has been used to contrast the effectiveness of different instructional methods (Johnstone & Sleet, 1994; Moore & Miller, 1996; Grieve, 1992). The ease with which something is retrieved from long-term memory is directly proportional to how well it was stored in the first place (Baddeley, 1976; 1990; Ormrod, 1995). This simply indicates that when re-testing takes place, some material is no longer accessible. The question arises of whether hands-on technology-based activities enhance learning by reinforcing cognitive knowledge and improving retention (Korwin & Jones, 1990; Harrison, 1995).

Researchers have defined student attitude toward science as the student’s feelings of like or dislike toward science (LaForgia, 1988; Koballa, Crawley & Shrigley, 1990; Atwater, Wiggins & Gardner, 1995). The question is to whether activity-oriented science instruction can help develop favorable attitudes toward science. Teaching strategy is related to student anxiety and performance levels (Westerback, 1982). Highly anxious elementary and junior-high students favored a less directive environment, while their less anxious counterparts favored stronger direction. Learning environments need to be created where students of different personalities and learning aptitudes can be successful, regardless of instructional mode, because students do not learn equally well from all modes of instruction.

Purpose of the Study

The purpose of this study was to investigate and compare the level of initial learning and also long-term retention of the frog’s internal anatomy between seventh-grade students using an interactive CD tutorial, a desktop microworld, and conventional frog dissection. Students’ anxiety toward science was also compared across the three

treatment groups. Additional data were collected on the students' preferred learning modality to explore possible relationships with the level of learning or long-term retention and their respective instructional treatments.

Subjects

The population used within this study was comprised of 354 seventh-grade students in fourteen classes in a suburban school district. Of the mostly Caucasian students, 181 were boys, and 173 were girls. Due to attrition and/or absence during one or more phases of the data collection, 74 students whose data were incomplete were excluded from the analysis, reducing the subject pool to 280 subjects, 142 males and 138 females. None of the students had had any instruction in frog dissection prior to the study.

Research Design

A quasi-experimental research design was used, specifically the nonequivalent control-group research design (Gall, Borg, & Gall, 1996), because the research participants could not be randomly assigned to the experimental and control groups due to the naturally occurring environment. Therefore, intact classes were randomly assigned to treatments. All subjects took a pretest, a posttest, and a delayed posttest. Except for random assignment, the steps involved in this design are the same as for the classic pretest-posttest control-group experimental design.

Variables

The independent variable or treatment was the method used to deliver instruction on frog dissection. The dependent variables were the achievement scores on the pretest, posttest, and delayed posttest; scores on a science anxiety instrument administered at the start and end of the experiment; and the preferred learning style of the students.

Treatments

The three treatments used within this study consisted of two experimental treatments, a desktop microworld and an interactive tutorial, and conventional physical frog dissection. The media for creating a desktop microworld and an interactive tutorial of a frog dissection had to be readily available, relatively easy to use and able to run on existing platforms within an average educational setting. After careful consideration of existing media for frog dissection, *Digital Frog* from Digital Frog International was chosen for the interactive tutorial. However, a combination of programs had to be assembled to create a desktop microworld environment.

Digital Frog Interactive CD-ROM

Digital Frog is a commercial interactive CD-ROM that incorporates full-motion video, animations, sounds, narration, in-depth text, full color photographs and a comprehensive workbook in three modules -- Dissection; Anatomy; and Ecology. The dissection module uses a tutorial approach with the dissection proceeding in a step by step presentation manner. Users can access multimedia files to view a frog dissection being performed, but do not actually "perform" a dissection themselves.

Desktop Microworld

The desktop microworld environment was built around the commercial product *Operation Frog* on CD with other programs serving as auxiliary forms of instructional delivery. *Operation Frog* contains a tutorial simulation of the dissection of a frog, male or female. Unlike *Digital Frog*, *Operation Frog* allows students to actually perform the dissection, not just view it. However, unlike a real dissection, students also can reconstruct the frog. Using graphical surgical scissors, a probe, forceps, and a magnifying lens, students probe and snip body organs, remove organs to the examination tray, and investigate frog body systems close-up.

To help compensate for some of the limitations of *Operation Frog* and to build a stronger microworld environment, the students were given access to three additional modes of instruction:

- 3D QuickTime movies of the frog at various stages of dissection, created locally and/or downloaded to each computer's hard disk prior to the treatment from the Internet site *Virtual Frog*. [<http://george.lbl.gov/ITG.hm.pg.docs/dissect/info.html>]
- QuickTime movies of the stages of dissection being performed, downloaded to each computer's hard disk prior to the dissection activity from the Internet site *NetFrog*. [<http://curry.edschool.Virginia.EDU/go/frog/>]
- Digitized pictures and sounds downloaded from various other sites on the Internet.

These components were accessible to students at appropriate times during the dissection process as indicated on their worksheets by icons matched with file names, which had been arranged at the top of the Apple menu for ease of access.

Conventional Frog Dissection

The conventional physical dissection method was used as the control treatment within this study. It was the traditional method of providing a preserved specimen of a frog for every two students within the class. Students used traditional dissection trays and related tools. The dissection activity was conducted in the science classrooms, which contain lab tables for science activities. Teachers guided students through the dissection process aided by worksheets given to the students.

Lab Worksheets

Lab worksheets were composed of the “Frog Dissection Laboratory Investigation” from the *Prentice Hall Life Science Laboratory Manual* as well as material used by the science team over the course of several years. The content and questions asked remained the same for all subject groups. However, the directions given within the worksheets reflected the individual treatments within the study.

The lab worksheets given to the control group performing the conventional dissection included directions for performing the physical dissection. The lab worksheets given to subjects in the experimental desktop microworld contained additional directions on where to go on the computer for certain activities. These directions were in the form of symbols, e.g., a movie camera symbol followed by a movie title for accessing the QuickTime movies, a camera followed by an image file name for accessing digitized images, etc. The lab worksheets for the subjects using the interactive tutorial, *Digital Frog*, contained directions for getting started in the program.

The format of the lab worksheets was designed to be easy-to-follow and to allow the students to complete the investigation largely on their own, leaving the instructor free to provide necessary help to individuals or groups of students. The lab worksheets also asked for observations after the procedure at each level of dissection and asked students to draw conclusions that encouraged them to use critical-thinking skills.

Procedures

The study was conducted within the prescribed seventh grade biology curriculum following the completion of the unit on cold-blooded vertebrates, which is the last unit curriculum conducted each school year. Students had performed dissections on earthworms earlier in the year and were familiar with dissection instruments and general lab procedures and safety precautions.

Each of the fourteen intact science classes involved in the study was randomly assigned an instructional delivery system subject to scheduling constraints (each teacher was to have at least one class of each treatment to help control for bias) and availability of conventional or computer lab space. This process resulted in four classes using the interactive tutorial, six classes using the desktop microworld, and four classes using the conventional dissection method. No class exceeded 30 students. Prior to the actual dissection activity, teachers received training in manipulating the computer treatments, using the same lab worksheets as the students would use.

The students in the experimental sections conducted their alternative dissection activity using the interactive tutorial or desktop microworld in the auxiliary computer lab at the school. This lab contains 15 Macintosh computers, which necessitated the partnering of subjects, two to a computer. This was appropriate, as the control group was also partnered, two to a dissection pan, as they historically had been grouped within the school.

For all groups the dissection took place over a span of four consecutive days with each class having a 43-minute instructional time period each day. The testing, preparation and closure took place during three class periods. All achievement tests used the same instrument. The pretest and preparation occurred on the day before the dissection activity began. The immediate posttest and closure occurred on the day following the dissection activity. The class period for administration of the delayed posttest was three months following the dissection activity, during the opening days of the following school year. The science anxiety survey was administered in each class two days prior to the start of the dissection activity to establish a baseline for comparison and then again on the second day following the conclusion of the dissection activity.

Data Collection / Instruments

The three regular science teachers conducted the classes and graded the pretest, posttests, and lab worksheets. They also administered the science anxiety survey. The study skills teacher at the school had previously conducted the learning style self-assessment.

The 43-item science anxiety instrument was adapted from one developed for high school age students (Wynstra & Cummings, 1993). The first 35 items asked students to indicate how nervous they would feel if they had to do each of the listed science-related activities. They responded using an ordinal scale from “a” (indicating “Not at all Nervous”) through “e” (indicating “Very Nervous”). The remaining eight questions were general questions such as their gender and their interest in science related topics. The interest questions were not used within this study, as the science teachers deemed them geared toward the high-school aged student.

Since the science anxiety instrument was originally targeted at high-school age students, the reliability of the instrument for this age group was tested by administering the instrument prior to the study to one class chosen at

random from the fourteen classes of subjects. With a maximum possible value of 1, Cronbach's Alpha yielded an alpha level of .9005 as the reliability coefficient. Thus the instrument was deemed reliable for this study.

The pretest and posttest were identical and were administered to both the control group and the experimental groups. The test was comprised of items from the *Prentice Hall Life Science* text for the junior-high school student and the lab worksheets used within the science curriculum for conventional dissection. Items consisted of multiple-choice, true-false, and matching questions that either had already been tested for this subject area and level using item-analysis techniques and been found to be reliable or had been judged to be reliable by the science team at the school over the years.

Data Analysis

Statistical analysis of data was completed using *SPSS 7.5* software. The level of significance for all tests was set at 0.05.

Demographic data concerning the subjects were tabulated using frequency counts. Because the subjects could not be randomly assigned to treatments, the issue of initial equivalency among the subjects was addressed. A pre-test was administered and when the scores were analyzed by gender using a *t* test and by treatment group and specific class using analysis of variance (ANOVA), no significant differences were found (see Table 1 for pretest statistics). To address the research hypotheses, which focused on differences across the three treatments, several techniques were employed. Achievement and retention were defined as the change in individuals' scores on the achievement test from pre-test to post-test, from post-test to delayed post-test, and from pre-test to delayed post-test. Means and standard deviations were calculated for each test by treatment to identify patterns. The "gain" scores for test pairs were calculated and submitted to one-way ANOVAs to identify any statistically significant findings relative to each hypothesis. With three treatment conditions, further analysis of significant ANOVAs was required to identify the individual pair(s) that differed significantly. Contrast tests were selected for this aspect of the analysis. The possible interaction effect on achievement of treatment and learning style of subjects was also explored. Analysis of these data utilized descriptive statistics, analysis of variance across learning styles within treatment, as well as a factorial ANOVA for the three treatments by the seven identified learning styles.

Table 1. Pretest Scores by Gender, Treatment, and Class Section

	N	Mean	SD
Gender			
Male	142	21.38	5.31
Female	138	22.12	4.36
Treatment			
CD Tutorial	86	21.97	4.62
Microworld	125	22.13	4.66
Conventional	69	20.78	5.44
Class			
M1	25	22.72	4.84
M2	26	22.27	3.87
M3	22	22.05	4.61
M4	18	21.78	5.17
M5	23	23.13	4.43
M7	24	21.96	6.00
S1	18	23.11	3.85
S2	22	20.95	3.40
S3	18	21.61	5.13
S4	15	20.20	7.34
S5	17	23.29	3.90
S6	15	20.93	4.45
W4	18	19.33	5.92
W5	19	19.95	4.22

Findings Pertaining to Research Question One

Research question one asked, What are the relative effects on student achievement of instruction using an interactive tutorial, a desktop microworld, and a conventional dissection of a frog? Three hypotheses proposed no significant difference among the three treatment groups in gain from pretest to posttest, pretest to delayed posttest or posttest to delayed posttest.

In looking at the relationship between treatment and gain scores, significant differences were observed. The mean gain from pretest to immediate posttest for students participating in the conventional dissection (Mean = 11.99) was significantly higher [$t = 2.97$, $p = .007$] than for students in the microworld treatment (Mean = 9.78). The conventional dissection group (Mean = 7.36) also showed a significantly higher mean gain score from pretest to delayed posttest than either the microworld group (Mean = 4.24, $t = 4.03$, $p = .000$) or the CD-tutorial group (Mean = 4.14, $t = -3.862$, $p = .000$). There was no significant difference in long term retention among treatments as evidenced by gain scores from posttest to delayed posttest.

In summary for the first research question and its three hypotheses, the data supported rejecting the hypothesis of no significant difference in achievement by treatment in the case of gain from pretest to immediate posttest as well as in the case of pretest to delayed posttest scores. Results favored the conventional dissection treatment. However, the data did not support rejecting the hypothesis in the case of gain from immediate posttest to delayed posttest, suggesting a leveling of results over time. Regardless of the measure, students in the conventional dissection treatment did outperform those in the two experimental treatments, which did not differ significantly from one another.

Findings Pertaining to Research Question Two

The second research questions was What are the relative effects and the effects of gender on students' level of science anxiety of instruction using an interactive tutorial, a desktop microworld, and a conventional dissection of a frog? Two hypotheses proposed no significant difference in science anxiety by treatment group or gender. The science anxiety survey was given before the start and after the conclusion of the frog dissection unit. Results showed the three treatment groups were not equivalent in anxiety at the beginning. Contrast tests revealed that students assigned to the conventional treatment reported significantly lower science anxiety than students in either the CD tutorial ($t = 3.11$, $p = 0.002$) or the microworld treatment ($t = 2.84$, $p = 0.005$.) The mean science anxiety score for students in the CD tutorial group did not differ from that of the microworld group.

These initial findings did not change after treatment, and no single treatment group showed a significantly different change in anxiety compared to the other treatment groups. Contrast tests showed that students experiencing the conventional treatment reported significantly lower science anxiety after treatment than students in either the CD tutorial group ($t = 2.71$, $p = 0.007$) or the microworld treatment ($t = -3.56$, $p < 0.001$.) The mean post-treatment score for students in the CD tutorial group did not differ from the microworld group.

In looking at the results of the science anxiety measures by gender, some interesting patterns emerged. A t test showed that females reported significantly higher initial science anxiety than males ($t = -3.46$, $df = 278$, $p = 0.001$). Although anxiety levels declined for both genders after treatment, females continued to report significantly higher science anxiety than males ($t = -3.36$, $df = 278$, $p = 0.001$). Therefore, the hypothesis of no significant difference in anxiety by gender was rejected for both the pre-treatment and post-treatment survey.

Looking at differences in anxiety levels by treatment received and by gender, the three treatment groups displayed varying results. Males and females in the CD tutorial treatment showed a significant difference before treatment ($t = -2.13$, $df = 84$, $p = 0.036$) but not after treatment ($t = -1.195$, $df = 84$, $p = 0.236$). Participation in the CD tutorial treatment appears to have closed the gap between the genders. This was in contrast to the conventional treatment subjects who, although showing a general decline overall in anxiety levels after treatment, showed a significant difference between genders both before ($t = -2.92$, $df = 67$, $p = 0.005$) and after treatment ($t = -2.35$, $df = 67$, $p = 0.022$). Apparently the conventional dissection was not effective in reducing the disparity in anxiety between male and female subjects. For the microworld group, anxiety levels across genders did not differ significantly before treatment. However, after treatment, the difference did approach significance ($t = -1.94$, $df = 123$, $p = 0.55$), with anxiety declining more amongst males than females.

In summary for the second research question and its two hypotheses, the data supported rejecting the hypothesis of no significant difference in students' level of science anxiety. The three treatment groups were not equivalent in anxiety at the beginning and this pattern held after treatment as well. The data also supported rejecting the hypothesis in the case of gender. Females consistently reported a significantly higher science anxiety level than their male counterparts, both before and after treatment. When looking at differences in anxiety levels by treatment received and by gender, the data again supported rejection of the null hypothesis. While the means by gender for the CD tutorial treatment and the conventional treatment were significantly different before treatment began, males and females in the microworld treatment did not differ significantly. After treatment males and females in the CD tutorial treatment no longer showed a significant difference. For the microworld group, the post-treatment mean difference approached but did not reach a level of significance, with anxiety declining more among male students than female students. Within the conventional treatment group, although the level of anxiety lowered across genders, there was still a significant difference between males and females after treatment.

Findings Pertaining to Research Question Three

The third research question asked Is there a relationship between students' preferred learning style and comprehension gain scores as they relate to the type of instructional delivery? Hypotheses were that there was no significant difference in achievement by learning style and no interaction between treatment and learning style. When looking at the relationship between students' preferred learning style and achievement, no significant difference in achievement by learning style was found for any of the three measures taken -- pretest [$F(5,274) = 1.125$, $p = 0.347$], immediate posttest [$F(5,274) = 0.707$, $p = 0.619$], or delayed posttest [$F(5,274) = 0.664$, $p = 0.651$]. Learning style alone does not appear to be related to achievement in this study.

However, significant interactions were observed between treatment and preferred learning style in terms of achievement. An analysis of variance found the interaction between learning style and treatment on the immediate posttest was significant [$F(10,269) = 2.11$, $p = 0.024$]. To identify the source of this interaction, separate analyses of variance were performed on the immediate posttest data by learning style for each of the three treatments. The results for the CD tutorial treatment were not significant [$F(5,80) = 0.589$, $p = 0.709$]. Likewise, the results for the microworld treatment were not significant [$F(5,119) = 1.703$, $p = 0.139$]. However, the results for the conventional treatment were significant [$F(5,63) = 2.396$, $p = 0.047$]. To determine which pairs differed significantly, contrast tests were used. These tests showed that the immediate posttest mean score for visual-kinesthetic learners in the conventional treatment ($M = 26.00$) was significantly lower than the mean score for auditory learners ($M = 32.63$), auditory-kinesthetic learners ($M = 35.50$), kinesthetic learners ($M = 34.18$), and visual learners ($M = 34.73$). The computed t-test values are shown in Table 2.

Table 2. T-test Values for Significantly Different Means, Immediate Posttest by Learning Style, Conventional Treatment

Mean Pair	Difference	T	DF	Sig
VK – A	-6.63	2.411	63	0.019
VK – AK	-9.50	2.534	63	0.014
VK – K	-8.18	2.714	63	0.009
VK – V	-8.73	3.026	63	0.004

VK = visual-kinesthetic

A = auditory

AK = auditory-kinesthetic

K = kinesthetic

V = visual

An analysis of variance for the delayed posttest scores by treatment within learning style showed no significant interaction [$F(10,269) = 1.047$, $p = 0.404$].

To summarize briefly, the hypothesis of no significant interaction between treatment and preferred learning style was rejected for the immediate posttest scores, but only for the conventional dissection treatment. Visual-kinesthetic learners scored significantly lower on average on the posttest than their peers who preferred either the auditory, auditory-kinesthetic, kinesthetic, or visual learning styles. No such difference existed initially, and it disappeared again at the delayed posttest.

Turning to achievement defined as gain scores, an analysis of variance of the gains from pretest to immediate posttest by learning style and treatment yielded a significant interaction (Table 3). Comparable analyses of gains from pretest to delayed posttest and from immediate to delayed posttest showed no significant interaction.

Table 3. Analysis of Variance, Gain from Pretest to Immediate Posttest by Learning Style and Treatment

Source	SS	DF	MS	F	Sig
Main Effects	141.54	7	20.22	0.850	0.547
LS	101.15	5	20.23	0.850	0.515
Treatment	28.19	2	14.095	0.592	0.554
Interaction	117.64	10	44.77	1.912*	0.017
Residual	6232.86	262	23.79		
Total	8318.84	279	29.82		

* $p < .05$

Contrast tests revealed the significant interaction of learning style and treatment was attributable to four pairings of scores by learning style preferences within the microworld treatment. Students showing a preference for the kinesthetic learning style achieved significantly lower gain scores (Mean = 8.24) than students with a preference for the auditory learning style (Mean = 10.84; $t = 2.29$, $p = .030$). Gain scores for kinesthetic learners were also significantly lower than for auditory-kinesthetic learners (Mean = 10.67, $t = 2.10$, $p = .045$) and for auditory-visual learners (Mean = 14.20, $t = 3.29$, $p = .005$).

In addition, the mean gain from pretest to immediate posttest among students exhibiting a preference for the auditory-visual learning style (Mean = 14.20) was significantly higher [$t = 3.00$, $p = .010$] than the gain for those students preferring the visual learning style (Mean = 9.08). It should also be noted that the gain scores for students with a preference for the auditory-visual learning style approached, but did not quite reach, significance [$t = -2.10$, $p = .058$] compared to students demonstrating a preference for the Visual-Kinesthetic learning style (Mean = 10.30).

Based on the preceding analyses, the hypothesis of no significant interaction between learning style and treatment relative to achievement (defined as gain scores) was rejected for some cases within the microworld treatment. Students who preferred the three variations on auditory learning attained the greatest gains, and each of the three was significantly higher than the gain for students with a kinesthetic preference. Students in the auditory-visual group also significantly outperformed those who preferred the visual learning style.

In summary for the third research question and its two hypotheses, the hypothesis of no significant difference in achievement by learning style preference could not be rejected for any of the three measures taken -- pretest, immediate posttest, or delayed posttest. Learning style alone does not appear to be related to achievement in this study. However, the hypothesis of no significant interaction between treatment and preferred learning style was rejected for the immediate posttest scores from the conventional dissection treatment. Here, visual-kinesthetic learners scored significantly lower on average than their peers who showed a preference for any of the other four learning styles. This difference was not found on the pretest and disappeared at the delayed posttest.

When looking at the interaction between learning style and treatment relative to achievement defined as gain scores, the hypothesis was rejected for some cases within the microworld treatment. The greatest gains were reported by students preferring the three auditory learning variations, with each showing a significantly higher gain

than students with a kinesthetic preference. In addition, students in the auditory-visual group significantly outperformed those who preferred the visual learning style.

Discussion and Conclusions

A discussion of the results and conclusions based on these results are presented next, based on the broad areas of inquiry defined by the research questions.

Relative Effects on Student Achievement

In looking at the relationship between instructional treatment and gain scores achieved, significant differences were observed. Conventional dissection appears to generate greater learning than the microworld treatment when looking at gains from pretest to immediate posttest. However, no difference was found between the conventional dissection and the CD-tutorial treatment. Therefore, if the desired outcome is immediate gain of knowledge, the preferred delivery system would appear to be either the conventional dissection or the CD-tutorial.

The question is why students within the microworld treatment scored significantly lower than both other treatments. If the hands-on component is thought to provide better encoding of information, then the logical conclusion would be that both the conventional and the microworld treatment groups would outperform the CD tutorial group on the immediate post-test. Perhaps the explanation lies in the findings of Thomas and Hooper (1991). They suggested that the effects of simulations are revealed not by tests of knowledge but by tests of transfer and application. Another explanation can also be offered by looking at the students' experience with the various forms of instructional treatment. All students had previous dissection experience and all students had experience with CD tutorials, albeit not one in which an entire science unit was delivered via this method. However, the microworld environment was completely new to their range of experiences and may have resulted in a lowering of their immediate achievement gain due to unfamiliarity with the format.

When looking at the mean gain score over time, from pretest to delayed posttest, students in the conventional dissection method showed significantly better retention than those in either the microworld or the CD-tutorial treatment. This seems to give the clear advantage to the conventional method of dissection, but this advantage disappears when looking at the gain scores from posttest to delayed posttest. Here the differences favoring the conventional treatment have disappeared, as no one treatment proved to be significantly better for retaining knowledge gained over the long term than either of its counterparts. In other words, the knowledge decrement (Grieve, 1992) was not significantly different across treatments.

When looking at knowledge retained over the long term, this study's results support the view that alternatives to dissection are as effective as the actual practice of physical dissection. This lends support to the National Association of Biology Teachers (NABT) official policy supporting alternatives to dissection and vivisection in the biology curricula wherever possible, as long as those alternatives satisfy the objectives of teaching scientific methodology and fundamental biological concepts. In the debate over animal dissection in the classroom, a number of studies (Downie & Meadows, 1995; Leonard, 1989; Quentin-Baxter & Dewhurst, 1992; Strauss & Kinzie, 1991; Strauss & Kinzie, 1994; Kinzie, Larsen, et al., 1996) have attempted to find suitable alternatives to animal dissection. This study has shown two forms, a CD tutorial and a desktop microworld, to be viable alternatives to physical frog dissection in retaining knowledge gained over the long term.

Relative Effects on the Level of Science Anxiety

When looking at the data from the science anxiety survey given before the start and after the conclusion of the frog dissection unit, the conventional treatment group showed significantly lower levels of anxiety both before and after treatment. While at first glance this appears puzzling, closer inspection reveals two possible explanations.

The first concerns the timing of the unit of instruction and the arrangement of lab facilities. Because the frog dissection unit was conducted at the end of the academic year and this was the first time that two alternatives to conventional dissection were to be offered, the teachers involved needed an uncommon level of coordination to plan use of lab facilities. Unfortunately, these teachers had no common planning period, and therefore coordination of facilities had to occur before and after school, as well as in the halls between class periods. All these discussions took place at times when students may have been present and overheard the planning. This could have resulted in students having an idea of which treatment their class would receive and therefore may have skewed the initial findings of pre-treatment anxiety levels.

A related explanation comes from the experiences of this study's subject pool. The subjects within this study had had previous exposure to dissection activities during their seventh grade life-science curriculum. While these dissection activities were limited to relatively simple exercises in the anatomy of a worm and a squid, the students were familiar with this type of instructional activity. Conversely, the students had received no prior exposure to a unit of instruction delivered entirely through a desktop microworld or a CD-tutorial. Koballa (1993) stated that activity-oriented science instruction can help develop favorable attitudes toward science. Previous

exposure to a like activity could have skewed the results of the science anxiety measurements in favor of the physical dissection activity.

When looking at the level of change in anxiety across treatment groups, no single treatment group showed a significantly different change in anxiety compared to the others. Apparently the treatment received had no bearing on change in the level of science anxiety exhibited.

It is interesting to note the relatively low levels of anxiety reported by students across the board. All but one of the mean anxiety level scores fell below 2.00 on a range of possible scores from 1 (Not at all Nervous) through 5 (Very Nervous). This finding may be a result of the timing of the study at the end of a yearlong, seventh-grade, life-science curriculum that stressed active participation by students. This follows the conclusions of Hill et al. (1995) that overall attitude toward science improved significantly when students were engaged in active participation within a seventh grade life-science curriculum over time. This study falls within their call for additional research to focus on particular connections among specific science instructional activities, in this case, approaches to a frog dissection unit.

Examining science anxiety measures by gender revealed some interesting patterns. Females reported significantly higher initial science anxiety than males. After treatment, although anxiety levels declined for both genders, females continued to report significantly higher science anxiety than males overall.

The three treatment groups displayed varying results in anxiety levels by gender. The initial gender difference within the CD-tutorial group was no longer present after treatment, suggesting a beneficial effect for that treatment in reducing female science anxiety. For subjects in the microworld treatment, the difference was not significant either pre-treatment or post-treatment. However, after treatment, the difference in means for males and females did approach significance, with anxiety declining more among males than females. It appears that the microworld treatment was more beneficial for males. Finally, for the conventional dissection group, the difference between genders was significant both before and after treatment. The experience of conventional dissection had no effect on the disparity in science anxiety between males and females.

It is interesting to note that the CD-tutorial treatment seemed to reduce the level of science anxiety more for female students, while just the opposite was occurring within the microworld treatment group as the level of anxiety lowered more for males after treatment. This might be due to the fact that students in the microworld treatment were active participants in their use of the computer and had much more control over the flow of information presented than those students in the CD-tutorial treatment, who merely observed a dissection taking place. Because the microworld group actually performed a frog dissection utilizing representations of dissection tools, they faced the very real possibility of making a mistake in the dissection process. This possibility did not exist for students in the CD-tutorial treatment as they merely watched as the computer performed the various dissection activities. Additional research is needed to pursue the interaction effect of active versus passive role and gender as to levels of anxiety exhibited.

Overall, this study demonstrated that science anxiety is clearly related to gender, which confirms the findings of Wynstra (Wynstra, 1991; Wynstra & Cummings, 1993). Wynstra suggested that in classes that involve activities that could make one squeamish, alternative delivery systems could be used. In this way students would have the option of working with charts, models, or interactive computer software instead of having to dissect once-living creatures such as frogs or pigs. The results of this study support Wynstra's findings.

Our world has rapidly become one based on scientific inquiry that crosses all economic, political, and geographical boundaries. Educators have long called for a fuller, stronger, and more fundamentally sound science curriculum within our schools and the development of ways to encourage students to pursue a scientific career path. Atwater, Wiggins, and Gardner (1995) concluded that the less anxious a student was toward science, the more positive that student was toward the sciences in general. In their review of the research, Koballa, et al. (1990) found that the years 8 to 13 are the critical ages for influencing science attitudes. By understanding what components of a science unit of study produce anxiety amongst students, middle-school teachers can better offset those levels of anxiety with the methods they use to teach science concepts.

This study showed the desktop microworld to be beneficial in reducing the level of anxiety among males while the CD-tutorial helped in reducing female science anxiety. Considering these results, it can be said that technology-based alternatives to conventional frog dissection appear to offer benefits in addressing the science anxiety issue.

Preferred Learning Style and Achievement

The data from this study did not support any claims of a general effect on achievement for the students' preferred learning style. This was true when looking at differences in achievement for pretest scores, posttest scores, and delayed posttest scores. Within this study, learning style alone does not appear to be related to achievement.

It was only when looking at differences in gain scores by preferred learning style within treatment that statistical differences began to emerge. The conventional dissection treatment seems to have the least effect on those students with a preference for the visual-kinesthetic learning style. These students significantly under-performed

their counterparts within the same treatment who displayed a preference for the auditory, the auditory-kinesthetic, the kinesthetic, and the visual learning style modalities.

The microworld treatment seems to have particular merit for students who prefer any of the auditory learning style modalities (auditory, auditory-kinesthetic, and auditory-visual) as they outperformed their counterparts with a kinesthetic preference from the pretest to the posttest. In fact, students with a preference for the auditory-visual learning style had the best performance overall of any subgroup in any treatment. They also showed significantly higher gain scores than students within the microworld treatment group who preferred the visual learning style.

Both the conventional dissection treatment and the desktop microworld alternative offered not only visual and auditory channels but also kinesthetic channels in the form of actually participating in the dissection process. However, within the CD-tutorial treatment, students merely observed the dissection take place. The findings of this study support the contention of researchers (Craik & Tulving, 1975; Ellis & Hunt, 1983; Korwin & Jones, 1990) that hands-on activities help to encode knowledge acquired into long-term memory and that knowledge decrement (Grieve, 1992) is less following activities that address all the varying modalities of learning. However, these hands-on activities must not be exclusively kinesthetic, but rather incorporate all modalities of learning.

Limitations Evident Within the Study

Several limitations were evident within this study. They are presented in no particular order, but should be addressed to more fully understand the results of the data obtained.

To assess the preferred learning style of a student, this study was limited to data from the school's study skills teacher. The instrument used to obtain these data allowed for categorizing students into groups reflecting a balance between the three major learning styles: Auditory, Visual and Kinesthetic. This resulted in small numbers of subjects falling into the shared categories of auditory-kinesthetic (12), auditory-visual (30), and visual-kinesthetic (21). Taken by themselves the numbers reflected in these groupings would not pose a problem, however when they were further divided by the instructional treatment received, the numbers in some cases were very small. This occurred most noticeably within the following categories: CD-tutorial treatment and auditory-kinesthetic (2 subjects); CD-tutorial treatment and visual-kinesthetic (6 subjects); conventional treatment and auditory-kinesthetic (4 subjects); conventional treatment and visual-kinesthetic (5 subjects); and microworld treatment and auditory-kinesthetic (6 subjects). Researchers attempting similar future studies should either utilize an instrument for assessing preferred learning style that would not allow for cross-groupings or increase the number of subjects included within the pool to offset the small numbers that might occur in any one group.

This study was conducted at the very end of the school year. Problems inherent with this timing are the built-in distractions to students of end-of-the-year activities, anticipation of summer vacation looming in the immediate future, and attrition due to students leaving school early for family vacations and/or relocation. All these factors can play a role in the level of concentration attainable by students and a reduction in the number of subjects included in the final assessment pool.

As stated previously, the timing of the study left little opportunity for teachers to coordinate the use of facilities. This led to a possibility of students overhearing teachers discussing arrangements during periods of the day when students were present. If this study were to be replicated, care should be given in the discussion of implementation plans to ensure that students are unaware of their treatment group prior to the actual start of the instructional unit.

Another limitation in this study was the makeup of the subject pool. The subjects participating in this study were predominantly Caucasian middle-class suburbanites. Only 2.1% fell within the low-income economic bracket. The racial makeup of the population consisted of 88% White, 7.6% Asian/Pacific Islander, 1.7% Black, 2.4% Hispanic, and 0.3% Native American. In addition, students classified as Limited-English-Proficient comprised only 2.3% of the school population. Taking all this into consideration, the results of this study cannot be extrapolated to the general populace, only to those populations with a similar makeup.

Suggestions for Further Research

In the course of conducting this study and in the analysis of the data collected, many questions arose that provide a varied base for further research. In order to offset the effects of previous experience on the levels of science anxiety reported, studies should be conducted comparing the various instructional treatments using a hands-on activity earlier in the year. It would be necessary to limit the subject pool to those students who had no experience in completing a scientific unit of study through conventional dissection, desktop microworld or CD-tutorial. It would also prove valuable to conduct ethnographic studies to provide insight into particular connections between science instruction, science attitudes, science achievement, and cultural background for groupings such as Asian-American students and African-American students.

The studies of Ester (1994-1995) and Messick (1976) revealed a significant interaction between instructional approach and student learning style. This study supports those findings in the case of the microworld

treatment but not for the conventional treatment or the CD-tutorial treatment. The question that naturally follows is, why didn't the pattern that appeared within the microworld treatment also appear within the conventional treatment, if both treatments incorporated all the modalities of learning within their environments? Further research in this area is needed in order to answer that question.

Addressing the gender issue in regards to the level of science anxiety displayed, several questions for future research emerge. If females exhibit a higher level of science anxiety overall than males during the middle-school years, will that difference increase, decrease, or remain the same in subsequent years? And if there is a change, what are the forces that cause that change? A follow-up study of the subjects within this study as they progress through high school could shed light on what influences science anxiety differences among males and females.

The belief that the effects of simulations are not revealed by tests of knowledge but rather by tests of transfer and application suggests further study. How would the microworld treatment compare with the CD-tutorial treatment if observations were made on the students' performances in later dissection procedures or life-science exercises?

The level of retention from posttest to delayed posttest bears a closer look in future research. While most tests within the school curriculum are geared toward immediate achievement gains, the goal of most educational institutions is to help students not only learn but to retain that which they have achieved. This leads to the following questions. Once knowledge is gained, how much is lost over time? And which methods of instructional delivery help the most in the retention of that knowledge? Further research into these areas is a must if we are to attain an educated populace.

There is a definite need for more research in the area of desktop microworlds. With access to the World-Wide Web increasing throughout our schools, spurred on by government initiatives, questions arise as to what can be done with all the information so readily available once it is accessed. This is particularly true for multimedia elements such as digitized pictures, sound and movies. Desktop microworlds composed of these downloaded elements and run by shareware programs offer a relevant and easily upgradable instructional environment. There are then many questions concerning these desktop microworlds and their role in the instructional process. How best can they be incorporated into today's learning environments? Will they be effective vehicles for information transfer for all students? Are they more effective if created by students for students? Do they allow for student control over the pacing of information flow and the pathways followed? If so, do they allow for the molding of the program to the student's preferred learning style? Just how do teachers and students interact with a microworld to gain the greatest benefit?

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DESIGNING INSTRUCTION FOR THE TECHNOLOGY-SUPPORTED K-12 CLASSROOM

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This paper proposes a context-driven model of instructional design incorporating constructivist-oriented methods and strategies for structuring meaningful, purposeful learning environments into the framework of a tradition systematic approach. An evaluation study is also presented which was designed to investigate the effects of implementing the context-driven approach into the initial planning of an instructional program. Twenty-one practicing teachers were presented with case-based material that elicited plans for developing instruction designed to support the learning of specific performance objectives within an electronic media-supported environment. Each teacher developed two plans for specific objectives using both a traditional systems approach as well as the context-driven design model proposed. These plans were analyzed and reported according to the number and type of instructional components and elements included, the type of contexts described and the role electronic media played within these contexts, the type of social interaction environments defined by the electronic media, and general attitudes about developing instruction according to the two different approaches.

Major planning differences with respect to the inclusion of specific instructional components and elements were identified between the two approaches, as was the role electronic media played between the teachers' different plans. Differences between context selections were also identified and reported. Implications for future research are included in the paper as well.

Introduction

Perhaps the most useful thing to emerge from Instructional Technology's focus on constructivism during the past ten years has been the critical examination of the role context plays within the instructional design process. Although debates surrounding the effects of context within the actual act of learning will most likely continue for quite a long time, the notion that context could and should play a more important role in the design and development of instruction seems to be more universally-accepted among those Instructional Technologists involved in the research and development of improved systematic instructional design models. Improving existing systematic instructional design models through the incorporation of successfully tested and implemented constructivist-oriented methods and strategies represents one of the more important challenges facing Instructional Technology today. The purpose of this paper is to propose one such context-driven model of instructional design that merges methods and strategies for structuring meaningful, purposeful learning environments into the framework of a tradition systematic approach. In addition, this paper also presents the results of a study designed to investigate the effects of implementing a context-driven approach into the initial planning of an instruction program to support the learning of a specific performance objective within an electronic media-supported environment.

Throughout the last decade a number of instructional design theories and models have been researched and evaluated which reflect a decidedly-constructivist perspective. Although it would be difficult to pin down a common design methodology between these models, they all seem to possess a unifying theme: context. Models such as Anchored Instruction, Situated Learning, and Constructionism have been widely evaluated and reported, and a closer examination of their instructional design methodologies reveals that they all value the cultivation of rich learning contexts over simply addressing prescriptive instructional goals.

Anchored Instruction represents a design model in which learning a related set of specific content-area skills, knowledge, and attitudes is "anchored" in a larger community or social context (see Cognition and Technology Group at Vanderbilt, 1992). Such anchors often include case-study or problems-based situations, and the instructional materials afford the learners many opportunities for individual exploration. Situated Learning represents a similar approach to the structuring of instructional environments. Within this model, instruction directed toward the learning of individual performance objectives is situated within a context reflecting a culture in which acquiring and practicing the identified skills "naturally" occurs (see Lave & Wenger, 1991). Social interaction is also a critical component of Situated Learning environments, as the learning culture itself is primarily defined by the interpersonal interactions of its members.

Constructionism represents a subtle departure from other constructivist learning strategies. This model, attributed to Seymour Papert (1993), places a special importance on the role of actual constructions in the learning environment as a support for knowledge construction in the head. Within this theoretical framework, effective learning is both facilitated and represented by the action of individual learners immersed in creation.

Each of these "constructivist-friendly" instructional models could certainly be viewed as providing opportunities for the learners to construct their own meaning to instructional stimuli and, consequently, direct any

number of instructional events. Attempting to represent these models within more traditional instructional systems design frameworks could take many different directions. For example, each of these theories/models might be viewed as simply various ways to ensure that the learning of individual SKA occur within contexts that are meaningful and purposeful to learners. They could also be viewed as nothing more, or less, than very complex motivational strategies. Although most “traditional” systematic instructional design models are grounded in behaviorist ideology, the overall purpose of any ISD model is to maximize the probability that learners experiencing instruction will, in fact, learn what the designers intend. Regardless of whether or not an instructional designer considers herself or himself a behaviorist or a constructivist (or an agnostic for that matter), most seem to accept the idea that learners will construct their own meaning to any information they receive through interacting with their environment. Learner interpretation of external stimuli will be influenced by their previous experiences as well as their cognitive abilities, any social negotiations presented within the learning environment, the type of instructional strategies presented, the general manner in which messages are presented, overall motivational levels, and any other physiological and/or emotional factors which define how individuals personally want to learn things. Very few instructional designers would argue that learners interpret events and ascribe their own meaning to external stimuli. Generally speaking, this constitutes one of the fundamental design problems facing instructional designers. It is their primary task to structure learning environments which maximize the probability that all (or most) of the learners will interpret events and assign or construct common meanings enabling them to learn the prescribed, defined SKA. In fact, if learners didn’t “construct” their own meanings to events then ID would probably be a much simpler affair.

A Context-Driven Model

Many “traditional” instructional design models include fundamental steps similar to those detailed in Dick and Carey’s (1996) systematic model of instructional design:

1. Assess needs to identify goal(s)
2. Conduct instructional analysis (including learner and context analysis)
3. Write performance objectives
4. Develop assessment instruments
5. Develop instructional strategy (conditions dependent on type of skill to be learned)
6. Develop and select instructional material
7. Design and conduct formative evaluation of instruction
8. Revise instruction (steps 2-7)
9. Design and conduct summative evaluation

The individual components of this model are relatively consistent with the primary steps described in other popular instructional design models, including Reiser and Dick (1996); Sullivan and Higgins (1983), Hunter (1982), and Merrill, Li, & Jones (1990). Instructional components aren’t the only similarity between these different models. Another basic similarity between these different instructional design models is reflected in their treatment of instructional strategy development. All employ some type of conditions-based approach, meaning that the most appropriate type of instructional strategy for any given design is dependent on the type of skill to be facilitated.

Although any given conditions-based instructional design prescription may incorporate a number of motivational strategies, none of the more popular instructional design models address the role(s) that the entire learning context plays within every aspect of the instructional decision-making and implementation process. It could be argued that the deconstruction of instructional events for the purpose of designing instruction for given performances can effectively occur outside specific contexts. But if developing contextual learning environments is the goal of the designer, then the identification of a meaningful, purposeful context as well as the role(s) that the media used to define the context will play within the entire instructional experience should be incorporated into the instruction design process from the beginning. Since many instructional design models today are directed toward the use of some form of electronic media, it makes sense to take advantage of the manner in which electronic media are commonly defined with respect to the context they help facilitate (see Figure 4). By capitalizing on the emerging roles that electronic media are playing within the real world, instructional designers can begin to construct more well-defined context-driven instructional models which designed to facilitate more meaningful, purposeful technology-supported learning environments. The following illustrates an instructional design model that is driven by a context integrating electronic media into the instructional planning and implementation process:

1. Assess needs and/or identify instructional goal(s)
2. Identify a context in which goal is applied/practiced in the real (or the learner's) world
3. Decide which electronic media-supported context(s) best approximate the essence of the real world context (see Appendix E):
4. Revise instructional goal to reflect identified learning context
5. Conduct instructional analysis and write objectives related to both goal (content) AND context
6. Develop assessment instruments
7. Conceptualize and articulate a "Big Picture" for the planned instructional program based on the identified prerequisite skills, the context to be established, the content area, and the instructional goal
8. Develop instructional strategy (see Figure 1) in which conditions (see Figure 3) are dependent on type of skill to be learned(see Figure 2)
9. Develop and select instructional material
10. Design and conduct formative evaluation of instruction
11. Implement instruction
12. Revise instruction (Steps 2-10)

Like its predecessors, this context-driven model of electronic media-supported instructional design is also conditions-based. Unlike other design models, however, it emphasizes the identification of a meaningful learning context very early in the design phase, and the context itself is incorporated into the goal and subsequent instructional analysis. Context identification is based on two important elements:

- How the instructional goal "practiced" in the real world
- How electronic media help approximate real-world contexts

Although it would impossible to systematize the identification of how any given goal might be practiced in reality, it is not quite so difficult to categorize the manner in which electronic media have traditionally established and cultivated different types of contexts. Many books dealing with electronic media and education have identified contexts similar to those described in Figure 4: Creation/Construction, Situation Exploration (including case-based situations), Simulation, Reference Exploration, Tutorial (direct instruction), Drill and Practice, Game (cooperative, competitive, puzzle), Communication, "Real" (Allesi & Trollip, 1991; Merrill, et al, 1996; Grabe & Grabe, 1996). Since these context categories represent time-tested development enterprises which have conformed to the various parameters of electronic media itself (specifically computers), it makes sense to use them as guidelines for instructional designers charged with the task of developing instruction specifically for a particular electronic medium. Although a strong argument could be made against the development of an instructional design model that incorporates media-specific strategies and procedures, in today's electronic media-rich work and school cultures it is common practice to articulate instructional needs and media needs in the same statement.

As indicated earlier, this context-driven model follows a traditional systematic instructional design framework while incorporating the learning context into most of the decision-making processes. Once an instructional goal is clearly identified, the designers are directed to identify a meaningful context based on how the goal is practiced in the learners' real world. The instructional designers are then presented with the listing of electronic media contexts (Figure 4) and encouraged to categorize their chosen context into one or more of the contrived types. This step may also aid in the selection of a meaningful learning context if the skills indicated within the goals aren't readily identifiable as real-world performances (see most Math and Social Studies curricula for plenty of examples).

After a meaningful learning context has been identified, the instructional designer is directed to review the initial instructional goal and incorporate the context into the goal if the context will require the learning of context-specific outcomes. For example, consider the following goal statement: "Given the length of one side of a right triangle as well as the internal angle measurements, the learners will use the Pythagorean Theorem to calculate the lengths of the unknown sides." Since the Pythagorean Theorem is often used to calculate the height of objects too tall to measure directly, the designer may choose a context in which the learners must calculate the height traveled by a model rocket. The revised goal statement might then read "Given the distance from an observer and a rocket launch pad (meters) along with the length (meters) of the hypotenuse for the right angle formed between the observer, the launch pad, and the rocket at its zenith, the students will calculate the height of the rocket to the nearest meter." This new goal statement focuses the entire instructional design experience around rockets and how math can be used to make calculated inferences about observed events. And including the context within the goal statement itself helps ensure that context-dependent skills (such as "define zenith") are addressed in the subsequent design.

The next step in the design process requires performing a complete instructional analysis of the goal/context to identify all subordinate skills that must be learned in order to accomplish the stated goal within the identified context. Following the instructional analysis, all performance outcomes are sequenced and placed into units or lessons. Each lesson is then treated separately, with each lesson developed according to the instructional design components indicated in Figure 1.

Experience with context-driven instructional design has indicated that certain context types lend themselves better than others to the implementation of specific instructional design components. Tessmer and Richey (1997) defined the role of any context as orienting, instructional, and/or transfer. These categories of context “functions” are easily correlated to those instructional design components included in Figure 1. This correlation indicates that an orienting context can successfully accomplish some or all of an effective instructional program introduction, an instructional context can accommodate part of an introduction, the activities/information, the practice/feedback, and perhaps the review. And a transfer context can accommodate those elements within an effective transfer component. Classifying the type of context and then determining its function is useful in identifying those components of good instructional design that may not be fully accommodated by the chosen context. If deficiencies in the design are detected, the designer is encouraged to develop additional, specific instructional components that complement the context, but are separate from it (A good example of this occurred during the development of the Jasper Woodbury Problem-Solving material. See CTGV, 1992).

By following the basic instructional design steps indicated, the instructional designer is encouraged to create an effective learning experience that is integrated within a purposeful, meaningful environment. Since the contrived contexts described in this model (Figure 4) were derived from a review of the way computer-based environments are typically described, perhaps a model such as the context-driven model described in this paper will further the cultivation and definition of those attributes of electronic media that can provide meaning and purpose to learning.

As this context-driven model of instructional design was being developed and tested, a number of research and evaluation experiences took place. On one specific occasion, the model was evaluated formally against a more traditional systems approach in the initial planning stages of design by teachers enrolled in an advanced instructional design and evaluation course. During this evaluation study, identical procedures and treatment materials were implemented, and these tests will be referred to in the following section as “The Evaluation Study.”

The Evaluation Study: Introduction

The purpose of this evaluation study was to explore the effects of using a context-driven model of instructional design on the initial planning of electronic media-supported instruction. Practicing K-12 teachers were charged with the task of planning instruction for specific instructional objectives while incorporating the use of specific electronic media, and they were compelled to articulate their instructional plans through both a traditional instructional design approach and the context-driven method described earlier in this paper. This investigation was conducted in an effort to answer the following questions about possible differences in the instructional plans developed by novice designers using a more traditional systems approach versus a context-driven design:

- Will practicing teachers incorporate different numbers and types of effective instructional components/elements between their two plans?
- Will they make different decisions about the role electronic media should play in the learning environment between their two plans?
- Will the manner in which student interactions with each other and the media be different between the two plans?
- Will practicing teachers’ attitudes about designing instruction be different between the two plans?

Previous to this evaluation study, it had been the experience of the author that a context-driven approach to instructional design not only helped to produce more effective instructional programs than more traditional approaches, but that utilizing a context-driven approach made it easier for instructional design novices to describe instructional plans that inherently included effective design components. It had also been demonstrated informally that forcing designers to categorize the role electronic media would play in the design process into one of the contrived categories described in Figure 4 resulted in the media itself playing a bigger part in the planned instructional program. In addition, the task of developing instruction seemed to be more enjoyable by those novice developers assigned to projects involving the comprehensive design and development of electronic media-supported instruction. These observations prompted the author to take a more empirical approach toward identifying the value of a context-driven instructional design model.

The Evaluation Study: Method

Subjects

The twenty-one subjects for this evaluation study were all practicing teachers enrolled in either an Instructional Technology (IT) or a Curriculum and Instruction (CI) graduate program at a major research and teaching university in the eastern United States. These students were enrolled an instructional design and evaluation course designed to teach an instructional systems design (ISD) model similar to Dick and Carey’s (1996) general systems design framework described earlier in this paper.

Procedures

The treatments for this evaluation study consisted of a case-based instructional design scenario which elicited two different instructional plans following both a “traditional” instructional systems as well as a context-driven planning design approach. The case prompted the subjects to “...imagine you are an instructional design consultant currently working for a publishing company interested in developing instructional material to support social-studies Standards of Learning (SOL) for K-8 schools. This company has previously developed a variety of electronic media-supported material addressing math and English SOL’s and successfully marketed them to a number of school districts. Electronic media, in this case, refers to the use of computers, video, and audio within the instructional program, and most of the school administrators and teachers indicated that the electronic-media aspects of the material are what they really valued about the instruction. The role electronic media played within these successfully-implemented instructional programs ranged from simply providing information and examples in conjunction with traditional text-based material to complete, individualized direct-instruction multimedia computer programs presenting information, practice and assessment. You have been enlisted by the company to create a plan for developing electronic media-supported instruction for one specific 7th-grade social studies standard. No decisions have been made about the type of mediated material to be developed or the role that the media itself will play in the finished instructional product, but all the electronic media-based components of each company products are designed to accommodate the following general classroom/school technology parameters: 25 students per class, three networked (Internet access) multimedia computers in each classroom, one 25-inch television connected to a VCR as well as one of the classroom computers, one audio “boom box” with cassette tape and CD player, one overhead transparency projector, and access to a school computer lab with 16 networked multimedia computers for a minimum of 2 hours per week.”

As indicated, the subjects were instructed to design a plan for developing electronic media-supported instruction for a specific social studies SOL. The two standards (one per type of design) used within the case were taken from the Standards of Learning for Virginia Public Schools (Virginia Board of Education, 1995): The student will compare the American political and economic system to systems of other nations, including Japan, China, and leading Western European nations, in terms of

- governmental structures and powers;
- the degree of governmental control over the economy; and
- entrepreneurship, productivity, and standards of living.

7.10 The student will interpret maps, tables, diagrams, charts, political cartoons, and basic indicators of economic performance (gross domestic product, consumer price index, productivity, index of leading economic indicators, etc.) for understanding of economic and political issues.

Following the portion of the ID course presenting the basic ISD model but before examining the specific role(s) context plays within the design process, the subjects were presented with the case-based scenario for the current study. They were informed that the material (represented as a course “pretest”) was going to present them with an instructional design scenario followed by a series of questions. They were instructed to answer each question with as much detail as needed to convey their messages clearly yet concisely. They were also told that their answers were not going to be graded for points; rather, all answers were going to be used as part of the second portion of the course. In addition, the subjects were instructed to answer each question without looking ahead to subsequent items or going back to change any answers once they had initially completed them.

The first treatment experience consisted of the case presentation, with 19 randomly-assigned students receiving standard 7.8 (“The student will compare the American political and economic system...”) and the other 19 receiving standard 7.10 (“The student will interpret maps, tables, diagrams...”) as the specific objective for which they needed to plan electronic media-supported instruction. Subjects were then asked to respond to the following questions, corresponding to a more traditional instructional systems planning approach:

- 1.1 List all the non-electronic and electronic media (textbooks, hand-outs, worksheets, teacher-led lectures, video, audio, filmstrip, computers, etc.) that this instructional program will employ and describe the role each will play within the instructional program.
- 1.2 Describe how your instructional program will introduce the selected topic to the learners.
- 1.3 Describe the activities and/or information that the learners will experience within the instructional program.
- 1.4 If applicable, describe the type of practice and feedback that the learners will experience within the instructional program.
- 1.5 If applicable, describe the review that the learners will experience before the posttest.
- 1.6 If applicable, describe the posttest that the learners will experience within this instructional program.
- 1.7 If applicable, describe any opportunities in which the program will provide the learners with an opportunity to apply the skills, knowledge and attitude indicated within the standard to another situation.

Following their experience with the case scenario as it applied to their first assigned standard (objective), the subjects were asked to perform the same task for the other standard. This time, however, they were asked to answer the following set of questions reflecting a context-driven planning approach:

- 2.1 Describe a situation in which the skill(s) indicated in Standard 7.X are used in the real world.
- 2.2 Review the different types of contexts that electronic mediated learning environments support (see Figure 4) and select a context type that you feel could be structured or cultivated within the instructional program you are developing which might approximate, in some way, the real-world application described in 2.1. State the context type (from the choices provided in Figure 1) you plan to develop within your program, and briefly describe how it will be structured.
- 2.3 Rewrite the standard so that it reflects the context you have selected as well as the skill it originally communicated.
- 2.4 List all the non-electronic and electronic media (textbooks, hand-outs, worksheets, teacher-led lectures, video, audio, filmstrip, computers, etc.) that this instructional program will employ and describe the role each will play within the instructional program.
- 2.5 Describe how your instructional program will introduce the selected topic to the learners within the context you have structured.
- 2.6 Describe the activities and/or information that the learners will experience within the within the context you have structured.
- 2.7 If applicable, describe the type of practice and feedback that the learners will experience within the context you have structured.
- 2.8 If applicable, describe the review that the learners will experience before the posttest.
- 2.9 If applicable, describe the posttest that the learners will experience within this instructional program.
- 2.10 If applicable, describe any opportunities in which the program will provide the learners with an opportunity to apply the skills, knowledge and attitude indicated within the standard to another situation.

Upon completing the second set of planning questions, the subjects were directed to respond to a series of items reflecting their attitudes about planning electronic media-supported instruction for the two different standards.

Responses to each question were evaluated and tabulated by the author. In an effort to determine how well each instructional plan corresponded to specific instructional design criteria, the responses for items 1.2-1.7 as well as 2.5-2.9 were categorized according to the instructional design components and elements indicated within Figure 1. For example, items 1.2 and 2.5 asked the subjects to describe “..how your instructional program will introduce the selected topic to the learners...” Responses to this item were evaluated based on how many of the following elements of an effective introduction were included in the answer:

- Gain learner attention
- Articulate in some way the SKA already needed to succeed within the new learning environment
- Identify opportunities in which learners will relate what is about to be learned (goal) to what they already know how to do
- Inform learners of objectives (o.k. to be vague)
- Fit objective(s) into a "Big Picture"
- Present the utility (relevance) of the SKA to be learned
- Clearly identify the incentives/rewards for learning the SKA and succeeding within the learning environment
- Establish clearly-perceived learner accountability, role(s) and task(s) within the learning environment
- Establish clearly-perceived instructor role(s) and learner support mechanisms
- Employ specific content-area methodologies if applicable (ensuring that all other elements are properly addressed)

Similar evaluation methods were conducted on each item related to the other instructional design components. In addition to the tabulation of instructional design element frequencies, the type of media selected as well as their described functions were also recorded. A comparison of the different context types by electronic media selection was also determined between those plans facilitated within the traditional model and those plans facilitated within the context-driven approach.

Results

As described earlier, individual responses to each treatment item were categorized and then tabulated according to each standard (7.8 “The student will compare the American political and economic system...” versus 7.10 “The student will interpret maps, tables, diagrams...”) and design approach (traditional versus context-driven). The purpose of initially tabulating data by standard was simply to determine if any major differences existed between responses to the two different standards themselves regardless of which design approach was utilized. Although some minor differences were identified, it was the judgement of the author that a pattern of differences between the two standards did not exist; consequently, no formal reporting or discussion will ensue with respect to this variable alone.

Table 1 reports the results of analyzing the treatment items that elicited specific responses to the planning of discrete instructional design components. These data indicate that a total of 65 elements of an effective Introduction were described within the plans following a traditional ID planning approach, and 98 elements of an effective introduction were described within the plans following the context-driven approach. A breakdown of individual introduction elements (delineated in Figure 1) are not included in Table 1.

The data presented in Table 1 also displays the number of Activity/Information design elements included in the planning responses. These data indicate that 93 total elements were described in the plans for the subjects’ responses using the traditional design approach, while 103 total elements were described in the plans for responses

using the context-driven approach. Table 1 also reports the number of Practice/Feedback elements included within the instructional plans. These data indicate similar totals for each type of design, with 58 instances of Practice/Feedback elements reported within the plans facilitated through the traditional model and 62 elements were identified within the plans described using the context-driven design approach. Likewise, responses between design approaches for the Review and Assessment components were very similar. The data in Table 1 indicate that 35 review elements were described within the traditional design approach plans while 31 instances of review elements were detailed within the context-driven plans. In addition, the data in Table 1 indicate that 22 assessment plans described within the traditional approach explicitly matched the "...performances and conditions indicated within objectives," while only 15 plans using the context-driven approach described such element. The final instructional design component analyzed was Transfer, and there appeared to be little difference in the number of transfer elements described within each design approach. The data in Table 1 indicate that 15 instances of transfer elements were described by subjects using the traditional approach, and 15 instances were described within the responses elicited from the context-driven approach.

Table 2 reports the data for the classification of contexts described within the instructional plans, and the frequency of different context types are broken down further by type of media utilized. Although the treatment materials specifically encouraged the subjects to select a single context within their context driven plans from the descriptions provided in Figure 4, most plans (context and traditional) included descriptions for more than one context type. These data indicate that five Creation contexts were described by subjects within those plans which followed the traditional design approach, while 9 were described by subjects using the context-driven design. All contexts in this case were described as facilitated through the use of computers. Two plans following the traditional approach reported Simulation contexts facilitated with the help of computers, and one traditional plan described a video-supported Simulation. This contrasts with 11 computer-based Simulation contexts described within the context-driven plans, and one video-supported Simulation context described within a context-driven plan.

The data in Table 2 also indicate that ten traditional ID plans described Situation Exploration contexts, with six of these computer-based and four video-supported. Sixteen Situation Exploration plans were described within the context-driven plans, with 13 being computer-based and three video-supported. Also, 14 Reference Exploration contexts were described within the traditional plans (11 computer-based, three video) while only nine of these contexts were described within the context-driven plans (seven computer-based, two video). Seven traditional plans and five context-driven plans described computer-based tutorial contexts, and 14 Drill and Practice contexts were described within traditional plans (10 computer-based, one video, two overhead transparency-based, and one audio) while only five computer-based Drill and Practice environments were identified in the context-driven plans.

Table 2 also displays data indicating that six traditional plans described Game contexts (five computer-based, one video) while only three computer-based Game contexts were detailed in the context-driven plans. In addition, seven computer-based Communication contexts were described, all within the context-driven plans. The data in Table 2 also indicate that one computer-based Real context was depicted within a traditional plan, while six Real contexts (five computer-based, one video) were identified in the context-driven plans.

Table 2 also reports data for the Linear Information Presentation context, representing those instructional plan descriptions which utilized media only to present information to the learners in linear fashion with little or no implied interaction. These contexts were only identified within the traditional plans, with five computer-based, two video, one overhead transparency, and two audio contexts described.

The data in Table 3 present information about the general type of social interaction environments facilitated by the different types of electronic media within the instructional plans. Instances of individual, small group, and/or entire class structures were identified and categorized by electronic media type. These data indicate that only one traditional plan described computers facilitating an entire class experience, seven plans described small group and 14 plans described individual activities. Computers were described as facilitating two entire class activities within the context-driven plan descriptions, 18 small group activities, and six individual learning experiences.

Table 3 also displays data for the type of social interaction environments defined within video-supported plans. These data indicate that nine entire class experiences were defined within the traditional plans, and three small group as well as two individual activities were identified. Video in the context-driven models was used for entire class activities within three plans, five plans described small group while two described individual video-supported learning activities. Use of the overhead projector was not described in many plans, with one class and one small group experience identified within the traditional models, and only one entire class experience depicted within a context-driven plan. Similar results were identified for the use of audio, with two class and one individual experience described within traditional plans and no audio experiences detailed in the context-driven plans.

Finally, responses to a few attitudinal items were tabulated. The first attitude item asked the subjects to identify "...which SOL was it easiest to develop instruction?" Six subjects responded that standard 7.8 ("The student will compare the American political and economic system...") was easiest, 11 felt that standard 7.10 ("The student will interpret maps, tables, diagrams, charts...") was easiest, and four reported that they were both the same. When asked "If each instructional program were to be developed according to your plan, which do you think would

be more effective for the target audience (7th graders)?” 12 subjects responded that their context-driven plans would be more effective, while only three indicated that their traditional plans would be more effective. Six subjects felt that they would both be equally effective. Similarly, when asked “If you were given the job of actually creating the instructional program you described, which would you rather develop?” 15 subjects responded that they would rather develop the instructional program following the context-driven plan, three responded that they would rather develop the program described within their traditional plan, and three responded that it wouldn’t make any difference to them.

Discussion

Although differences were subtle between the manner in which subjects were directed to plan for technology-supported instruction using a traditional versus context-driven approach, there appeared to be definite differences in how certain aspects of their plans were articulated. This, in itself, is relatively important because it illustrates that instructional planning by practicing teachers can be affected by the presence of specific resources (Figure 4) and differences in planning question strategies.

The data in Table 1 indicate that plans following the context-driven model included many more elements of an effective introduction. A closer examination of these results revealed that, in describing the introductions to the proposed instructional programs, nearly twice as many context-driven plans addressed prerequisite skills and made provisions for connecting what the learners were about to learn to what they already knew how to do. In addition, more than twice as many context-driven plans articulated the relevancy of the new skill to be learned. Inclusion of these important Introduction elements would most likely improve the overall effectiveness of the instructional program, and the fact that the context-driven plans facilitated more of these elements indicates that “real” contexts necessitate more effective and complete introductory experiences. It’s likely that the subjects felt the 7th-graders receiving the instruction would be less accustomed to a real-world context in the classroom and would therefore need more information up front. Conversely, the instructional plans following the traditional approach included twice as many instances of the Activity/Information elements dealing with relating the skills to be learned to a clearly-defined content domain, providing learner guidance for the application of the information presented to the target skills, and breaking down the process of performing rules into steps. It’s possible that provisions for the more directed nature of these elements were not considered by the subjects as they incorporated those less-directed contexts constituting a majority of the context-driven plans: creation, simulation, or situation exploration. This represents an important point that has no doubt been identified by developers of creation or simulation environments: How much guidance is appropriate within these types of environments?

On the other hand, a closer examination of the elements included in the activity/information component showed that the context-driven plans described many more opportunities for the learners to explore the learning environment with minimal instructor guidance, and these plans also offered many more instances of examples and nonexamples. Again, these effective Activity/Information elements were most likely inherent in the chosen contexts, which lends support to the value of structuring these types of environments. However, another example of a potentially harmful use of more student-directed learning environments is apparent in the data for the Practice/Feedback component. Surprisingly, most of the plans included provisions for appropriate practice provided to all the learners. But nearly twice as many instances of providing initial learner guidance within the practice was identified within the traditional plans. Initial learner guidance is an important element of effective instruction (Hunter, 1982; Merrill, 1994), and it is quite possible that the meaningful learning contexts depicted within the context-driven plans were conceptualized by the subjects as requiring or demanding less direction from the instruction/instructor. This attitude may diminish the potential effectiveness of successfully implementing such learning environments within the classroom, and may in fact represent some of the reasons why teachers often have mixed results when structuring more student-directed contexts.

Subjects reported many fewer elements of effective reviews or transfer opportunities, and this was consistent across both design types. Either they were simply tired of writing, or they neglected these important elements of effective instructional design.

The biggest difference between the plans following the traditional versus context-driven approaches was the type of contexts selected and described. Thirty-three context descriptions for Creation, Simulation, Situation Exploration, Communication, and Real types were identified in the traditional plans, while 51 of these contexts were described in the context-driven plans. These contexts generally represent more student-directed environments favored by constructivist designers. This big difference in frequencies indicate that simply encouraging the designer to consider how the skills are used in the real world and then make a context selection from an existing list can have a dramatic impact on the type of context selected. It is interesting to note that, without such prompting, a good percentage of the traditional plans communicated more tradition uses of electronic media to define learning contexts: Reference, Game, Drill and Practice, Tutorial. And in the analysis of the different plans, the category “Linear Information Presentation” needed to be included to accommodate those traditional plans that could not be

categorized into one of the other context types. Perhaps the most important thing about this data is that no use of electronic media to deliver linear instruction was identified within any context-driven plan.

Perhaps one of the most important findings within the data analysis was the role computers played in encouraging different social environments in the classroom. Eighteen context-driven plans described the use of computers in small groups, compared with only six context-driven plans for individual computer-based instruction. This was nearly the opposite of the traditional plans which described seven instances of small group computer use compared with 14 plans for individual computer-based instruction. While individual computer use can prove to be a very effective learning situation, the benefits of grouping students around computers and sharing the resources may contribute to a more effective overall learning environment, especially in classroom where computer resources are limited (see Johnson, Johnson and Holubec, 1990).

Taken as a whole, the results from this study offer both promise and insight into the possibilities of utilizing context-driven instructional design. The limited results reported in this study indicate that, in order to maximize the potential efficacy of a context-driven design, certain learning conditions or instructional component elements must be explicitly addressed. Providing initial learner guidance for practice, connecting instructional information to the target skills, relating target skills to a particular content domain, and breaking down the process of learning intellectual skills into steps represent important aspects of the learning environment that may not be inherent within the implementation of those meaningful learning contexts described.

Most of the subjects reported that they would prefer to design instruction following the context-driven model. They also felt as if the context-driven plan would be more successful in the classroom. This indicates that a context-driven type of design may help motivate designers to develop more effective and creative instructional programs.

The contrived list of contexts seemed to have a profound impact on context selection. Although most instructional design models shy away from providing such contrived lists and descriptions of media use or content/context methodologies (presumably to increase the generalizability of the model), it may benefit novice designers to have such tools at their disposal. This may also benefit the novice designer in the area of media selection. It is interesting to note that computers represented the medium of choice within most of the designs. Some contexts (like Communication) are more dependent on computers, but it's possible that computers were favored because teachers and novice designers lacked the training and/or experience to conceptualize how other media might be used to facilitate meaningful, purposeful learning environments, with much less expense involved.

Results from this simple study raise a number of questions suitable for future research consideration. For example, will a context-driven model of instructional design actually result in a more effective instructional program than a more traditional ISD model? How can context-driven versus more traditional ISD models be compared? Is it possible to determine if different context types favor the natural inclusion of specific instructional components/elements? Do different types of electronic media favor different context types or context functions? What, if any, is the relationship between describing how a particular skills is used in the real world and selecting the type of context to be cultivated within the classroom ? It is the hope of the author that the quest toward answering these types of questions will help instructional technologists develop more productive, innovative, creative, and effective models of instructional design.

Figure 1: Basic Instructional Design Model

Component	Elements	Context Function ⁷		
		Orienting	Instruction	Transfer
Introduction	<ul style="list-style-type: none"> Gain learner attention Articulate in some way the SKA¹ already needed to succeed within the new learning environment Identify opportunities in which learners will relate what is about to be learned (goal) to what they already know how to do Inform learners of objectives (o.k. to be vague) Fit objective(s) into a "Big Picture"² Present the utility (relevance) of the SKA to be learned Clearly identify the incentives/rewards for learning the SKA and succeeding within the learning environment Establish clearly-perceived learner accountability, role(s) and task(s) within the learning environment Establish clearly-perceived instructor role(s) and learner support mechanisms Employ specific content-area methodologies if applicable (ensuring that all other elements are properly addressed)³ 			
Activities	<ul style="list-style-type: none"> Establish <u>in context</u> the appropriate conditions for the type(s) of new SKA facilitated⁴ Relate all SKA to a clearly-defined content domain⁵ <ul style="list-style-type: none"> Provide learner guidance for learners as they apply information presented <u>in context</u> to SKA being facilitated Present a variety of clear, concrete examples and nonexamples <u>in context</u> Provide opportunities for learners to explore the learning environment with minimal instructor guidance and intervention 			
Practice & Feedback ⁶	<ul style="list-style-type: none"> Provide initial learner guidance Must match performances and conditions indicated within objectives and presented <u>in context</u> All should get practice Feedback as immediate as possible (unless delayed feedback is desirable) 			
Review	<ul style="list-style-type: none"> Provide opportunities for learners to summarize the key ideas (including how these ideas fit into the "Big Picture"), what they learned how to do, and how they personally learned it Restate objectives 			
Assessment	<ul style="list-style-type: none"> Must match performances and conditions indicated within objectives (goal may be only thing assessed) 			
Transfer	<ul style="list-style-type: none"> Present new context which elicits the same performances under different conditions Make the utility of succeeding within the new context apparent Present cues within the new context which aid learners in selecting and applying the appropriate previously-learned SKA Clearly identify the incentives/rewards succeeding within the new context 			

Notes:

¹ SKA refers to Skills, Knowledge, and Attitudes. Unless otherwise noted, "SKA" represent content-domain as well as context-specific (including social interaction) performances.

² A "Big Picture" often consists of a text and/or graphic representation of how a goal's SKA fit into a particular context (like saving the rain forest, meeting a client's need, running a small business), a content domain (like biology, American Literature, project management), a cognitive-behavioral domain (like problem-solving, study skills, self-esteem, physical fitness), and/or social domain (like cooperative learning, team building, role-playing). Big Pictures often present a bridge between what the learners already know how to do and what they are going to learn how to do.

³ Examples of content-area methodologies include "Math Their Way," Distar Reading Program, and biology learning cycles.

⁴ The manner in which learning activities (including information presentation) are structured depend on the type of behavior stated in each objective (see the [Classifying Performances](#) and [Learning Conditions for Different Outcome Types](#) charts).

⁵ "Content domain" refers to the general body of knowledge (information) in which the SKA are associated. For example, music, biology, football, world history, and team building all represent various content domains.

⁶ Once an objective has been established, practice and feedback are the most important elements of any instruction. The most important things humans learn are acquired through informal information presentation and lots of practice and feedback.

⁷ These context functions are described by Tessmer and Richey (1997) as context "types." The orienting type represents a context which precedes the learning event (information and examples directed at the target SKA) and contains factors which influence the learner's readiness to learn the target SKA. The instructional type represents a context in which conditions specific to the acquisition of the target SKA are presented. The transfer type of context is presented after learners have demonstrated they have acquired the target SKA. Transfer contexts provide an opportunity for learners to apply SKA to conditions outside initial learning context. It is important to identify which component(s) are addressed by a chosen context type because it helps the designer determine which elements of the learning environment need to be presented before, during, or after the learners experience the events associated with the context.

The ID components and elements presented in this chart are based on Gagné & Driscoll (1988), Keller, (1987), Merrill & Tension (1994), Sullivan & Higgins (1983), and Tessmer & Richey (1997).

Figure 2. Classifying Performances

Category	Description of Performance Outcome	Common Verbs
Verbal Information (Declarative Knowledge)	Verbal information the students must state , including: facts, dates, people, names, principles, generalizations etc.	State, Recite, Tell, Declare, Name, List, Define [Bloom: Knowledge] ¹
Intellectual Skills: (Procedural Knowledge) Discriminations	Distinguishing objects, features, or symbols (smooth versus not smooth, for example)	Distinguish, Differentiate,
Intellectual Skills: Concepts	<u>Concrete Concepts:</u> Objects (parts of the body, for example), Classes of objects (plants, cells, etc.), Object features (5 arms, red, etc.), and Object relations (above, near, etc.) ...that can be pointed out and identified. <u>Defined Concepts:</u> Objects, principles, classes, features, and relations that <i>cannot be identified by pointing them out. They must be defined.</i>	Identify, Label Classify instances, Sort, Categorize [Bloom: Comprehension]
Intellectual Skills: Rules	Rules make it possible to <i>do</i> something using symbols (most commonly, the symbols of language and math). Rules include the application of single principles to explain, describe, or predict phenomena or events. Rules make it possible for students to respond to a <i>class</i> of things with a <i>class</i> of performances.	Solve, Show, Demonstrate, Generate, Develop, Create, Determine, Calculate, Predict [Bloom: Application]
Intellectual Skills: Higher-Order Rules (Problem Solving)	Higher order rules employ more than one rule or principle to solve problems, perform tasks, or explain, describe, and predict phenomena or events. Students must decide which rules or principles must be utilized to perform tasks or explain, describe, or predict phenomena or events.	Solve, Show, Demonstrate, Generate, Develop, Create, Determine, Calculate, Predict, Defend, Support [Bloom: Analysis, Synthesis, Evaluation]
Motor Skills	Motor skills represent physical activities requiring movement and coordination of all or part of the body.	Execute, Perform, Swim, Walk, Run, Climb, Drill, Saw
Attitudes	Attitudes represent intrinsically motivated choices people make. Some of the most important outcomes are really attitudes.	Choose, Decide, Participate [Bloom: Evaluation]

¹Schools often use Bloom's Taxonomy of Educational Objectives (1984) as a basis for classifying outcomes and standards in an effort to ensure that skills at variety of cognitive levels are being addressed.

Figure 3. Learning Conditions for Different Outcome Types

Performance Type	Strategies or Conditions for Presenting Instructional Events
Verbal Information	<ul style="list-style-type: none"> • Use the term or definition in a sentence. • Relate the information (term or definition) to preexisting knowledge. • Present all terms clearly using the fewest number of words to convey the meaning. If more than five terms or units of information are to be presented in one lesson, group related terms or units into five or fewer clearly defined categories. • Use a variety of concrete (observable) examples when possible, emphasizing the clear and well-defined features that relate directly to the information. • Explain clearly how learners will be expected to recall the information.. • Make information readily accessible to learners, and provide opportunities for them to explore “nice-to-know” information associated with the knowledge • Practice with immediate feedback!
Intellectual Skills	<ul style="list-style-type: none"> • Present varied examples or instances of concepts and rule applications, calling attention to the distinctive features of examples, definitions, and procedures. • Present nonexamples or noninstances of the concept if they will help to clarify the concept. • Encourage learners to recall previously learned information or examples that illustrate concepts or rules being presented. • Clearly communicate the definition of defined concepts, using the fewest words. • Break down the process of performing or applying rules into steps, and clearly communicate these steps to the students. • Demonstrate an application of the rule for the students. • Provide learners with opportunities to “play” with concepts and rules within simulated or “real” environments, identifying and selecting their own examples and nonexamples of concepts and rule applications if possible. • Present a variety of contexts or experiences that allow the students to practice applying the rules or identifying/describing concepts, providing guidance throughout early stages of practice.
Attitudes	<ul style="list-style-type: none"> • Clearly identify examples of choices made by people who possess the desired attitude (credible and attractive-similarity, familiarity, appearance). • Clearly identify instances in the students’ lives in which making choices are based on the attitude being presented. • Make students aware of the personal benefits gained by making choices based on attitudes (preferably by someone the students admire). • Allow students the opportunity to practice making choices associated with the desired attitude (role-playing, group discussion, etc.) and give them feedback.
Motor Skills	<ul style="list-style-type: none"> • Verbally guide learners through routine. • Visually present example of routine execution. • Practice with immediate feedback. • Encourage the use of mental practice.

Figure 4. Classifying Electronic Media-Supported “Educational” Contexts

Context	Description
Creation:	This type of context provides opportunities for learners to create something. [O,I,T] ¹
Simulation:	This context type allows the learner to make decisions in the development and subsequent operation of a simulated environment or situation. Simulations often try to replicate real-world environments. This type of context is often “problem-solving” in nature. [O, I, T]
Situation Exploration:	Unlike a simulation context, this type of context does not allow the learner to make decisions regarding the development of a simulated environment, but the learner can freely explore within a simulated environment or situation. This type of context is often “problem-solving” as well case-based. [I, T]
Reference Exploration:	This context type allows the learner to freely explore and access reference-type information. [I, T]
Tutorial (Direct instruction):	This context type generally presents “new” information (usually in a linear or stepwise format), and either provides a certain degree of practice using the information in some way, or applies the SKA to specific example(s). [I]
Linear Information Presentation (No-practice tutorial):	This context type simply provides the learners with the linear presentation of information and examples. That’s it. [I]
Drill and Practice:	Generally, this type of environment does not present “new” information, but provides practice and feedback over specific skills (often knowledge, defined concepts and rules). [I]
Game:	This type of context usually engages learners in competition, cooperation, puzzles, or strategies, often for the sake of entertainment. Other contexts may employ this context to because of the motivational advantages of games. [O, T]
Communication:	This context allows learners to communicate with other people via text, audio, binary files, and/or video information. [O, I, T]
Real:	Contexts in this category could fall into any of the above groups, or none. The distinguishing characteristics for these contexts are simply that they constitute real-world situations and settings (home, school, work, play). [O, I, T]

¹In general, each context type lends itself to one or more ID context functions. O = orienting function, I = instructional function, T = transfer function.

Table 1. Total Instructional Component Element Occurrences by ID Type and Standard

Instructional Component	Number of Component Elements Described					
	Standard 7.10 (Maps)		Standard 7.8 (Compare)		Total	
	Trad. ID	Context ID	Trad. ID	Context ID	Trad. ID	Context ID
Introduction	27	46	38	52	65	98
Activity/Information	45	46	48	57	93	103
Practice/Feedback	30	27	28	35	58	62
Review	20	17	15	14	35	31
Assessment	9	8	13	7	22	15
Transfer	10	8	5	7	15	15
Total	141	152	147	172	288	324

Table 2. Context Type Selected by Electronic Medium and Scenario

Context Type	Media ¹	Standard 7.10 (Maps)		Standard 7.8 (Compare)		Total	
		Trad. ID	Context ID	Trad. ID	Context ID	Trad. ID	Context ID
1: Creation	C	3	5	2	4	5	9
	V	0	0	0	0	0	0
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
2: Simulation	C	1	1	1	2	2	3
	V	0	1	1	0	1	1
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
3: Situation Exploration	C	4	7	2	6	6	13
	V	3	1	1	2	4	3
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
4: Reference Exploration	C	5	2	6	5	11	7
	V	3	0	0	2	3	2
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
5: Tutorial (Direct Instruction)	C	4	3	3	2	7	5
	V	0	0	0	0	0	0
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
6: Drill and Practice	C	6	3	4	2	10	5
	V	1	0	0	0	1	0
	OHP	0	0	2	0	2	0
	A	0	0	1	0	1	0
7: Game	C	4	2	1	1	5	3
	V	0	0	1	0	1	0
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
8: Communication	C	0	2	0	5	0	7
	V	0	0	0	0	0	0
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
9: Real	C	1	3	0	2	1	5
	V	0	0	0	0	0	1
	OHP	0	0	0	0	0	0
	A	0	0	0	0	0	0
10: Linear Information Presentation	C	4	0	1	0	5	0
	V	1	0	1	0	2	0
	OHP	1	0	0	0	1	0
	A	1	0	1	0	2	0

¹C = Computer, V = Video, OHP = Overhead Projector, A = Audio

Table 3: Social Interaction Environments by Electronic Media

Electronic Medium	Interact	Standard 7.10 (Maps)		Standard 7.8 (Compare)		Total	
		Trad. ID	Context ID	Trad. ID	Context ID	Trad. ID	Context ID
Computers	Class	1	0	0	2	1	2
	Group	3	10	4	8	7	18
	Indv	13	8	15	5	14	6
Video	Class	2	1	5	2	7	3
	Group	1	2	2	3	3	5
	Indv	1	0	1	2	2	2
Overhead Projector	Class	1	1	0	0	1	1
	Group	0	0	1	0	1	0
	Indv	0	0	0	0	0	0
Audio	Class	0	0	1	0	1	0
	Group	0	0	0	0	0	0
	Indv	0	0	0	0	0	0

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INSTRUCTIONIST VERSUS CONSTRUCTIONIST WEB-BASED COLLABORATIVE LEARNING ENVIRONMENTS

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Abstract

This study investigated the effects of “instructionist” (navigational, functional) versus “constructionist” (adaptive) World Wide Web (WWW) site environments on collaboration, achievement, attitudes, perceived level of learner controls reported by students after working in cooperative dyads within the different types of web-based learning environments.

Three different versions of an instructional WWW site were developed, corresponding to the different types of interaction strategies. Twelve 8th-grade students (6 dyads) were each assigned three similar instructional problems to solve, and they worked within the different web environments to accomplish their instructional tasks. When the dyads experienced the navigational site, they viewed a main menu with broad topics displayed as hypertext links. Selecting a particular link displayed a listing of specific informational pages related to the topic. This type of environment was classified as “instructionist” due to its relatively low degree of learner interactivity and the inherently linear format of the information presentation. When the dyads were assigned to the functional site, they began their exploration with a site-specific search engine. After entering one or more terms, the search engine displayed topic pages and/or specific information pages related to the terms submitted. When the dyads experienced the adaptive (constructionist) site, they were instructed to construct a web site that addressed the instructional problem. Preliminary results indicated a number of differences between the subjects’ performance and behavior while experiencing the adaptive site (construction) versus the other two treatments. These included spending more time with the material, reporting a higher level of interest in the instructional material, trying harder to learn the material, reporting a higher degree of learner control, a higher perception of interactivity, and an increase in the amount of positive interpersonal interaction.

Recommendations for future research are also included.

Introduction

“Interactivity” as it relates to computer-based instruction (CBI) is commonly defined as the degree to which user input affects message presentation. With the emergence of the WWW as a viable and somewhat homogeneous computer-mediated environment, distinct types of web-page interactivity have emerged. Web pages may include interactive strategies classified as navigational, functional, or adaptive (Guay, 1995). The characteristics of these different website design strategies follow:

Type of Web Interactivity	Description	Relative Degree of Interactivity
Navigational (instructionist)	<ul style="list-style-type: none">• Focus on navigating information space• Hypertext menus and/or individual links• Control limited to what user can access “next”	Low
Functional	<ul style="list-style-type: none">• User interacts with system to accomplish goal by making decisions about what information is available on a page• User receives feedback throughout interaction• Common examples include search engines, games, accessing databases	Medium
Adaptive (constructionist)	<ul style="list-style-type: none">• Similar to functional site, except user adapts information space to meet specific needs or desires• User “authors” information site	High

The “navigational” web environment is loosely classified as *instructionist* due to its relatively low degree of learner interactivity and the more structured nature of the information organization and presentation. Papert (1993) describes instructionist learning environments as those learning situations subscribing to a teacher-centered paradigm in which students assume the role of information recipient. He contrasts “instructionism” with what he refers to as “constructionism,” which represents learner-centered educational experiences focusing on student creations or constructions. As students construct things in the real world (or the classroom), these experiences support the construction of knowledge structures in the head. Constructionism, in a sense, represents operationalized constructivism.

Adaptive web environment can be classified as “constructionist” due to their relatively high degree of learner interactivity and the fact that learners have an opportunity to create their own web environments. Adaptive web experiences range from using web editors to create web pages and sites, to more structured creation strategies in

which users make specific design decisions about existing web pages (for example, see the adaptive features used within the websites described by de La Passardiere & Dufresne, 1992; and Eklund, 1996). As it becomes easier to create web pages and sites, opportunities for the use of adaptive web experiences within instructional settings are increasing.

This exploratory study was designed to examine the effects of navigational, functional, and adaptive web-based learning experiences on a number of dependent variables, including achievement, attitudes, and perceived level of learner control.

Method

Part of the exploratory nature of this study involved the development of different versions of the instructional websites corresponding to the different types of interaction strategies. The first step in the instructional web development process involved the creation of a website that contained individual pages with content that could be categorized in a number of ways. "Battles of the Civil War" was chosen as the topic for this study because the subject matter lent itself to the subject pool (junior high school and high school students), and because the topic was broad enough to support the different types of web environments under development. The following chart summarizes the main characteristics of each web type developed:

Web Type	Characteristics
Navigational	This type of web environment consisted of an introduction page that displayed the information about one of the selected battles (for example, the battle of Shiloh was the first battle studied by all the groups). A link on this page led to a main menu page with broad topics displayed as hypertext links. Selecting a particular link displayed a listing of specific informational pages related to the topic. See Figure One for a sample.
Functional	This type of web environment consisted of an introduction page that displayed the information about one of the selected battles. A link on this page led to a search page that required the inputting of terms to display links to specific informational pages related to the terms selected. Subjects could also choose how the links to the requested term(s) would be displayed: alphabetically, by timeline, by location, by people involved, and by battle event. See Figure Two for a sample.
Adaptive	In this environment, the students were directed to the same introduction and search pages as displayed in the Functional group. They were then directed to construct their own website that could help other students (and themselves) learn the information needed to successfully answer questions about the battle. All students had experience using Netscape Composer to create local webpages. The students were informed that they could use any resources on the web, but that the pages found within the local Civil War site did include an adequate amount of basic information.

The subjects for this study were twelve 8th-grade students who were participating in an afterschool enrichment program at a middle school in a small rural Midwestern town. These students volunteered to participate in the enrichment program, which usually involved a good deal of extra time spent on the school's computers using the Internet for independent research. Most of the time, these students worked in pairs or triads to complete assigned group project work. Seven females and nine males participated in this study.

During the first afterschool meeting constituting the study, the subjects were informed that they were going to study a web-based unit of instruction about some of the important Civil War battles. They were told that successfully completing these units of study would help them perform better on the standardized history questions to be presented on their standardized tests administered at the end of the year. They were also informed that their performance on the unit quizzes would be ranked, and the highest-ranking student at the end of the unit would receive a special Civil War prize. The subjects were also informed that they were going to be randomly assigned to cooperative dyads for the unit.

The subjects were informed that the Civil War unit would cover three important battles: the battle of Shiloh, the battle of 2nd Manassas (the second battle of Bull Run), and the battle of Gettysburg. The subjects were also informed that the information to be studied was web-based, and that they would study each battle in a different way during the unit. During the first week, all groups studied the battle of Shiloh. Two groups were randomly assigned to one of the three different types of web environments (navigational, functional, or adaptive).

No time limits were imposed on any of the groups. The students met regularly for one and a half hours, three times per week. The students were told that they could take the quiz whenever they felt ready. When a group indicated that they were finished studying their assigned battle, they were administered a brief attitude questionnaire followed by a 20-question multiple-choice quiz. After taking the survey and quiz, they were assigned to one of the other battles under a different web-based condition, according to the schedule below:

	Navigation	Functional	Adaptive
Shiloh	1, 4	3, 5	2, 6
Manassas	2, 5	1, 6	3, 4
Gettysburg	3, 6	2, 4	1, 5

The students worked in a small computer lab in a corner of the school's media center. Although the lab contained 15 computers, only six were turned on, with the two members of each dyad sharing a single computer. After all the students had studied all the battles, the quiz scores, time, and attitude survey data were tabulated.

Results

The mean quiz scores for each battle by instructional web type are presented in Table One. These data indicate that the mean score for all 12 subjects on the battle of Shiloh quiz was 14.1, the mean score for the Manassas quiz was 15.5, and the mean score for the Gettysburg quiz was 16.6 out of a possible 20 correct. Table One also presents the quiz scores by instructional web type. These data indicate that the mean quiz score for the 12 students experiencing the navigational web type was 14.4, the mean score for all subjects experiencing the functional web type was 14.9, and the mean quiz score for students experiencing the adaptive web type was 16.9.

Table Two presents the average amount of time spent experiencing the different battle webs. These data indicate that the mean time for all 12 subjects studying the battle of Shiloh web was 89 minutes, the mean time studying the Manassas web was 116 minutes, and the mean time experiencing the Gettysburg web was 112 minutes. Table Two also presents time by instructional web type. These data indicate that the mean time spent by the 12 students experiencing the navigational web type was 61 minutes, the mean time spent by all subjects experiencing the functional web type was 67 minutes, and the mean time spent by students experiencing the adaptive web type was 190 minutes.

Table Three presents the mean attitude item responses by type of web. Many of the responses to these items were very similar across web types, but some of the items appeared to have a wide variation in responses. After experiencing the navigational web, subjects appeared to strongly agree with the statement "The structure of this website encouraged me to explore all the information presented about my assigned Civil War battle" (3.6). In contrast, after experiencing the functional website the subjects reported a 2.4 on this item, indicating that they did not agree with the statement as strongly. Subjects experiencing the functional website also reported relatively lower agreement with the statements "I had control over what I learned related to the Civil War while using this Civil War websites" (2.8) and "I am confident that I will do well on a quiz over this battle" (2.8). The data in Table Three also indicate that the subjects reportedly agreed more strongly with a number of statements after experiencing the adaptive website relative to the other two types of web-based experiences. These statements included

"Learning about this Civil War battle was interesting" (3.7), "I had control over what I learned related to the Civil War while using this Civil War websites" (3.8), "I had control over the Civil War information presented on the computer" (3.8), "I am confident that I will do well on a quiz over this battle" (3.7), and "I tried hard to learn the information presented about this battle" (3.8).

When asked to rate the level of interactivity each type of web experienced offered, subjects reported less interactivity in the navigational experience (1.6), relatively moderate amount of interactivity in the functional web experience (2.2), and relatively higher interactivity in the adaptive web experience (2.8). These data are also reported in Table Three.

Discussion

Due to the limited number of subjects participating in this pilot study, not many conclusions can be drawn about differences in performance and attitudes between subjects assigned to the different treatment groups. However, based on the preliminary data collected, a number of observations and questions seem worthy of further discussion and subsequent investigation. For example, subjects appeared to score higher on those quizzes that addressed information over the battles for which they developed websites (adaptive). The following observations and attitudinal responses may help explain why:

Time	Subjects spent much more time with the material as they developed their websites.
Motivation	Subjects reported that they were more interested in learning about their “adaptive” battle.
Effort	Subjects reported that they tried harder to learn about their “adaptive” battle.
Control	Subjects reported that they felt as if they had more control over the information presented as well as more control over their own learning while creating their battle website.
Interactivity	Subjects reported that they felt the adaptive experience was more interactive than the other experiences. Also, the additional time spent working together on creating the website increased the amount of time the dyad members spent interacting with each other.

All of the factors described above may have influenced the amount of information “learned” from the Civil War battle site. Certainly, a positive relationship should exist between the amount of time spent with a topic and the recall of information associated with it. In the same vein, the adaptive website did require a lot more effort on the part of the learners to understand and organize the material well enough to generate an informational web page about the assigned topic. And given the probable personality type of students who would choose to participate in a voluntary afterschool enrichment program, an increase in interest for a topic requiring a lot more “work” isn’t surprising. It is also possible that the construction assignment within the adaptive experience provided a meaningful context for learning about the relatively abstract content associated with a war fought over 200 years ago. It would be interesting to see if similar results are obtained from students across a wider range of academic ability and experience.

Perhaps the most intriguing aspect of these VERY LIMITED and PRELIMINARY findings is the notion that differences in perceived learner control as well as interactivity may have influenced learning. Although degree of interactivity has not been a research variable in many studies involving CBI, a related concept that has been investigated by researchers is “learner control.” Learner control within computer-mediated environments has been an important instructional design variable during the past 15 years of instructional technology research. Learner control has been defined and operationalized differently throughout a number of studies (see Reeves, 1993; Ross, et al, 1989), and findings from various learner control studies are mixed (see Friend & Cole, 1990; Large, 1996). Although learner control strategies have varied within different research studies, one factor that has helped to delimit all types of learner control is “interactivity.” In the case of a number of learner control studies, the users could choose to access specific types of information related to elements of an instructional program. These elements included additional examples, ancillary information, additional practice items and specific types of feedback (see Hannafin & Sullivan, 1995; Lee & Lee, 1991; Pridemore & Klein, 1993). A closer examination of different learner control studies reveals that none explicitly manipulated variables directly related to degrees of interactivity, and very few studies included data indicating the perceived level of control learners reported after interacting with the computer-mediated learning environment (Schwier, 1993). The relationship (if any) between perceived learner control, degree of interactivity, and learning would be an excellent focus for subsequent investigation!

Another important factor related to interactivity that presumably has an impact on learning within cooperative dyads is the type of social interactions occurring between group members. Originally, each dyad in this study was going to be videotaped, and the nature of group member interaction was going to be examined. The school district where this study took place had a policy against videotaping students; consequently, social interactions were not studied. In future studies, group member interaction will be closely observed, and the following types of interactions will be documented:


- Shared the mouse and/or keyboard
- Helped explain information
- Helped summarize the information presented
- Helped discern relevant information
- Asked for help
- Collaborated on making navigation decisions
- Did not respond to solicitation for help
- Checked for partner’s understanding
- Encouraged partner
- Off-task

Perhaps the most important elements provided by “constructionist” learning environments like the adaptive type employed in this study are more dynamic and constructive social interactions within a meaning and purposeful learning context. Productive social interactions between group members (as well as human-computer interaction) may be a key element for deeper cognitive processing, more motivation to learn, and more effort employed by the learners. If this is true, then the additional time needed may be justified.

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Figure One. "Navigational" Website Sample




The American Civil War

Directions: Next week, you will be given a quiz over the **Battle of Shiloh**, one of the important Civil War battles fought in Tennessee. This quiz will include multiple-choice questions about the following aspects of the battle:

<p>1. Dates</p> <ul style="list-style-type: none">• Timeline of events leading up to battle• Timeline of battle events• Timeline of events following the battle <p>2. Battle</p> <ul style="list-style-type: none">• Location(s)• Detailed Battle Timeline• Events• Outcome	<p>3. Impact of battle</p> <p>4. People</p> <ul style="list-style-type: none">• Military leaders• Other important figures <p>5. History</p> <ul style="list-style-type: none">• Official reports• Historical reflections• Historical commentary
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Click the arrow below to access a main menu of links to access specific information about the Battle of Shiloh.



To the Main Menu...

Battle of Shiloh Main Menu

Dates

- [Timeline of events leading up to battle](#)
- [Timeline of battle events](#)
- [Timeline of events following the battle](#)

Battle Info

- [Location\(s\)](#)
- [Detailed Battle Timeline](#)
- [Events](#)
- [Outcome](#)


[Impact of battle](#)

People

- [Military leaders](#)
- [Other important figures](#)


History

- [Official reports](#)
- [Historical reflections](#)
- [Historical commentary](#)



[Back to Battle of Shiloh Introduction Page](#)

Figure 2. "Functional" Website Sample




The American Civil War

Directions: Next week, you will be given a quiz over the **Battle of Shiloh**, one of the important Civil War battles fought in Tennessee. This quiz will include multiple-choice questions about the following aspects of the battle:

<p>1. Dates</p> <ul style="list-style-type: none">Timeline of events leading up to battleTimeline of battle eventsTimeline of events following the battle <p>2. Battle</p> <ul style="list-style-type: none">Location(s)Detailed Battle TimelineEventsOutcome	<p>3. Impact of battle</p> <p>4. People</p> <ul style="list-style-type: none">Military leadersOther important figures <p>5. History</p> <ul style="list-style-type: none">Official reportsHistorical reflectionsHistorical commentary
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Click the arrow below to access a page that will allow you to search and display pages which MAY include the specific information about the Battle of Shiloh that you wish to access.


[To the Search Page...](#)

Battle of Shiloh Search Page

Search for:

Group and display the results of your search by the following categories (Check as many as you wish. The default is alphabetical):

☐ Alphabetical

☐ By People Involved

☐ By Timeline

☐ By Battle Event

☐ By Location


[Back to Battle of Shiloh Introduction Page](#)

Table 1. Quiz Score Means by Battle and Instructional Web Type

Battle	Instructional Web Type			Total
	Navigational	Functional	Adaptive	
Shiloh	13.2 ^a	12.4	16.7	14.1
Manassas	14.3	15.7	16.5	15.5
Gettysburg	15.8	16.5	17.4	16.6
Total	14.4	14.9	16.9	15.4

Notes: 20 possible correct answers per battle. ^a Each battle by web type cell reflects mean quiz scores for 4 students in 2 dyads.

Table 2. Mean Time (Minutes) by Battle and Instructional Web Type

Battle	Instructional Web Type			Total
	Navigational	Functional	Adaptive	
Shiloh	52 ^a	43	173	89
Manassas	67	82	201	116
Gettysburg	64	77	195	112
Total	61	67	190	106

Notes: ^a Each battle by web type cell reflects the time for 2 dyads each.

Table 3. Attitude Response Means by Web Type

Survey Item	Web Type		
	Navigational	Functional	Adaptive
Learning about this Civil War battle was interesting.	3.2 ^a	2.9	3.7
I would like to visit other Civil War websites on the Internet.	3.3	3.4	3.6
I would like to learn more about the Civil War.	3.4	3.3	3.5
I tried hard to learn the information presented about this battle.	3.2	3.5	3.8
I had control over what I learned related to the Civil War while using this Civil War websites.	3.1	2.8	3.8
The structure of this website encouraged me to explore all the information presented about my assigned Civil War battle.	3.6	2.4	3.6
I had control over the Civil War information presented on the computer.	3.0	3.5	3.8
I am confident that I will do well on a quiz over this battle.	3.1	2.8	3.7
Rate the level of interactivity you experienced while learning about this battle from the computer. ^b	1.6	2.2	2.8

Notes: Each cell represents 12 students (from 6 dyads) responding. ^aThe scale for these items was: 4 = strongly agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree. ^bThe rating scale for this item was: 0 = Not interactive at all, 1 = A little interactive, 2 = Fairly interactive, 3 = Very interactive.

MODELS FOR WEB-BASED INSTRUCTION: A DISCUSSION OF RECURRING THEMES

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Abstract

This paper will review some of the current themes from three web-based instruction (WBI) models. These models include: Reeves and Reeves' WBI model, Ritchie and Hoffman's model, and the Duchastel's model. Recurring themes from these three models will be consolidated into a model under development for application to WBI in higher education.

Introduction

Currently there are no time-proven models for WBI in existence, simply because the Internet has not been used very long as a means of instruction in higher education. The author contends that new instructional models, which are quite different from the traditional instructional models found in today's universities and colleges, must be considered and various aspects and strategies must be adapted from existing instructional design models. These instructional strategies will be different because of the nature of teaching over the Internet, because of the functions available in online courses and because of the lack of face-to-face interaction and visual cues. The Internet allows for new methods and models of instruction, most of which could and should employ constructivist, hands-on, learner-centered, project-based, collaborative methods, strategies and activities.

Reeves and Reeves WBI Model

This model includes ten areas for interactive learning on the WWW called dimensions. They emphasize that what is important about the web is not the media, but what pedagogical features and strategies can be delivered via WBI. The 10 dimensions they propose include "(1) pedagogical philosophy, (2) learning theory (3) goal orientation (4) task orientation (5) source of motivation (6) teacher role (7) metacognitive support (8) collaborative learning (9) cultural sensitivity and (10) structural flexibility" (Reeves and Reeves, 1997, p. 59). Reeves and Reeves present these dimensions as two-ended continuums with contrasting concepts at each end. For example, they define the teachers' roles as a continuum between didactic and facilitative roles.

Ritchie and Hoffman's Model

This model incorporates instructional design principles into WBI. Ritchie and Hoffman (1997) have classified Dick and Rieser's (1989) instructional sequences into seven events that can be incorporated into instruction for the World Wide Web. These elements include: motivating the learner, explaining what is to be learned, helping the learner recall previous knowledge, providing instructional material, providing guidance and feedback, testing comprehension, and providing enrichment or remediation.

Duchastel's Model

Duchastel's model (1997) proposes radical changes to the concept of the present typical university instruction model. His web-based model for university instruction proposes several functions that define advantageous approaches to WBI. These functions are contrasted with the usual functions found in traditional university teaching. They form a model that can guide the development of courses and programs that are more appropriate to WBI. Professors and instructional designers could, rather than specify content to be learned, and common learning results, specify the goals to be pursued and accept a variety of learning outcomes. Duchastel (1997) suggests evaluating learners at the task level rather than relying on the standard mode of testing. And instead of having learners study and work individually, cooperative and collaborative learning teams should be emphasized. Instructors should encourage learners to produce knowledge rather than require the communication of knowledge. Lastly, he advocates encouraging global learning communities rather than restricting programs to local interactions (Duchastel, 1997).

Recurring Themes

At first glance, it might seem that there is not much in common between these three models. There are however, several recurring themes. The first is the need for clear goals. The second theme suggests that WBI include collaborative learning teams. The third theme addresses the issue of consciously incorporating motivational aspects into WBI. The forth theme revolves around the idea that trainers or instructors should act more as

facilitators or coaches who provide guidance and clear feedback. Finally, the fifth theme suggests that WBI facilitate the production of knowledge and the development of skills.

These themes form the basis of a working model of WBI in higher education that I am in the process of developing. This model is aimed specifically at higher education and adult learners; however, elements of this model could certainly be applicable to any type of WBI. These will lay the foundation for issues to be considered when designing, developing and delivering WBI for higher education.

The following are the basic foundations of this web-based instruction model:

- Goal-Oriented
- Motivational Provisions
- Student-Centered
- Guidance/Feedback Provisions
- Collaborative Learning Strategies
- Project-Based

Clear Goals

First, WBI should provide clear goals and expectations. Students need to know early on what will be expected from them in a WBI course. Instructors should have a clear, week by week or unit by unit explanation of the activities and exercises in the course. In WBI, learners are often unsure of how to proceed, and easily lose sight of the purpose of the course. Reiterating the goals and expectations at various points in the course may keep students on track.

Student-Centered

WBI should be more student-centered with the instructor as a facilitator or coach. Learners should take more responsibility for recognizing patterns of information, organizing the information, constructing their own views and perspectives and creating and presenting knowledge in new ways (Reeves & Reeves, 1997). In WBI, learners can and should be presented with problems to solve, and projects and papers to complete. In WBI the tools are readily available to allow the instructor or trainer to take on the role of facilitator, coach, mentor or guide.

Guidance/Feedback Provisions

Since there may be little or no face-to-face interaction in an online course students will require a large amount of guidance and feedback. This can be accomplished by providing the students with a detailed syllabus and a clear timeline for discussion of content, activities, projects and discussions. It is also important that students receive feedback in a timely manner. E-mail should be answered within a day or two. If there is no time for a detailed answer, the instructor should at least acknowledge that the e-mail was received and a more complete answer will be sent later. This answer could be in the form of a posting to a FAQ or even a group e-mail if required. In order to keep students on track and informed, the instructor may want to consider either posting a weekly reminder to the course web site or sending a group e-mail. Some online software allows for a message center where an instructor can post messages for all students to see. An online journal provides a format in which the learner record reflections on materials covered and instructors can provide personalized guidance and feedback. Finally, it is important the WBI instructor or trainer learn strategies for facilitating asynchronous online discussions and synchronous chats. These skills come over time with practice and experience.

Motivational Provisions

Motivational issues are always essential in instruction, but they are much more important for WBI because there is no face-to face interaction available. Learners in a WBI environment will benefit greatly if provided with positive feedback, relevant problem-based learning (PBL) activities, relevant examples, and the establishment of the value of skills to be acquired in the WBI course (Duchastel, 1997).

Collaborative Learning

There are a rich array of possible techniques and strategies for incorporating collaborative and cooperative learning into WBI (Bonk & Reynolds, 1997). Students could collaborate on projects via e-mail, or through synchronous or asynchronous conferencing. Students in conferencing situations could be assigned roles such as a leader, initiator or facilitator of discussion topics (Bonk, Appelman, & Hay, 1996). Giving students roles in discussions facilitates students' processing of the content. Structured controversy, also known as academic controversy, (Millis & Cottell, 1998) is another strategy which would work well in the WWW environment. Teams of students would be assigned opposing viewpoints of a controversial topic. The teams would gather materials and present their sides. Later teams would reverse their roles and argue for the opposing viewpoint. (Millis & Cottell, 1998)

Project-Based

The web offers a rich variety of possibilities for project-based activities. Students can collaborate on research papers, on problem/solution activities, authentic, real-world and practical activities. The hyperlinking capabilities of the Web and the large amount of resources online also present many possibilities for rich project-based activities. These types of activities give learners the chance to acquire skills useful in real-world situations and experience working as a member of a team.

Conclusion

This model is far from complete and is not intended to cover every single aspect of WBI in higher education. Rather it aims to give instructional designers, course developers and faculty a starting point for the design and development of WBI. This model is still very much in the process of being developed, and fine-tuned. The author invites suggestions and feedback on this Web-based instructional model.

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MULTIPLE INSTRUCTIONAL DESIGN MODELS: NECESSITY OR EXCESS BAGGAGE?

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Abstract

The topic of the proliferation of Instructional Design models is often overlooked, ignored and considered cliché. This paper explores the necessity for the multitude of models, as well as a simple framework for keeping them organized. Additionally, a rationale is given for accepting empirically validated instructional design models. The reasons include professional accountability and historical honesty (we learn from our past trials and tribulations). Furthermore, the author posits that the learning process and the design environment are far too complex, and our knowledge of the learning process incomplete, to accept the status quo of any one particular model.

A brief reflection of the past 30 years of Instructional Technology reveals an ever-evolving profession. Deep within this evolution are the instructional design models that comprise the methods by which designers ply their trade. A review of the literature relating to this period of time supports this notion. For instance, McCombs (1986) posits that the years between 1970 and 1985 represent a period of time of significant change within instructional design models. However, the inherent change during this time didn't effect the rather ubiquitous category of general design tasks. It was the instructional design strategies and processes that continued to change in response to the demands of the times.

In the late 1990's, Instructional Technology can still be considered a relatively new discipline (Sullivan et al, 1997). Professions yet to mature can expect to undergo periods of significant change and even evolution. The status of instructional design models is positioned at the forefront of today's contribution to this evolution. In a context similar to the one asserted by McCombs (1986), Willis (1998) suggests "that models continue to change as new theories of learning and instruction become popular and influential" (p.5).

These changes are anchored by a desire to understand how learning occurs and how to best facilitate the occurrence of learning. Furthermore, Merrill (1991) postulates that very little is known about the acquisition of knowledge. It would appear that Instructional Design will continue to evolve as Instructional Technology professionals strive to understand the learning process and utilize their findings to augment existing design methodologies and develop new paradigms.

Just as instructional design models continue to evolve, so have the number of models increased. Edmonds (1994) found that "since the first appearance of instructional design models in the sixties, there has been an ever increasing number appearing in the literature of both instructional technology and general education" (p.55). Additionally, Gustafson and Branch (1997) acknowledge the amount of research, and the number of related models, has grown disproportionately through the expanded use of systematically designed instruction. Consequently, a systematic approach dominates as the prevailing instructional design methodology.

Related to the systematic design of instruction is Instructional Systems Design (ISD) of which there are many representative models. It has been suggested that ISD provides those directed with designing, developing, and delivering instruction an excellent means of controlling quality, providing a common source of communication, and managing projects. Additionally, McCombs (1986) found that ISD models generally address all design tasks and, because of their methodic nature, lend themselves well to virtually any instructional design project."

Alternatives to the traditional ISD models are becoming more prevalent. At the forefront of this charge are influences based upon Constructivist tenets (Willis, 1995) and the fields of performance technology and organizational development (Reigeluth, 1996). These tenets are impacting the way traditional instructional design models are evolving (Dick, 1996; Reigeluth, 1996) and new models are developing. Trying to decipher the nuances of each and every model presents an imposing task for researchers and practitioners alike.

Comparative Frameworks

To help with this task, several individuals have proposed a taxonomy of ID models based upon grouping of like characteristics. Edmonds (1994) suggests that Andrews and Goodson (1980) and Gropper (1983) were primarily responsible for early efforts in this area. Andrews and Goodson's (1980) framework was comprised of categories or dimensions: Origin, Theoretical Underpinnings, Purposes and Uses, and Documentation. Gropper (1983) presented a metatheory, which is intended to compare instructional design theories and models. A work by Gustafson and Branch (1997b) suggests that instructional design models could be placed into one of three categories: classroom focused, product focused, and system focused. Edmonds (1994) builds upon the works of others by extending his analysis to a framework that includes context, orientation, knowledge structure, expertise level, structure, and level. This framework was then developed into a matrix as a means of simply comparing instructional design models. Other

frameworks are either aimed at suggesting the superiority of one model over another or aren't comprehensive enough.

The frameworks cited are very appropriate for their intended purpose. With the exception of the work by Gustafson and Branch (1997b), however, the frameworks aren't very intuitive for individuals with less than an advanced knowledge of instructional design terminology. This creates a problem of interpretation. Methodological sophistication is not worth much if you cannot reach the audience you wish to reach, and it is difficult to serve both a technical audience and a general audience in the same work. The framework represented in Table 1 is a modification of the frameworks listed above (see Andrews & Goodson, 1980; Edmonds et al., 1994; Gustafson & Branch, 1997b). Its purpose is to simplify the comparison of models and reach an audience far less technical in orientation than those served by more sophisticated frameworks.

Table 1 Modified Comparative Framework

Context	ID Model	Expertise	Product		Orientation		Knowledge Structure	
			Unit, Module, Lesson	Course, Institution	Descriptive	Prescriptive	Procedural	Declarative
K-12	IDI	Novice	X			X	X	
	Gerlach and Ely	Novice	X			X	X	
	Dick and Reiser	Novice		X	X	X	X	
	Heinich/Assure	Novice	X		X	X	X	
	R2D2	Expert	X		X			X
Higher Education	Diamond	Expert	X	X	X	X		X
	Kemp	Novice	X		X	X		X
	Gerlach and Ely	Novice	X			X	X	
	Romizowski	Expert	X	X		X		X
Government	Chaos	Expert	X	X	X			X
	Dick and Carey	Novice	X		X	X	X	
	IPISD	Novice	X		X	X	X	
	Van Patten	Expert	X			X	X	
Business Training	Bergman and Moore	Novice		X	X	X	X	
	Kemp	Novice	X		X	X		X
	Van Patten	Expert	X			X	X	
	Dick and Carey	Novice	X		X	X	X	
	Rapid Prototyping	Expert	X		X	X		X

Although most of the general classifications were retained from earlier works (see Edmonds, Branch et al., 1994), the categories were rearranged for ease of reading. The classifications with brief definitions are as follows:

- **Context.** Similar to Gustafson's (1998) framework. The type of environment for which an ID model appears best suited first delineates table 1.
- **ID Model.** A representation of systems and non-systems based ID models.
- **Expertise.** The level of knowledge one must possess before attempting to utilize the model.
- **Product.** The type of product for which the model appears best suited.
- **Orientation.** Whether a particular model is better at prescribing or describing the steps of the ID process.
- **Knowledge Structure.** Procedural or declarative related outcomes. The procedural aspect relates to how learners reach their goals. With the declarative orientation, the learner is able to state why something is the case. (Edmonds et al, pp.60-71)

It is important to note the various categories aren't mutually exclusive. Just because a model is considered novice, doesn't mean that it isn't well suited for expert level designers. On the other hand, expert level models are more or less heuristic and probably wouldn't be well suited for novice designers. Similarly, some models may not be adequate for more than one context area (see Edmonds et al, 1994).

Conclusion

Models are a vehicle of communication . . . a way of making abstract ideas concrete. Additionally, models can serve as algorithms for problem solving, as avenues for scientific discovery, and as job aids. Instructional Technologists have done well to provide their peers with a plethora of models from which to choose. The framework presented in this paper is one of the ways in which these models may be organized. The models this paper represents are only a few of the multitude that exist. Are all of these models necessary? The answer is a qualified, it depends.

Much like an architect, an instructional designer is able to better construct meaningful relationships with his or her environment once the foundational relationships are understood. Whether the model of choice at the time is the Dick and Carey model or a model by any other name, awareness of the other design models within the profession

has its merits. To not consider the merits of other models is shortsighted and professionally irresponsible. Is it responsible to accept the status quo of any particular model, when we don't completely understand the learning process and, therefore, the best way to facilitate the learning process? Reigeluth (1996) asserts, that "we should not reject the basic tenets of current and past ISD models. These paradigms offer the knowledge generated from past experiences and provide us with the building blocks for future direction."

There is a problem, however, when these paradigms or models lack a firm foundation upon which to build this future. Many of these models lack the scientific proof necessary to provide evidence of validity. Willis (1998) states, that "we can adopt a behavioral, a cognitive, a critical, or a constructivist framework for design, but whatever framework we adopt, it will be on the basis of something other than convincing body of research that demonstrates that framework is stronger than the others" (p.12).

It becomes incumbent of all stakeholders to critically assess the validity of instructional design models. On one hand, there is a need for researchers to continue investigations that help bridge the gap between theory and practice. Consequently, Developmental research can show how models and theories work and identify situations of optimal performance. Richey (1997) On the other hand, practitioners can contribute by staying abreast of professional developments. By doing so, there is an increased likelihood that models are utilized as intended and learning strategies match the desired outcomes.

Comparative frameworks, such as those proposed by Gropper (1983), Andrews and Goodson (1980), and Gustafson (1997b), provide a means by which many of the models may be compared and organized. The author's modified framework is meant as a tool for a novice; a starting point which is seen as less confusing (and rigorously developed) than many of the other frameworks discussed within this paper. As models are compared and either gain acceptance, lose favor, or are forged into new paradigms, both learner's and Instructional Technology wins. This means the likelihood increases that individuals eager to learn will be able to do so in an environment conducive to the pursuit of their endeavors, with materials and media designed to optimize their learning experience and abilities.

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WHAT CAN WE LEARN FROM COMPUTER GAMES: STRATEGIES FOR LEARNER INVOLVEMENT

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This paper reports the findings of an ongoing study of engagement in computer-based learning environments. Participants engaged in both open systems and closed systems were studied to ferret out strategies of learner engagement. Findings indicate that problem identification, physical representation, and interaction styles can be manipulated to help foster engagement of learners in computer-based learning environments.

Introduction

The computer and all of its digital manifestations are causing us to rethink the way we do everything from producing to disseminating media (Negroponte, 1996). The term Virtual Reality (VR) is meant to imply that the reality exists outside of the physical world. For a number of people, computer generated reality isn't virtual at all. Computer generated environments are real: they just happen to be on the computer. This can best be seen in computer and video games, where people may spend their time, to the point of distraction, playing these games. It matters not that the environment has no counterpart in the physical world. What matters is the quality of the interactions, the problems, and representations of them. People not only play in these environments, but they live within these environments as well (Herz, 1997). For better or worse, digitally rendered environments can be as, at times more, engaging than reality. While this is true for computer-based gaming environments, this is not true, necessarily, for computer-based learning environments (Jones, 1997). The impetus for this study was not that educational software should look like, or in any way mirror computer games. Educational software that tries to copy gaming patterns tends to be fatuous. Rather the question was are there engagement strategies that are used in games that can be applied to educational software. Again, the desire was to look at strategies and not techniques. The purpose of this study was to look at what engages people in computer games, and to see how those patterns of engagement might be used within computer-based learning environments. The findings presented here represent nearly two years of studying various populations of people as they play games and work in computer based learning environments. The study has progressed to include both open and closed environments (Jones & Farquhar, 1997). The ages of participants ranged from age 4 to adulthood. The number of study participants to date is 17. However it should be noted that each individual may have been engaged and studied in multiple environments. Current research is looking at on-line formal and informal learning communities.

Procedures

Engagement here is defined as "...nexus of intrinsic knowledge and or interest and external stimuli that promote the initial interest in, and continued use of a computer-based learning environment" (Jones, 1998, pg. 205). Engagement was studied in three ways: (1) direct observations of people as they worked in an environment; (2) interviews with people after they had been engaged in the environment; (3) analysis of written discourse through e-mail, journals, and other artifacts. Many of the interviews were conducted at a distance, consequently not all participants were observed working in the environment.

Findings

Findings of the study are presented through a combination of narratives and static graphics. Because many of the findings discussed here involve intricate interactions, it may be difficult to represent them on a printed page.

Problem Definition

Engagement was found to be enhanced due to the nature of the problem itself. Problems that are accepted by a user can promote engagement, and consequently the user maintains interest in the problem. Interest in the problem, or having a well defined question, provides the learner with intrinsic motivation to be working within the environment.

Learners who are intrinsically, or self, motivated have found that something as generic as a multi-media encyclopedia can be engaging. The motivation comes from within, and the environment itself need not be engaging beyond its ability to present the content in a factual manner. Learners have reported being engaged in generic environments such as data bases. For example, one participant was relocating to another city, and was doing research on their new city. While not formal didactic instruction, the activity was certainly about learning.

Ned and his family were relocating to Tampa, FL from Chicago, IL. Among the many things he had to do was to find a house. Ned is a 60 year old college professor. While he has access to the WWW, he has never used it beyond very simple browsing. When shown a web site listing real estate for sale in Tampa, his interest and expertise increased as his use increased. The problem itself provided him with a compelling reason to be on line. He reported increased interest in the web, and demonstrated greater command of the online world. "It is funny. I started out looking for a house, but what I found was a collection of information that was available to me. I soon found out that I could manage one of retirement accounts on line. I never thought that I would ever do this."

The point is not a dramatic conversion to the WWW. The point is that Ned found a problem that engaged him, thus keeping him actively engaged in the environment. Finding other problems that were equally engaging has kept him using the web. Ned has not, at this reporting, become an expert HTML programmer and opened an e-commerce operation. It is unlikely that he will. He will, however, continue to use the WWW to solve certain types of problems thus pointing further that problem identification by the user can be an important means of engaging the user. Learners who can generate their own problems often demonstrate greater manifestations of engagement in open systems. In closed systems, the problem is often generated for the learner.

If the learner is not intrinsically motivated, or interested in the problem the environment provides, then the environment may need to offer greater extrinsic motivational features to keep the learner interested. This was noted in non-golfers playing computer-based golf games. People who were not golf players in the physical world were often engaged in golf games. There are many reasons for this. It is less time consuming to play golf on a computer. It is less expensive; less stressful, and for many people, less embarrassing. One of the key reasons stated by several participants was that the manner in which the game was represented gave them the impetus to play it.

"I don't really have the time to play golf. I have always thought it to be kind of an elitist activity. And I really don't think I want to play golf 'live.' But I did think that the golf game was kind of cool. It didn't feel much like golf, but more like just, you know, playing any other kind of game. ...the music in the background was a little weird, but the graphics were very good. I liked having the control over the game. Choosing the clubs, having to click just right to get the right swing...."

While this person did not find golf that interesting, the environment about golf was interesting. And while problems which are fatuous or uninteresting do not promote engagement regardless of the quality of the visuals or other features of the product, the quality of the presentation appears to have an impact on whether or not somebody will try the problem. This leads into the next area, visual quality.

Visual quality

The gaming community appreciates not only good problems, but well rendered problems as well. In order to contribute to the engagement of the user, graphics and other multi-media assets must not only be well rendered, but must also contribute to the gestalt of the environment. Including graphics as "window dressings" is not appreciated, and can impact engagement levels negatively. As one player in a computer game reported:

"I don't know why they included those video clips on top of the heads of the still graphics. I suppose it is because they could. But honestly I started to think of some old Saturday Night Live gag, and I couldn't take it seriously."

In looking at the use of multi-media assets in varying environments, it has become useful to look at them through the lens of Csikszentmihalyi's (1990) Flow Theory. I propose that there are two types of aesthetic elements, active and passive aesthetics (Jones & Surry, In Press).

Passive Aesthetics

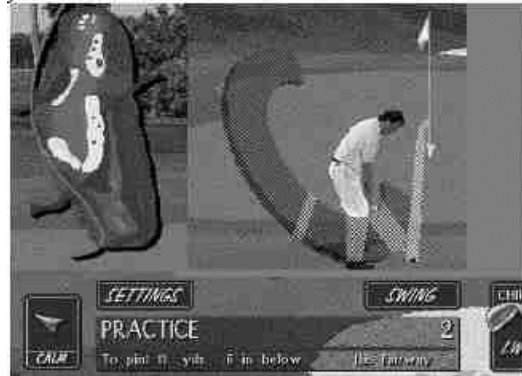
Passive aesthetics may be aligned with Csikszentmihalyi's (1990) definition of pleasure. Pleasure is defined here as being passive in nature, and not requiring active participation by an individual. Passive aesthetics are elements in the program that may provide visual or auditory texture to the program. For example, background images in a program can do a number of things. A background can provide depth and texture to your program. It can provide learners with a visually pleasing image that is not overwhelming to look at, and which may provide the developer with an interesting canvas on which to "paint." Additionally, background music can help set the tone for an environment as well. For example, the driving beat in *Doom II* provides a feeling of intensity, while the nature sounds in *Golf* give one the feeling of being out of doors. Background images may help the user maintain the feeling of belief in the environment. Simply having an attractive background is not enough. The background must sell the user on the underlying theme (I hate to say metaphor) of the program.

In educational software, passive aesthetics are often attended to. It is not difficult to locate background images that can add visual depth and texture to the program. The washed out image residing behind control bars is quite familiar to us. It is seen in both educational CD-ROMS (closed systems) and web-based environments (open systems). What is more difficult is finding tools that are integrated into the visual system of the program which perform the function intended. We refer to these elements as active aesthetics.

Active Aesthetics

It is easier to locate active aesthetics in commercial computer games than in educational software. It is also difficult to represent them on the printed page. Active aesthetics are tools within the environment which perform particular functions within the environment. For example, in *PGA Tour Golf III* your goal is to manage all the data available to play the hole well. The user has access to wind direction and speed, the type of terrain, and suggested club to be used. This is represented in Figure 2. These pieces of the program all work together to weave a seamless fabric of integration of images, content, and control. It works to provide the user with an environment that works to promote the engagement of the user.

Figure 2. Tools Working Together In An Environment



Within educational programs, active aesthetics serve as tools to help people interact with the software. At its most basic level, we are talking about stimulus and response activities here, and stimulus response activities are often pejoratively associated with behavioral psychology and basic drill and practice activities. But it is important to note that what involves people in a computer based environment is *being involved*. Users should be clicking, dragging, calculating, comparing, and generally interacting with the information in the program itself. Simply being presented with the information is not enough for many learners. Working with the information takes on paramount importance. It follows that if we are to develop interactive materials then we need to develop methods to allow users to interact. Computer games provide two types of interaction to examine.

Types of Interactions

Interaction in computer games can be classified in two ways: Twitch and Strategy games. Strategy games are ones in which the user must employ higher order thinking skills and problem solving skills to continue playing and win the game. Twitch games are games in which the user must react quickly to circumstances, usually by killing someone, to continue playing and win the game (see Figure 3). *SimCity* and *War Craft II* are immediate examples of strategy games, while games like *Doom* and its various representations are consummate twitch games. The advantage to a twitch game is that the movement is quick, and the feedback immediate. This works to keep the user actively engaged. However the level of this engagement is often superficial. It does not typically engage one beyond the most basic level of seeing, pointing, and clicking. Strategy games require the user to look at the larger problem, and plan a strategy to solve the problem. In some games, such as *SimCity*, the results of your decisions are not immediately recognized. You must have a fair amount of internal motivation to stay with the game to realize the fruits of your labor. While twitch games offer immediate results of your work, strategy games appear to offer a greater feeling of accomplishment and satisfaction. One participant who was playing *War Craft* praised the combination of “twitch and strategy.” While they ultimately liked working on complex problems in an environment, they also appreciated the sheer visceral rush of immediate feedback.

Consequently, when designing learning environments, it should be the goal to include “fast action” along with a more unifying problem to be solved. One simple method of doing this is to include twitch type mini-games within a larger strategy game. *Monty Python’s Quest for the Holy Grail* does this, as does *11th Hour*. And while it is not seamless, and can appear a bit crude, it does at least provide a faster element to the environment than many strategy games typically afford. Educational games such as *Math Blaster* offer the twitch with some elements of thinking, but these types of games are simple drill and practice activities in disguise. They are good for practicing certain skill sets, but do little to help develop higher order thinking skills. One possibility would be to use math skills to solve certain problems that relate to the larger problem. The difference is that the individual skills then become tools to solving the larger problems, which is ultimately the goal of education in the first place.

Point of View

Engagement can be done through how the user sees or controls the screen. Referred to as Point of View (POV), the reference point that one takes can influence how one is engaged. Looking at the screen down the barrel of a gun (see Figure 3) engages you in the world as the participant. You never see the entity being controlled: it is assumed you are the entity and you are controlling yourself.

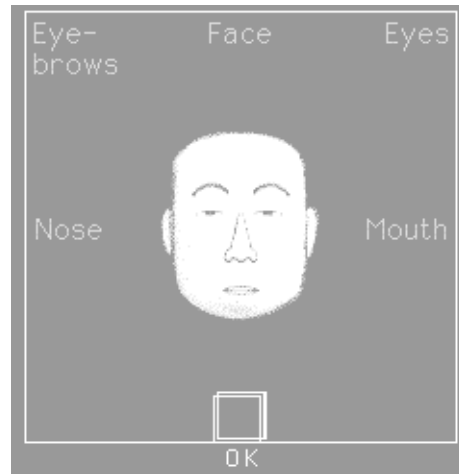
Figure 3. A Single Point Of View: Looking Down Barrel Of A Gun In A Twitch Game



Other games, such as Golf, (see Figure 2) have you see the person you are controlling. There is a distinct visual difference between the two. In one, you are looking at the world as a participant. In the other, you are looking at the world as a disconnected observer/controller. People engaged in these environments do not report a difference between which environment is likely to be more engaging initially. Nor does there appear to be any difference in a person's ability or likely hood to accept that the entity being controlled is the user in either environment. The key difference appears to be that over time many people become bored with a single point of view. Therefore it may follow that multiple perspectives in the environment can help keep the user engaged in the environment. Working from a single POV can promote tunnel vision, and may not support continued use over time. This supports something that has been known in the gaming community for a number of year: A level is still just a level. The quality of the level, the problems one encounters, how those problems are manifested, will determine how well it is received by the user. Many games provide the user with multiple points of view. One may be from the perspective of your character or agent, the other may be a map view to help you navigate a maze, as in *Doom II*, the other may be a birds eye view, as in many golf games, to let you see the entire hole at one time. Multiple views provide multiple perspectives, or multiple representations of the phenomenon. Multiple perspective appear to provide a greater feeling of engagement on the part of the user. In *Kyoto: The Cosmology of Old Japan*, the user has the opportunity to determine physically how they are represented (See Figure 4). There appears to be some support for allowing this kind of control over the POV.

In Kyoto: The Cosmology of Old Japan the user has the option of selecting the features of their character in the program. One can select gender, body type, and facial features. Among participants, this was found to be a unique feature. Only one person represented themselves as a different gender, but many people played the game several times from different perspectives. Sue, an 18 year old college freshman said: "What was weird was that I felt like different things happened because of the shape of my face. I don't know if they did, or if my awareness of it changed. ...I definitely knew that I was different in the game."

Figure 4. Changing The Face Of Your Character In An Environment



Future Research

In terms of problem identification for users, this appears to provide greater support for student centered learning environments. As we move from more traditional closed learning environments, such as educational CD-ROMS to more open environments as can be found on the WWW, the notion of letting learners generate the problem becomes more critical. The one area that those of us working in educational software need to consider more carefully is representation of our materials. It is becoming increasingly important to produce materials that can challenge a sophisticated group of users. As always, more research is needed to fully understand exactly how and why people are engaged in computer-based learning environments.

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COMPARISON OF GENERATIVE LEARNING STRATEGIES

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Abstract

The purpose of this study was to assess the effectiveness of two generative learning strategies, concept maps and manipulation of objects, and to determine if either works better with individual learners or in cooperative learning groups. A total of 80 sixth-grade students in science education were randomly assigned to group or individual conditions and to one of the two experimental treatments. Experimental treatments were changed between first and second post-test. Long-term retention was evaluated with a third and delayed post-test. Students starting with concept maps showed higher achievement on delayed post-test than students beginning with manipulation of objects. No difference was found between students working as individuals or cooperative student teams. Furthermore, a significant interaction between generative learning strategy and grouping condition was revealed. Implications for sequencing generative learning strategies are discussed.

Introduction

“How can I help my student learn?”

The goal of increased student learning is a fundamental concern for teachers. Over the years, learning techniques and strategies have evolved as our understanding of learners, and how they acquire knowledge, has grown. From the 1950s to the early 1980s, much of the prevailing educational research focused on improving teaching by analyzing elements of *external* stimuli that formed the instructional environment. In the 1980s and 1990s, more energy was focused on identifying the processes that occur *internal* to the individual. Although many questions remain unresolved, countless educational researchers view learners as active participants in their learning, and believe that the role of a teacher should be to facilitate the learner's efforts to make meaning of their world (Jonassen, Beissner, & Yacci, 1993; Jonassen & Tessmer, 1996; Wittrock, 1974, 1990, 1991, 1992).

But how does a teacher facilitate knowledge acquisition? According to Osborne and Wittrock (1985), teachers need to provide opportunities for students to construct their own knowledge and to reflect on their freshly generated views. A common teaching strategy is to create an environment in which students analyze new material, provide opportunities for students to combine their new ideas with previously constructed knowledge, and facilitate student articulation on how the new information fits in with their existing mental structures. As this occurs, new mental structures are created, or existing structures clarified. The teacher's role then is to assist the students by providing additional information to either clarify the knowledge structure if misconceptions are obvious or to enrich, enlarge, and strengthen their newly developed mental structures.

Although students are continually going through the process of constructing and molding their knowledge networks, teachers often structure events to facilitate this process. Many of these activities have their roots in a learning theory originally articulated by Merlin Wittrock, known as generative learning theory (Grabowski, 1996; Wittrock, 1974).

Types of Generative Learning Strategies

The fundamental concept upon which generative learning strategies is based is that learning involves the creation and refinement of individual mental constructions of the world. Thus, facilitating that construction should be a primary concern for teachers. On the other hand, not all class work is considered generative in nature, even though it might help students build and clarify their conceptualization of the environment. Grabowski (1996) informs us that only those activities that involve the actual creation of relationships and meaning are classified as generative learning strategies, and that there are two basic families of these strategies.

One type of strategy is used to generate organizational relationships between different components of the environment, which helps a learner understand how items are related to one another. Well documented examples include creating titles, headings, questions, objectives, summaries, graphs, tables, and concept maps. On the periphery of this group is the manipulation of objects which some argue may also qualify as a generative strategy, “because a relationship is being drawn and extended between parts of the environment” (Grabowski, 1996, p. 911). A second type of generative activity integrates relationships between external stimuli and memory. Examples include asking students to construct demonstrations, metaphors, analogies, examples, pictures, applications, paraphrases, or inferences. This group differs from the previous group in that these strategies not only require deeper processing of the instructional content, but they also result in a higher level of understanding.

Problem statement

Although generative strategies have been found to improve the effectiveness of learning (for a discussion of the studies on generative learning see Wittrock, 1992, or Grabowski, 1996), it cannot be assumed that all generative strategies work equally well under all conditions, and questions regarding the selection of appropriate strategies or how best to implement them are not yet sufficiently solved.

One question related to the instructional setting is whether students learn better as individuals or in groups. Kourilsky and Wittrock (1992) found that cooperative learning environments foster generative learning. Based on their study with 12th grade economics students, they reported that, "Cooperative learning appeared to provide an excellent context for students' discovery of one another's misconceptions and for the generation of alternative relations that better synthesize experience within the concepts of economics" (p. 874). However, the success of cooperative learning depends on effective small group interaction, which cannot be assumed for all groups. Hooper, Sales, and Rysavy (1994) replicated a study conducted by Wittrock and Alesandrini (1990) examining the effects of generative learning strategies on text comprehension. Hooper et al. attempted to extend the original study by investigating the effects of using a generative learning technique while studying alone or in small groups. Unexpectedly, they found that students working alone achieved better results on a posttest than students learning in groups. The researchers attributed this effect mostly to deficiencies in group interactions.

The instructional setting may influence the selection and effectiveness of appropriate generative learning strategies in other ways as well. For example, science and math teachers often face different requirements and challenges in terms of resources, classroom organization, etc. when conducting experiments that require specific apparatus as compared to traditional teaching activities. Under such conditions, the additional efforts can only be justified through improvements in the expected outcomes. As stated earlier, manipulating these sorts of objects may also qualify as a generative strategy and therefore justify the additional efforts, yet little research has been done in this area.

Sayeki, Ueno, and Nagasaka (1991) investigated the effectiveness of using a manipulative strategy to teach Japanese elementary students how to calculate the area of a parallelogram. The way students used the mediational objects appears to qualify as a generative learning strategy. Sayeki et al. reported that the use of the manipulatives increased students' comprehension of mathematical principles. Might it be possible, then, that manipulative activities can be truly considered generative, and successful in other content areas and for other types of learning outcomes? This question, along with the question of whether an individual or team approach works better for generative learning environments, became the driving forces of our study.

Purpose of Study and Hypotheses

The purpose of this study was to assess the effectiveness of two generative learning strategies, concept maps and manipulation of objects, with sixth-grade students, and to determine if either strategy works better with individual learners or groups of learners.

Two research hypotheses were generated:

- Based on the notion that the manipulative activity of completing a science experiment acts as a generative learning strategy, students who use this method will obtain criterion achievement scores equal to those of students developing concept maps on the same topic.
- Students who work in teams will score significantly higher on criterion achievement tests than students who work individually.

Methodology

Population and sample

The accessible population was sixth-grade science students enrolled in a middle school in San Diego, California. The cluster sample of 80 students included all sixth grade students at this school. Three students dropped out of the experiment between the second test and the delayed-post test.

Materials

A chapter from the Prentice Hall Science textbook *Exploring Earth Science* (Maton, Hopkins, Johnson, LaHart, Warner, & Wright, 1995) served as basis of the subject-matter content. Knowledge acquisition was measured by a 13-question multiple-choice test. Questions for the test came from the chapter test and additional questions were generated to match the content area. The classroom teacher worked with the researchers during the construction of the additional test questions, and verified the questions' face-validity.

Treatment and Procedure

Students were randomly assigned to one of four treatment groups using the class list and a table of random numbers. The groups included students working with concept maps in a team situation (CT), students working with

concept maps individually (CI), students working with manipulatives in a team situation (MT), and students working with manipulatives individually (MI). Each of the four classrooms had approximately equal numbers of students in each of the four groups.

Each classroom participated in parallel instruction provided by the same teacher and textbook. At the conclusion of the first chapter segment (about 1/3 of the way through the chapter), students in the CT and CI groups were separated and moved to another room. There, they were given a blank sheet of paper. They were then asked to generate a concept map that describes nine characteristics of minerals (the topic they had just studied). All students were familiar with making concept maps as they had made numerous concept maps earlier in the school year. Students assigned to the CT group created the concept maps in teams of two or three students, while the students assigned to CI created concept maps individually.

Students assigned to groups MT and MI were separated and given a set of hardness points, a Moh's hardness scale table, a mineral color chart, and a set of six minerals. The students were asked to use the equipment and charts to identify each mineral sample. Students in MT performed the experiment in teams of two or three students, and students in MI conducted the experiment working individually. Students in all four groups (CT, CI, MT, and MI) were allowed to use the textbook as support material.

The following day all students were assessed on their knowledge of the content with use of the instrument described above.

At the conclusion of the chapter (10 days later), students who previously created concept maps were assigned to conduct the manipulatives experiment, and students who conducted the experiment created concept maps (the CT group switched activities with MT, and the CI group switched activities with MI). To allow testing of the second hypothesis, students who worked in teams during the initial activity continued to work in teams during the second activity (although they switched between concept mapping and manipulatives). The next day a chapter test was conducted, including the same questions as used during the initial quiz. Thirty-two days later all students completed a delayed posttest which was part of a larger unit test.

Results

Descriptive Statistics

The group names, number of individuals, means, and standard deviations of the results for each of the three tests are shown in Table 1. Note that the differences in the number of individuals (n) are caused by the variance in class size combined with variations due to using the table of random numbers.

Table 1. Descriptive statistics for the three tests

Group names based on first test	Test 1 (Following day)			Test 2 (10 days later)			Test 3 (32 days later)		
	n	M	SD	n	M	SD	n	M	SD
Manipulatives, Teams (MT)	18	10.72	2.35	18	11.11	1.97	18	10.56	2.23
Concept Maps, Teams (CT)	22	11.95	1.25	22	12.05	1.00	21	12.14	1.11
Manipulatives, Individual (MI)	19	11.32	1.53	19	12.05	1.39	19	11.63	1.80
Concept Maps, Individual (CI)	21	10.9	1.58	21	11.05	1.47	19	11.47	1.78
Concept Maps, Total	43	11.44	1.50	43	11.56	1.74	40	11.82	1.48
Manipulatives, Total	37	11.03	1.97	37	11.56	1.33	37	11.11	2.07
Teams, Total	40	11.40	1.90	40	11.63	1.56	39	11.41	1.87
Individuals, Total	40	11.10	1.55	40	11.53	1.50	38	11.55	1.77

Inferential Statistics

The data were statistically analyzed using a 2 X 2 factorial analysis of variance (ANOVA), with a level of significance set at .10. The level of significance was set at .10 because little research has been done comparing generative learning strategies (therefore this could be considered an exploratory study) and we felt it better to make a Type 1 error than a Type 2 error. The two manipulated variables under study included the types of generative learning strategy (concept maps and manipulatives) and the method of instruction (individual and team). Besides comparing the initial test results, a secondary analysis was conducted to identify if any changes in long-term memory occurred that may have been dependent on the treatments.

The following charts report the F and p values from the three tests:

Table 2. ANOVA table for Test 1

Variable	DF	Sum of Squares	Mean Square	F-Value	P-Value
Concept Map / Manipulatives	1	3.352	3.352	1.166	.2837
Team / Individual	1	1.034	1.034	.360	.5504
Concept Map / Manipulatives * Team / Individual	1	13.418	13.418	4.668	.0339
Residual	76	218.480	2.875		

Table 3. ANOVA table for Test 2

Variable	DF	Sum of Squares	Mean Square	F-Value	P-Value
Concept Map / Manipulatives	1	.25	.25	.011	.9150
Team / Individual	1	.016	.016	.007	.9323
Concept Map / Manipulatives * Team / Individual	1	18.688	18.688	8.627	.0044
Residual	76	164.632	2.166		

Table 4. ANOVA table for Test 3

Variable	DF	Sum of Squares	Mean Square	F-Value	P-Value
Concept Map / Manipulatives	1	9.802	9.802	3.192	.0781
Team / Individuals	1	.794	.794	.259	.6126
Concept Map / Manipulatives * Team / Individual	1	14.612	14.612	4.758	.0324
Residual	76	224.174	3.071		

Concept Maps and Manipulatives

For both Test 1 and Test 2, no significant difference was found between either of the two generative learning strategies (manipulatives and concept maps). This supports the first hypothesis that students engaged in a manipulative activity will achieve scores equal to those of students developing concept maps on a similar topic.

The delayed posttest, however, revealed a statistically significant difference between concept maps and manipulatives, $F(1,76) = 3.192$, $p < .10$. This result identifies a statistically significant difference in long-term retention scores among students who began with concept maps ($M = 11.82$) compared to students who initially worked with manipulatives ($M = 11.11$).

Individual Learning and Collaborative Learning

No significant differences were found among students who worked individually versus collaboratively in any of the three tests. This finding fails to support the second hypothesis that students who work in teams would score significantly higher than students who work individually.

Interaction between Strategies and Organization

For each of the three tests, the factorial ANOVA revealed a statistically significant interaction between concept maps/manipulatives and teams/individual. In Tests 1, 2, and 3, the respective F values were: $F(1,76) = 4.668$, $p < .10$; $F(1,76) = 8.627$, $p < .10$; $F(1,76) = 4.758$, $p < .10$. The graphs below display the interactions for each test.

Figure 1: Interaction Line Plot for Test 1

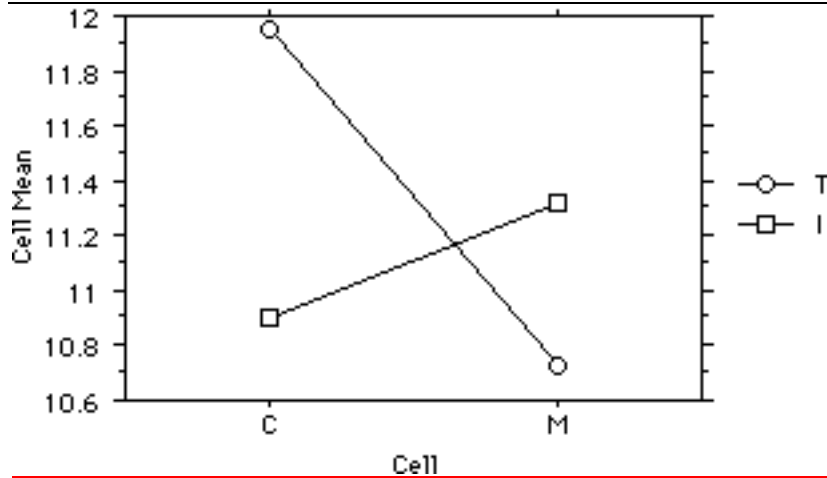


Figure 2: Interaction Line Plot for Test 2

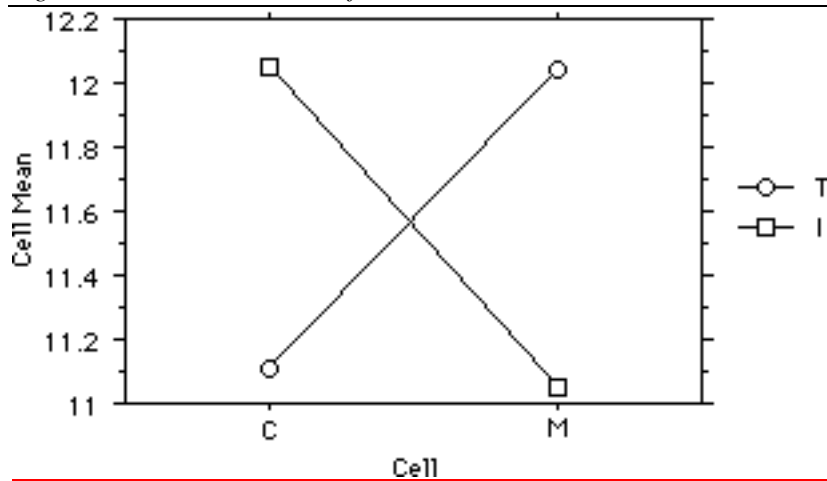
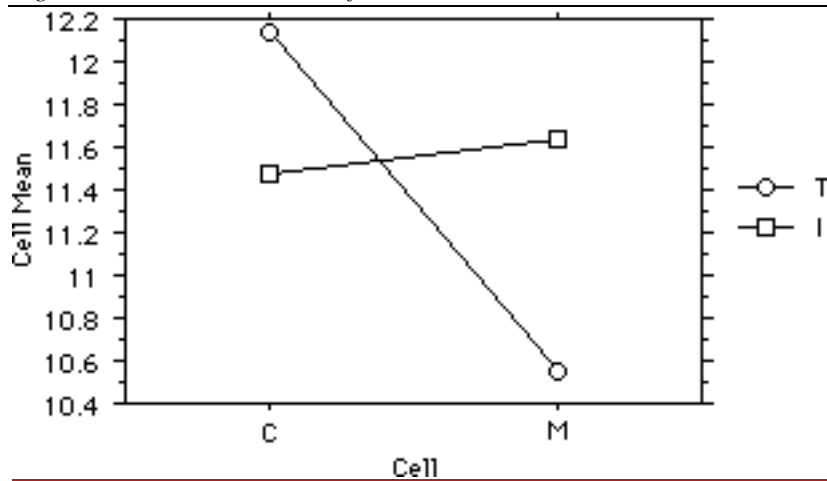


Figure 3: Interaction Line Plot for Test 3



Discussion

As mentioned earlier, the study verified our first hypothesis in the first and second test—that students engaged in a manipulative activity will achieve scores equal to those of students developing concept maps on a similar topic. This lends support that, at least in this case, the two strategies work equally well. When the equality of strategies is added to the idea that the manipulation of mediational objects is helping learners to create mental relationships and meaning between knowledge components, it supports the idea that manipulation of items may be considered a generative learning strategy.

The study failed to confirm the second hypothesis (i.e., students learn better in teams than as individuals). Interestingly, when these two variables were analyzed together, we found statistically significant interactions between the generative learning strategies (concept maps and manipulative experiments) and the classroom organization (individuals and teams) for each of the three tests.

These treatment interactions cannot be easily explained because they seem to be in reverse order between Test 1 and Test 2. For example, on the first test teams creating concept maps (CT) showed higher mean scores ($M = 11.95$) than their counterparts in the manipulative groups (MT) ($M = 10.72$). But in the second test, teams conducting the manipulative experiments (MT) achieved higher mean scores ($M = 12.05$) than teams creating concept maps (CT) ($M = 11.11$). Because the same group of students outscored the other group no matter the generative strategy imposed, this led us to originally conclude that the results might be better explained by parameters such as pre-test performance, general aptitude, or student learning style than by the experimental treatments. However, the delayed posttest yielded a treatment interaction again, but this time in combination with a significant difference between mean scores achieved by students working on concept maps ($M = 11.82$) versus students engaged in the manipulative experiments ($M = 11.11$).

Before we present what we consider a potentially noteworthy finding, we feel it important to acknowledge the limitations of the study. Our finding could simply be a consequence of the experimental design, which may not have addressed all threats to external validity (i.e. multiple treatment interaction). Another limitation was that although all students were in the class for the instruction, there was a difference in information imparted between the test sessions, and this difference may have influenced student scores. Additionally, it can be said that students may not have received enough specific instruction regarding collaborative learning techniques. This reminds us of the study of Hooper, Sales, and Rysavy (1994) who pointed out that one cannot simply assume that effective small group interaction occurs naturally without teacher's guidance.

A more tantalizing explanation is that the sequence of generative learning strategies may be responsible for the differences we found. Students who started with concept maps and then switched to manipulative experiments retained information better than those who started with experiments and then did concept maps. Interestingly, the mean scores of students who started with concept maps were higher on the delayed post-test than on their first test, whereas the mean scores of students who started with manipulative experiments were lower on the delayed post-test than on the initial test.

These results appear to indicate that creating concept maps prior to engaging in manipulative experiments produces better long-term retention than the opposite sequence. Or to over generalize for a moment, better results are found when teachers use more inclusive, encompassing, or general activities before specific or concrete activities. This finding supports Reigeluth's elaboration theory (English & Reigeluth 1996; Reigeluth, 1983), which claims that it is important to explicitly state the overall structure of the content before getting into the details. Elaboration theory proposes a simple-to-complex sequence "with the most essential information presented in advance of more complex and detailed information" (Jonassen, Beissner, & Yacci, 1993, p. 116).

Why does the sequence make a difference? Translated to the framework of this study, one could argue that the students' mental models achieved during the concept map activity were more expansive than mental models achieved while the students were focusing on the details during the manipulative experiment. Thus, learners creating concept maps first may have established a better network to which they attached the small chunks of information encountered later during the manipulative experiment.

Contrarily, doing the concrete activity first (i.e., the manipulative experiment), some of the facts may have seemed disassociated with the other pieces; or—to say it metaphorically—students couldn't see the forest for the trees. They learned little things, but didn't get the big picture. Grasping the big picture first through the use of concept maps provided the expansive view, to which they attached the individual facts when they did the experimental activity.

In conducting the literature review for this study, we were only able to identify one previous study that examined the sequence of generative learning strategies in regards to knowledge acquisition. In a study investigating the effects of generative strategies on reading comprehension, Linden and Wittrock (1981) compared sequences of learner activities that proceeded from imaginal to verbal generations with sequences of activities in the reverse order. They concluded in their study that the sequence wasn't critical, and that "...it seems that the generation of text-relevant associations, in either order, was the more important factor in enhancing comprehension in this study" (Linden and Wittrock, 1981, p. 55). However, with the results of this study indicating that sequence is important, and recent explorations into learning proposed by the elaboration theory, further inquiry into this topic is warranted.

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PROBLEM-BASED LEARNING: A DECISION MODEL FOR PROBLEM SELECTION

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Abstract

Problem-based learning (PBL), initiated when learners meet the problem scenarios, develops learners' skills and subject-matter contents to make the transition from beginner to more expert problem solver. Beginning students might benefit from simple, well-structured problems, in which the understanding of sets of rules and principles result in a straightforward solution. And for learners with more experience, facilitators may consider to provoke them with complex, ill-structured problems. However, seldom have reports provided PBL facilitators the solutions for how to design or select problem scenarios so that it opens the door to significant learning outcomes consistent with course or program goals. The gray area between well-structured problems and ill-structured problems need to be further clarified for better learning effect. After a brief literature review, the author outlines a decision model for problem selection. Conclusion suggests that a PBL facilitator should consider the learning strategies both systematically and systemically. Future research is required to further develop this decision model.

Introduction

From the instructor's viewpoint, the most important part of problem based learning might be the problem selection. Selecting and crafting the problems represents the major way in which the instructor plans the learning and also portrays the course goals that the instructor wants to reach. No matter whether instructors adapt a well-structured problem or an ill-structured problem, once the students confront a problem, they will start reacting and take ownership for their own learning. Thus, Instructors must carefully conceive the problem scenarios before giving them to students (Stepien W. & Pyke S. L., 1997).

This study will start describing some conceptual issues regarding the nature of problems and their roles in the environment of problem based learning. A brief analysis of whether a well-structured problem or an ill-structured problem could better fulfill students' needs will be presented. Lastly, the detailed explanation of the decision model of problem selection will be categorized in these three dimensions: Conditions, Methods, and Outcomes.

The problem of problem based learning: A few conceptual issues

Nature of the problem

In most PBL environments, two different structures of problem scenarios are used: well-structured problem scenarios and ill-structured problem scenarios. They differ from one another in significant ways.

1. Well-structured problem scenarios

A well-structured problem scenario is tidy and has little complexity. It is well organized and may lead students to a straightforward solution. Naives might benefit from simple, well-structured problems, in which the understanding of a set of rules and principles leads to a straightforward solution. Bridge (1995) describes the well-structured problem as "The type of problem that most instructors encounter annually and has certain steps for solving the problem".

2. Ill-structured problem scenarios

An ill-structured problem scenario is formed by undefined problems and incomplete information. It simulates a real-world situation. Because it has no single path to solution (Mason & Mitroff, 1988), students will need to explore the situation they have been given by building hypotheses that initiate inquiry into the numerous aspects of the problem. Bridge (1995) defines an ill-structured problem that is complex, messy, and without clear goals. With the belief of authenticity and fidelity (Brown & Collins, 1989; Dyson, 1993; Duffy & Savery, 1994) to resemble situations in the real world, when students confront a ill-structured problem, they will not have most of the relevant information needed to solve the problem at the outset. Nor will they know exactly what actions are required for resolution. And even after they propose a solution, the students will never be sure that they have made the right decision.

Simon (1978) indicated three characteristics to explain the differences between well-structured and ill-structured problems. First of all, in contrast to an ill-structured problem, a well-structured problem could be solved by correct methods which are obvious and do not conflict. An ill-structured problem often means a complex inquiry process before sets of hypotheses and solutions can be formed. The secondary characteristic is the availability of information for diagnosis. A well-structured problem is well organized, containing the information needed for solutions. Namely, students are led to instructors' desired outcomes. On the other hand, an ill-structured problem is mess and disorder. It supplies less than enough information and requires careful inquiry and numbered trials before

students can finalize the appropriate solutions. Lastly, the third characteristic Simon proposed to differentiate well- and ill-structured problems is “legal move generators” (Simon, 1978). In a well-structured problem scenario, routes and procedures are pre-defined by instructors. Unlike an ill-structured problem, the solutions for the problem are not constrained. An ill-structured problem simulates an authentic situation as in the real world, and the “problem space” (Voss, J. F., 1989) is wide enough for people with various backgrounds come up with different solutions for the same problem.

However, the way Simon distinguished well-structured and ill-structured problems is to place each of them at the opposite end of a continuum (Simon, 1978). The ambiguous area for the spectrum of problem representation, is still an open question for instructors and researchers.

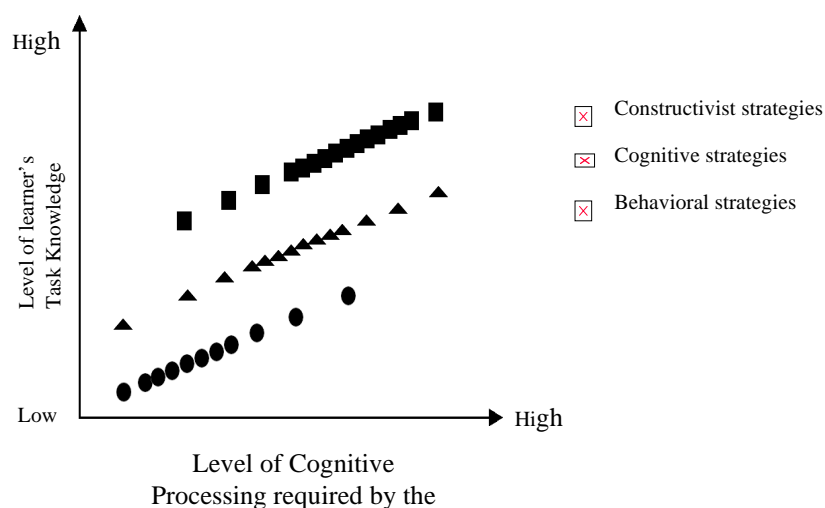
Well-structured VS Ill-structured problem

Some studies advocate that in problem based learning, ill-structured problems could serve all learners’ needs no matter their abilities are in what levels. A naïve learner still could benefit from solving a problem with mess situation, incomplete information, and undefined questions. However, a PBL facilitator still needs to consider the scope of a problem. It should be reasonable enough for naïve learners without much experience to complete within limited time and could also achieve the goals fulfilled their needs and facilitators’ expectations.

Well-structured problems might be still worthwhile for certain situations during the PBL process. The author would like to analyze this from an epistemological viewpoint. PBL is a learning approach based on the theory of constructivism. With the belief of constructivism, learning is a construction process. Learners have their unique experience to the world. Some constructivists may argue that there could be no ultimate, shared reality (Duffy & Jonassen, 1992) and only has best “description”. And the best “description” is developed through social negotiation (Vygotsky, 1978). Instructors should not have the objectives predetermined and contents bounded. However, this issue might not apply to each level of learning. However, in Dick’s study (1991), he argues that constructivism is compatible with system theory. Constructivism also could be a micro level theory in a systematic process. Schwen et al. (1993) advocates a similar idea. In the article *Enriched Learning and Information environment*, they proposed the small “c” constructivism by arguing that instructors can put the “idiosyncratic” intellectual thinking of experts into the instruction and allow learners to select according to their needs. It has been suggested that learners at different learning statuses might require different instructional strategies.

Jonnason (1991) points out that there are three levels of learning stages: Introductory, Advanced, and Expert. In the Introductory stage, what learners need is the instruction closer to objectivist. And in the advanced or expert stages, the constructivist approach may become more appropriate. This argument was supported by Ertmert’s

Figure 4. (Ertmert, p69, 1993)



study. Ertmert et al. (1993) indicate that there is no single theory that can fulfill the needs of entire instruction design (Figure 4). As learners acquire more knowledge and skills, they will progress along the knowledge continuum from low to high. That is, learners will move up from the knowledge about “knowing what”, to “knowing how”,

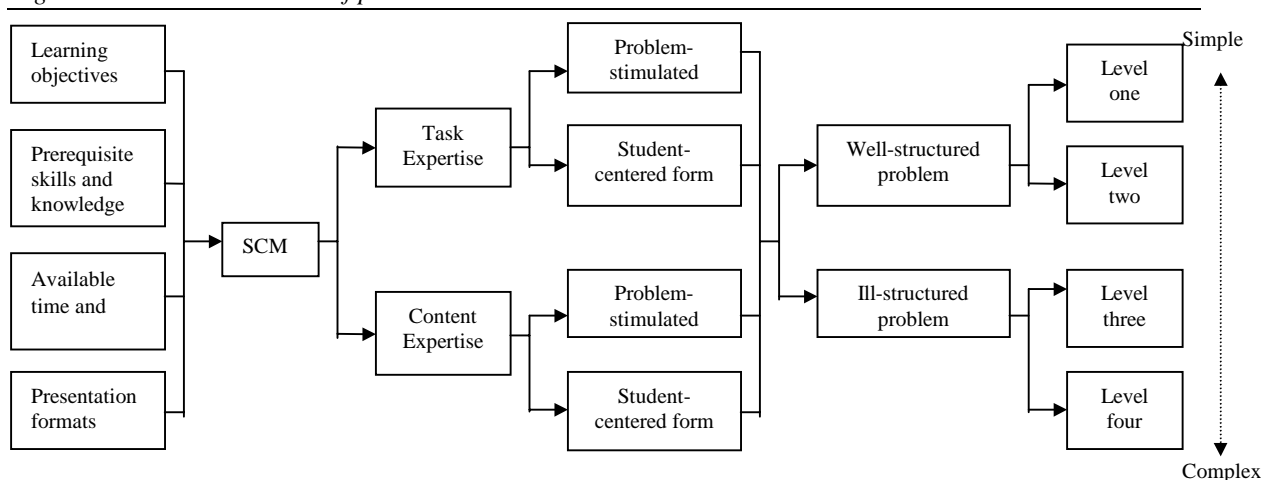
and eventually achieve the “reflection-in-action” level. Learning strategies should be chosen according to where the learners “sit” on the continuum in terms of their knowledge and skills.

Therefore, PBL could still be compatible with the systematic learning process. In other words, a teacher could still be an instructor role for the naïve user during the process of PBL. If it is the need of students, a lecture of a well-structured problem could be helpful for them to establish the basic knowledge domain. Beginning learners could benefit from a simple, well-structured representation (Wilkerson, L & Geletti, G.). And learning objectives for what needs to be learned should be decided jointly by teachers, students, and even parents. In this way, the transmission and adoption become desirable. Students will no longer feel what all they do are for teachers' requirements only. In general, teachers should always remember that to provide a well-structured problem is for students' desires not for fulfilling teachers' expectation.

The decision model of problem selection

Based on above assumptions, this decision model of problem selection (Figure 2) is organized and explained by the following three dimensions: Conditions, Methods, and Outcomes (Reigeluth, 1983). Conditions are defined as the factors that can not be controlled by instructors, while they still have a cause-effect relation with Methods. Methods are manageable and represent various ways to achieve desired outcomes under different conditions. Finally, outcomes could be viewed as "various effects that provide a measure of the value of alternative methods under different conditions" (Reigeluth, p15, 1983). In terms of these three dimensions in this study, the Conditions stage is to provide the facilitator with the things that need to be considered during the diagnosis process. The Methods stage is to provide facilitators the available strategies and techniques which could reflect the needs of Conditions. The Outcomes stage is the criteria of well-structured problems and ill-structured problems listed from simple to complex. PBL facilitators will be able to choose the appropriate problems by thinking through the stages of Conditions and Methods.

Figure 2. The decision model of problem selection



Conditions

As Stepien et al (1997) indicate, to identify an appropriate problem, a PBL facilitator should consider whether it (a) contains significant content; (b) fits curriculum outcomes for a specific course or program; (c) is appropriate for the targeted audience; and (d) can be managed effectively by students in the time available to them.

Bridges & Hallinger (1995) also propose a similar idea that a teacher should consider, such as (a) learning objectives; (b) prerequisite skills and knowledge; (c) available time and time constraint; and (d) presentation formats when trying to choose a problem. Accordingly, the author adopts these four factors and puts them in the Conditions step. It is suggested that PBL facilitators base their diagnosis in correspondence with these factors in choosing an appropriate problem.

Learning Objectives (course goals)

For facilitators of PBL, their consideration is whether the learning objectives are appropriate to the course goals. Certainly, for some cases of PBL, the fit between learning objectives and course goals may not be quite as straightforward as it sounds. Thus, facilitators and learners should jointly discuss and finalize the learning objectives. It needs to be highlighted here that in a PBL context, setting the learning objectives is a continually rolling process during the class period. It is not a must to have learning objectives concretize before the class while PBL facilitators could seed these objectives in mind. The learning objectives that need to be designed or assembled for a problem solving project should allow "to meet the individual learning needs of any student or student group at any level, depending upon their personal career goals, ability, and background knowledge" (David Bond, 1991).

Prerequisite skills and knowledge

Since the learner's need is the first consideration for selecting learning objectives, it will also be helpful for both instructors and learners to preview whether they lack any of the prerequisite skills or knowledge that are explicitly needed for solving problems. If results do show the needs, instructors should act as learning coaches to guide and support students in completing learning issues.

Available time and time constraint

The instructor must consider time constraints relevant to curriculum implementation. Time constraints will influence how complex or messy a problem should be. Instructors can expect to underestimate the time students need to complete a project. Students could experience how they manage their work under stress and time pressure the same as a situation in the real world. In fact, it is suggested that learners work more productively in more substantial blocks of time (Bridge, 1995). Although PBL can be applied in a wide variety of time formats, PBL facilitators should consider the recommended duration of their course schedule for each project as well as consider the format of the course, such as the number of times and length of class meeting per week?

Presentation formats

According to Bridges (1995), instructors can present problems as a written case, a live role-play, interactive videodisk, a taped episode, or even an interactive computer simulation. Each different delivery "vehicle" has different functions. PBL facilitators should choose the most suitable way to transmit singularly different characters of problems.

Method

Strategy 1: Simplifying Conditions Method (SCM)

Simplifying Conditions Method is a kind of sequence strategy that provides guidelines to process course contents. Reigeluth (in press) indicates that "an SCM sequence begins with the simplest version of the task that is still fairly representative of the task until the desired level of complexity is reached." In other words, when an instructor decides to adapt SCM to be the scaffolding tool, the instruction will start by giving students the simplest task first. Although this task may be very simple and basic, it still includes every necessary sub-skill (basic style) and fair representation of the whole task. As students acquire more skills and content knowledge, the next task will require more complex or deeper skills to solve until students achieve the desired level of complexity. SCM does not just include the topical fashion. In fact, it is topical fashion with the concept of spiral fashion.

Technique 1: Task Expertise & Content Expertise

There are two different versions derived from SCM according to their different characters. First, Task Expertise is the sequence that "relates to the learner becoming an expert in a specific task" (Reigeluth, 1995). For instance, a task might ask students to perform as a good writer.

Two subsequences for Task Expertise are distinguished as follows in order to fit different course contents (Reigeluth, in press).

1. Procedural SCM Sequence
For tasks that need "a set of steps to decide when to do what" (Reigeluth, in press), the Procedural Sequence is appropriate for skill development task.
2. Casual SCM Sequence
For tasks that need to apply "a set of principle to decide when to do what" (Reigeluth, in press), the Casual Sequence is appropriate for developing tasks like thinking skills or management skills.

Secondary, Domain Expertise applies to the situation which "relates to the learner becoming an expert in a body of subject matter not tied to any specific task" (Reigeluth, in press). It focuses on learners' ability in the knowledge domains. Two subsequences are further defined for use in different course contents (Reigeluth & Darwazeh, 1982; Reigeluth, in press).

1. Conceptual Elaboration Sequence
Are for the courses which focus on "interrelated sets of concepts" (Reigeluth, in press), for instance, a Biology course that introduces kinds of animals or plants would be well advised to apply this sequence.
2. Theoretical Elaboration Sequence
Are for the courses which focus on "interrelated sets of principles" (Reigeluth, in press). For instance, a Biology course that emphasizes principles of life cycles and bodily functions would do well to apply this sequence.

Both subsequences under Domain Expertise are similar to those two under Task Expertise. They all lead to a gradual progress of content sequence from simple to complex and happen concurrently once the course includes such kinds of contents described above.

Strategy 2: Problem-stimulated strategy & Student-centered strategy

PBL can be divided into two different forms. One is the Problem-stimulated form and the other is the Student-centered form (Bond, D & Felett, G., 1991). The major differences between the two center on who defines learning objectives, resources, and questions. In the Problem-stimulated form, the instructor is supposed to be responsible for identifying learning objectives, providing available resources, and guiding questions. However, instructors should be notified that they still act as a learning coach role whereas they just supply more directed guidance in this stage. In contrast, in the Student-centered form, students are obligated to be responsible for these three components. That is, when students confront a specific problem, they are able to identify their own learning objectives, locate the relevant resources, generate hypothesis, and evaluate solutions. Although Student-centered form requires fewer instructors' time and efforts, there are certain weaknesses that challenge instructors. First, when given the opportunity to choose their own learning objectives, students may pick ones that only partially overlap with those objectives considered important to the instructor. Second, since students are generally less knowledgeable than the instructor, they may fail to locate the correct resources within the available time. Third, students may cover less of the content deemed desirable by the instructor.

Technique 2:

1. The selection of tasks and content domains

Instructors need to determine which tasks or contents should be combined into the problems. Instructors will need to keep asking themselves: "Is this task the right one that can reflect students' needs?" There are several methods to help instructors make such decision so. The author adopts the following criteria suggested by Bond, D. and Felett, G. (1991) and Bridges, E. M. (1995). Instructors can select tasks in their area which meet these characteristics:

- Tasks, or conditions that have the greatest frequency in the usual practice setting
- The tasks are suitable for integrating knowledge from a variety of disciplines
- The tasks are ones that have high potential impact; that is, they affect large numbers of people for an extended period.
- The tasks might expose students to "discovered" and "presented" problems.
- The tasks that emphasize or underline important basic concepts in a specific area

Then, instructors can rate each task with a score from one to five based on each of three different factors: frequency, potential impact, and the effectiveness of intervention (Bond, D. & Felett, G., 1991). With the multiplied product of these scores, instructors can determine the position of each condition on a list. Accordingly, instructors will know which task or when it should be selected.

2. Locating resources

Students can search the relevant information from the following resources: articles, films, computer information networks, and consultants. Besides, since students often bring specialized knowledge and skills to a problem-solving project, they should be encouraged to inventory the resources existing within their knowledge background and to exploit these resources. For instance, the student knows a convenient information resource that is seldom utilized or recognized by others.

3. Generate questions

In the Problem-stimulated form, PBL facilitators can use the following principles to guide learners forming questions (Bridges, 1995):

- to direct students to key concepts,
- to assist students in thinking through the problem, and
- to stimulate students to view the problem from alternative perspectives.

For the Student-centered form, learners discuss in a small group format and decide which learning issues to pursue, and subsequently which resources to utilize in order to obtain the necessary information. According to Duffy and Cunningham (1997), this step is not complete until each learner has an opportunity to reflect verbally on his or her position in the problem, and to assume responsibility for some of the learning issues identified. Hence, ownership extends from buying into the problem to buying into the learning issues identified. The process to generate questions (learning goals) basically fall into three categories (Stepien, Gallagher, & Workman, 1993; Mardziah et al., 1995):

- **What do we (students) know**

Information always confined learners' thought as they face problems for the first time in the real world. This category refers to learners' prior knowledge that may be applied to help evaluate the ideas generated. At this point, learners need to challenge any ideas or knowledge presented for accuracy and understanding.

- What do we (students) need to know
This category refers to topics or issues that need further investigation to yield information that would help learners evaluate the ideas generated. As information is collected, gaps and conflicts within the problem are noted.
- What should we (students) do
Learners will start to analyze and revise the list of questions under the heading “What do we need to know”. The reasoning process will keep cycling until learners are satisfied with the exact questions that need answering.

Outcome

As Simon (1987) proposes to place two types of problems (well- and ill-structured) at the opposite end of a continuum to describe and differentiate them, PBL facilitators might feel difficulties in forming problems without defining the “gray area” in between. A clear classification for problems with various levels of complexities is considered necessary. Both Bashook (1976) and McGuire (1980) describe valuable systems to solve this problem. Berner (1984) values Getzels’ dimension (1982) to be a major structural way for problem classification. Getzels’ problem typology attempts to categorize well-structured and ill-structured problems into four levels.

Well-structured Problems

1. Level one
This type of problem is that both information needed for problem diagnosis and appropriate solutions are known to the problem solver. In addition, the instructor often encounters this type of problem annually. Berner (p630, 1984) indicates “This type of problems may be pattern recognition tasks with a standard solution, or they may be ones for which a standard algorithm is used”.
2. Level two
This is the problem that exists, but remains to be identified. Once it is identified, the solution is clear. The instructor might know what is wrong in the problem but needs to face the situation with alternative ways for solving the problem. That is, the students may pick problems and solutions which are different with the instructor’s expectation. This class of problems involves a sacrifice or a tradeoff of important personal and organizational goals.

These two types of problems could serve for learning objectives such as memorized facts or known processes. They present a comparatively easy task for instructors to teach and for students to master. However, unlike the above two types of well-structured problems, there are some problems that can not be solved by such a simple way. Problem solvers might even face a tradeoff situation for the solutions they chose.

Ill-structured Problems

3. Level three
“The problems are those which, even if the diagnoses are known, there is no agreed-upon method of solution” (Getzels, 1982). Considered strategies may each have their associated risks and benefits. For instance, clients’ values might conflict with methods that agents choose although these methods might be able to solve clients’ problems. This class of problem is the generalized mess that is so complex. Problem solvers need to go through a careful diagnosis process for decision making. Their previous experience might provide better help than the standard answers from their textbooks (Berner, 1984). It is the type of problem scenario that even the instructor has difficulty in getting a handle on what the problem is.
4. Level four
This type of problem is the one that is just invented or conceived recently. And a solution may or may not be available yet. For instance, an instructor is assigned a new project from his department. He / she asks the problem-solving groups in the class to work on parts of this project. However, the situation is that even said the instructor himself / herself still need to figure out how to complete this project.

Instructors and facilitators could have a better idea for choosing problems based on the above framework, while it is worth to know that what is unknown for a learner may be known for others. For instance, a level 2-problem for learner A might require complicated decision analysis that is akin to a level 3-problem, while for learner B, this problem might be like only a level 1-problem.

Conclusion

Generally, this model shows not only the complexity of problems that can help structure the instructor’s course objectives and cultivate students’ problem solving skills, but also that the whole environmental structures should be considered to work the same function. For instance, for naïve learners, it is better to choose the Procedural SCM Sequence, the Problem-stimulated Format, and a well-structured problem. This type of well-structured environment helps non-experienced students to become familiar with the basic knowledge of subject domain and prepares them for the next more complex problem and more ill-structured context. In conclusion, learning should not just be considered in a systematic format but should also be weighed in a systemic matter. In other words, PBL facilitators should realize that the student ability used to solve the problem is dependent on the problem’s structure,

subject, and context. In this decision model, a total of thirty-two different PBL structures are arranged from simple to complex. Instructors can combine different levels of sequences (four subsequences), formats (Problem-stimulated and Student-centered), and problem structures (four levels) to conduct the PBL context. However, this decision model should just work as a reference. An experienced PBL facilitator should decide his / her own instructional environment after considering both the course goals and students' needs.

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TEACHING INSTRUCTIONAL DESIGN: REFRAMING THE RELATIONSHIPS BETWEEN TEACHERS AND DESIGNERS

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Abstract

The purpose of this paper is to present the results of the implementation of an instructional approach that supports their learning of instructional design (ID) and honors teachers' beliefs and concerns within the ID process. We present the theoretical framework that supports this inquiry, summarize how instructional design is viewed and consequently taught (the designer's view), how ID is used by teachers (the teacher's perspective), followed by a summary of collaboration between teachers and designers, and teacher inquiry into their teaching. We describe our research method, including our instructional approach. We summarize ways that teachers used to describe and represent their practice in ID projects, personal ID models, and course evaluation, and how our co-participatory approach helped teachers and designers to learn from each other.

Introduction

Efforts at diffusing instructional design (ID) into teaching practice have largely been unsuccessful (Gustafson, 1993; Martin & Clemente, 1990). Such results are partly due to the different worlds that characterize the lives of designers and teachers. One means of diffusion has been through formal ID instruction. However, how one teaches instructional design comes to be viewed by newcomers as the means by which it ought to be conducted in practice. Its use by teachers may be limited if the process is represented to them as linear and overly prescriptive, or conducted via the use of one standard model. Instead, ID can be presented as a systematic and holistic process to examine and address instructional problems. Teachers can be introduced to a range of models and be encouraged to develop their own. An unrealized potential of ID instruction is to use it as a structured means to help teachers examine their teaching. Thus, ID instruction provides an important opportunity to establish meaningful relationships between teachers and designers.

The purpose of this paper is to explain the instructional approach and present the results of using that instructional approach that includes teachers' beliefs and concerns within the ID process itself and supports their learning of instructional design. We used a co-participatory, reflexive approach to instruction, in which we viewed all participants as learners who continually reflected and appraised our joint efforts at teaching and learning ID. Along with this stance on teaching, we used the ID process as a tool for us to learn about these teachers, as well as to guide them in a self-examination of their teaching stance, along with ID learning. Thus, inquiry was built into the ID process, embracing not only the traditional ID components of needs assessment and program evaluation, but beliefs examination. In this research, our inquiry is a study of our own teaching of instructional design with in-service teachers.

Theoretical Perspective On Learning

If an instructional approach is to empower learners, it must first honor the learners' role and agency in the construction of their own learning. Three basic tenets from contemporary learning theory inform this stance and serve as the foundation of our instructional approach. We begin with the notion that learning is a constructive process (e.g., Bartlett, 1932; Bruner, 1990). Knowledge and skills are developed through the building, linking, and clarifying of the personal experiences that arise as learners attempt to make sense of their worlds. This purposeful quest toward making meaning of life's complexities involves multiple components that comprise the learning enterprise: culture, cognition, affect, individual differences, and so forth. Along with this, we recognize that learning is developmental and historical (John-Steiner, 1997; Vygotsky, 1978). Prior learning experiences along with available strategies, influence how learners perceive the world and their role and possibilities within it.

Our second basic tenet holds the notion that learning is situated and mediated in social contexts (Brown, Collins & Duguid, 1989; Lave & Wenger, 1991). This social theory of learning is an intersection of theories of collectivity, subjectivity, power, and meaning that mediate our practice and, in turn, shape our identity (Wenger, 1998). Cognitive and communicative functions that are inherent in a specific social world are intimately entwined within everyday experiences (Lave & Wenger, 1991). Higher mental processes, such as reflection, have their origins in the community of learners in which one resides (Moll, 1990). As Vygotsky (1978) has written, learning is first at the interpersonal level, but that capable others help one move learning to an intrapersonal level. Consequently, it is

critical that the social milieu supports intellectual activity in order for its participants to fully realize their creative and problem solving potential (John-Steiner, 1997).

Our third basic tenet requires that we view teaching as assisting learners (Tharp & Gallimore, 1998). Here we mean that teachers and learners engage in a co-participative, responsive learning relationship that requires a mutuality that transcends the traditional and authoritative role of teacher and reactive and subordinate role of student. The construction of shared understandings through authentic, meaningful activity is the goal of the enterprise. This assistance in learning of ID resonates with the ideas of Rowland and colleagues (e.g., Rowland, Fixl & Yung, 1992) that instruction consists of authentic design tasks, modeling of design expertise, and reflective activities (Schön, 1987).

Perspectives On Instructional Design

How ID is taught is based on one's view of the ID process and can be regarded as the "designer's perspective." Researchers have configured instructional design as a systematic, problem solving process for designers (e.g., Dick & Carey, 1996; Gagné, Briggs & Wager, 1992). ID instruction has typically involved presentation of these models; in particular, models developed for novices (e.g., Dick & Carey, 1996) depict prescriptive processes that omit contextual features (Edmonds, Branch & Mukherjee, 1994). Attempts to develop ID models for teachers (Gerlach & Ely, 1980; Kemp, Morrison & Ross, 1996; Reiser & Dick, 1997; Wedman & Tessmer, 1990) have attempted to more closely approximate teacher tasks. However, systematic processes have proven difficult to transfer into a teacher's daily practice, due to the very individualistic and personal nature of teaching, the complexity of classrooms, and the multiple influences affecting their practice. Because teaching is a human activity, one model, especially one that was constructed by one other than the teacher who has to use it, is insufficient to be responsive to teacher needs. Thus, a process that represents algorithmic solutions to messy instructional problems is ultimately inappropriate to address teacher concerns.

Meanwhile, teachers' views of the ID process, the teacher's perspective, are due, in part, to how the ID process was taught to them and their experiences using the process. As Martin and Clemente (1990) have written, "The particular decisions we make as we teach ISD [Instructional Systems Development] and the amount of time or emphasis we give to aspects of ISD ...affect how these aspects will ultimately be used in the classrooms" (p. 83). Studies have identified that teachers use some systematic practices (e.g., Branch, 1994; Kennedy, 1994), such as learner analysis, goal identification, and matching tasks and assessment to specific objectives. Other aspects of systematic practices have typically not been addressed by teachers in these studies, including the lack of media selection criteria, needs assessment with subject matter experts, learner characteristics, and matching assessment to overall goals. Studies in the differences between new and more experienced teachers (e.g., Driscoll, Klein & Sherman, 1994; Rowland, 1991) have shown that novice teachers focus on immediate tasks and objectives, while more experienced teachers take a broader view of instruction and goals. In these studies, teachers have cited time as a major impediment to using instructional design, that "ID is too time-consuming" or "There's not enough time to use the ID process." Instructional design, being a complicated process, does take time to learn. However, this initial view can jeopardize a teacher's perception and valuation of the process. The second category of responses, that "there's not enough time" is a broader institutional issue involving how others in the institution view the teacher's role and the expert outsider and a view of the complexity of teaching (e.g., Elbaz, 1983; Jackson, 1968; Lortie, 1975; Yinger, 1980). We maintain that the relationships between teacher and designer represent another category of impediments to the teacher's use of systematic processes. More specifically, how one views relationships needs to be examined. That is, the ways that teachers' personal practice and knowledge about teaching are honored in the learning event mediates the degree to which they consider instructional design as a tool either to examine or improve their teaching.

Collaboration Between Teacher And Designer

The diffusion of innovation in any institution is not simply a matter of implementing that innovation, but, rather is based on the interrelated factors of the features of the innovation, the relationship of the individual with the organization, and the personal characteristics of users (Doktor, Schultz & Slevin, 1979). The diffusion of instructional design into schools would likewise be influenced by these three interrelated factors. A teacher would assign a value to the innovation relative to other options (Leonard-Barton, 1987). How one teaches ID might carry great weight in how a student would make such a value decision, relative to that person's learning experiences and personal and professional needs. This value judgment might also be contingent on the teacher's relationship with the institution; in particular, the support and reward structures in place, as well as the relationships with the people in that institution. Another interconnected influence is the personal characteristics of the teachers. One set of characteristics could include years of experience, professional needs, technical competencies, and demographics (i.e., age and education). A second set of personal characteristics would include teachers' views towards learning and teaching, and dispositions towards themselves as learners and towards outside evaluators or experts.

The applied educational research enterprise concerns itself with practice rather than theory (LeCompte, 1995), and collaboration has been seen by evaluators and instructional designers as a “cure for some of their most difficult investigatory problems” (p. 94). Two such problems, according to Huberman (1991), are knowledge utilization and dissemination, or a “diffusion” issue (e.g., Gustafson, 1993). Huberman described this approach as the “two communities” problem, with differences “in norms, rewards, and sensibilities between the two” (LeCompte, p. 95) characteristics. Huberman characterized three variations of relationships between teacher-researcher communities (i.e., teacher-designer). The first relationship is “Hello-Goodbye,” a short-term involvement in which the designer shows up on the scene, consults, designs, or evaluates, and departs. The second relationship is “Two Planets,” in which the relationship is an interaction of different cultures, individuals circling around each other but never touching. The third relationship is labeled as the “Stand-Off,” in which disagreement between the parties is the rule. Rather than facing differences and issues, the parties act from their respective positions without any intent to bring out differences in the open, to learn from each other’s position, or to re-examine one’s own position.

Rather than trying to increase teachers’ knowledge base (i.e., utilization) as the aim of professional development, Rhine (1998) proposes that teachers’ engagement with research should be stimulated by teachers who desire to inquire into student learning. “Our human, bounded rationality dictates the value of educational research to the teaching community is not the acquiring of research-based knowledge of students’ understanding, but the process of teachers engaging with that knowledge and considering implications for their instruction” (p. 27). His reasoning is that teachers cannot know and process everything there is to know (bounded rationality). The aim, according to Rhine (1998), is to shift teachers’ focus from teaching to inquiring into learner’s thinking, although we view the shift as away from a view of teaching as management of students to ways in which teachers support students’ learning. Rhine suggests that teachers need to be provided with guidelines on using research-based resources and provide access to these resources using “teacher-friendly” language and formats. Collaboration then requires the “building of relationships between research-based models of children’s thinking, their own student’s thinking, and how they can interpret the model in light of their own students and classrooms” (p. 29).

One way for teachers and instructional designers to consider each other’s practices is to report the results of teacher planning/ID processes in publications each audience might read (Earle, 1994). Another forum for relationship building is through formal instruction, including teacher education, as well as graduate programs. A third possibility involves teachers and outside ID practitioners who might be conducting research in schools. Instructional designers should be encouraged to discover what’s happening in schools and attempt to understand the lives of teachers, their clients.

Teacher Inquiry

The idea of teacher-as-researcher has been based on the idea that the teacher, who is at the forefront of what happens in classrooms, can contribute to knowledge building on teaching. This knowledge informs not only the teacher, but also can contribute to the educational community (Lytle & Cochran-Smith, 1990). Furthermore, teachers as researchers come to learn about and debate the research enterprise, about “what counts as new knowledge” and how one comes to arrive at this new knowledge. One way of implementing research into teaching lives has been action research (e.g., Duffield & Robinson, 1998; Keating, Diaz-Greenburg, Baldwin & Thousand, 1998; Somekh, 1997). Inquiry as action research adds data collection and analysis to the teacher’s routine to help them become more objective in interpreting their experiences. Rather than making judgments, teachers use data to help them describe what is occurring and to provide a basis for action.

Reflective practices are another aim of action research. Reflection is an “active process providing an opportunity to look at past experiences and relate them to future action” (Keating et al, p. 383). Winn (1989) suggests a reflective practicum, in which Schön’s (1987) reflection-about-action and reflection-in-action can be supported. Technical competencies are not enough (Quinn, 1994), that a creative supplement is also necessary (Rowland, Parra & Basnet, 1994), one that encourages flexibility and intuition based on experience (Nelson, Magliaro & Sherman, 1988), to address human instructional problems.

We propose the use of instructional design (ID) as a systematic, intellectual tool to help teachers’ to “relate” past experiences to future action by (1) examining their learning beliefs and instructional practices and (2) designing responsive approaches to instructional problems. Thus, we view teachers within the ID process itself, structurally supporting teacher self-examination (inquiry), but also as a tool (technology) to systematically examine instructional problems and propose responsive, bounded solutions. Our view is that the tools of analysis, design, and evaluation within the ID process can help teachers to realize the differences and complexity of student’s thinking. Rather than closing down the inquiry, or bounding the problem prematurely, our view of ID is to examine the possibilities inherent in any instructional problem. The value of the systems approach is “taking in the whole problem,” while examining the component issues. Our view of ID for teacher use is that the process retains the bounded rationality of professionals, but ID’s systematic features provide structure to keep learning in the forefront and continue to examine, design, and evaluate one’s efforts.

Research Questions

Our research orientation included all participants, teachers and instructors. Thus, the research questions for this study included both.

1. How do teachers view teaching in what they designed?
2. How do teachers view teaching in what they represented?
3. How do teachers talk about their teaching?
4. In what ways does our co-participatory approach help teachers and designers (i.e., instructors) learn from each other?

Method

Participants And Setting

Participants included two instructors and 23 practicing teachers enrolled in an instructional design course, as part of a master's program sponsored jointly by their school system and a state university. The K-12 teachers' instructional responsibilities ranged across all disciplines and contexts (e.g., general education, special education, vocational-technical education, consulting teacher, and librarian). The focus of this master's program was the integration of instructional technology, and the curriculum was designed so that all coursework should be interrelated and projects emanate from the teachers' daily practice. The ID course (the second of a 10-course/30 credit-hour program) was offered in one of the county schools and met for three hours each week over a 15-week semester.

Instructional Approach

As instructors we were responsible for introducing these teachers to the formal instructional design process, and as such, our voices valued or signified this process by the way in which we advocated and modeled the ID process, using it to study our own teaching. Although we presented a traditional treatment of the process (i.e., analysis, design, evaluation), our instructions to the teachers were to use this framework as a tool to examine and bring forth for examination the process they use to guide their practice. Rather than depicting instructional design as a complex algorithm, we represented ID as a systematic means to examine important instructional issues before settling on a response. Instead of specifying a set of rules or procedures, which could not cover all contingencies of human learning, we advocated to teachers that they consider a range of possibilities that might responsively address the learning needs of their students (Magliaro & Shambaugh, 1997). We engaged them in tasks that would help them to try components, reflect on their appropriateness, and make revisions based on this reflection and our feedback.

Our reflexive approach to teaching instructional design views instructor and student as co-participatory learners, in which participants learn from each other (Shambaugh & Magliaro, 1995). As such, all participants are inquiring into their teaching practices, including the instructors for the course. Through constant dialogue (i.e., live communication, computer-mediated-communication), we all design with each other and serve as formative evaluators in a supportive and collegial way. Logistically, we create the participation structures, including classroom activities, learning tasks, electronic mail, individual conferences, and text (Shambaugh & Magliaro, 1997), in which dialogue and performance are supported. The teachers bring their instructional design problems to the table and mediate the participation structures in order to address their design problem, which may have been a part of their overall professional goals.

Being reflective and critical together required an element of trust and history within the cohort. The ID class was preceded by a course in educational psychology, taught by the same instructor, in which the teachers examined learning theories (i.e., behaviorism, cognitive psychology, and social constructivism) and wrote papers that juxtaposed these approaches to their teaching. These activities enabled the teachers to name the activities and principles that they had been using in the classroom. No one theory was deemed "better" than the others. Teachers were encouraged to adopt, adapt, or create a personal theory of learning that could be articulated to another interested party (e.g., colleague, parent, friend, etc.). A final reflection paper on their learning beliefs and corresponding instructional practices served as a transition to the instructional design course, in which this self-examination mode continued.

The sequence for the 15-week semester course included three weeks in which the context for instructional design was established. Part of this context was to have these teachers continue to examine their beliefs about learning and teaching, as these became the foundation for judging the veracity and cohesion of their ID project. Teachers were asked to first represent their own design or planning process. This served two purposes: (1) to honor their present conceptions of the ID process, and (2) to provide a tangible representation of a tacit process that could be examined in a more open manner. Throughout their semester, we asked them to update their models based on any new ideas, revelations, or understandings that emerged from either class or their project work.

The core of the ID course content consisted of a 9-phase instructional design sequence, with the principal assessment method involving ongoing drafts and a completed ID project. A mission statement task, the first phase of the sequence, provided a written means to evaluate the extent to which personal beliefs were incorporated in individual projects. Across the semester, we provided overviews and group activities examining important ID

process components, including analysis (i.e., needs assessment), design (lesson sequence, assessment, instructional framework, instructional media, and prototype lesson), and program evaluation. Teachers were introduced to a range of ID tools, including ID models and taxonomies. Teachers formed work groups in which they either all worked on the same project or worked on complementary projects. Class time from each class period was devoted to group work sessions. During the final week we returned to a self-examination in which teachers revised and shared their personal ID models and wrote a self-evaluation of their learning and their responses to the course.

Data Sources And Analysis

Three domains of analysis were identified and explored: we analyzed what teachers designed in their ID projects, how teachers represented their thinking about and planning processes in their ID models, and what teachers said about their teaching after the course. Data sources included teachers' ID projects, their personalized ID models, and self-reports on their learning from a course evaluation.

A recursive process of categorization and theme building were used to investigate our work (e.g., Spradley, 1980). Thirteen completed individual or group projects were available for analysis. Analysis consisted of the extent to which teachers conducted research to inform their understanding of their instructional problem, the extent to which teachers' learning beliefs were consistently and coherently applied throughout the project, and to what degree their "technology component" supported their project. Research efforts were examined in the project's needs assessment. The application of learning beliefs was analyzed by comparing what teachers wrote in their mission statement with their design components. The technology component was examined in the project's instructional media section. Teachers were asked to represent graphically and/or narratively the components and processes they considered in their everyday practice. Nineteen personal ID models were analyzed by describing the features of the visuals metaphor and the language from a written narrative accompanying the visual. Initially, each model was given a label that attempted to encapsulate that teacher's view of teaching. A second step involved assigning these labels to categories with similar labels. The teachers also provided feedback on the impact of the course and master's program on their professional lives in an end-of-the-course questionnaire. Teacher responses were coded as to themes and summarized into categories.

Results

What Teachers Designed: Their ID Projects

All of the projects were based on personal/professional beliefs about what it meant to teach in particular content areas (e.g., spelling, science, video as a persuasive medium, calculator use, aerospace, geography). None of the projects brought forward research findings from texts assigned from the program's previous educational psychology course (Bruer, 1993; Schauble & Glaser, 1996), which examined the complexity of content to be learned and learning environments that supported this learning.

Nine of the 13 projects achieved a consistency of teachers' learning beliefs, expressed through a mission statement, across their project's design components. Four projects did not demonstrate a consistent stance between mission and instructional action. For example, one mission statement expressed a desire to "assist learners to reach their goals through collaborative partnerships" but did not examine what "assistance" or what "collaborative partnerships" meant in his teaching. Another mission statement advocated "active involvement...using a variety of instructional methods...to produce self-directed learners," although the ID document only described direct instruction and strictly adhered to Virginia's Standards of Learning.

Achieving consistency of beliefs across components was not always responsive to learners' needs. One teacher cited being "practical and hands-on" in his mission statement, which was exhibited in activities, but was inadequate to support the conceptual learning called for in the project. Materials in the lesson prototype did not provide any explanation for the conceptual content underlying the activities. The teacher did not conduct research on ways to teach the content or re-evaluate or describe the pre-existing curriculum materials that were inserted into the project. Another student wrote about "collaborative partnerships" but did not specify any affective dimensions in project goals to support these. In another project, in which cooperative groups were stressed, the assessment plan accounted for skill learning without any provisions for social learning goals. Coherence across design components was found in eleven of the thirteen projects. In all eleven instances of coherence, lessons identified goals, which had been determined from the needs assessment. Of the two projects that were judged not to have coherence, a 6-week lesson outline did not match activities with goals, and a geography unit specified goals in a mission statement but were not identified in later design components, although lesson activities were keyed to state standards. Six of the thirteen projects used Virginia's Standards of Learning (SOL's) as goals. Three of the thirteen projects used an activities sequence to address their instructional framework, assessment, and media. Four of the projects minimally described their proposed instructional framework.

A technology component was required in their ID projects, although only the instructional design issues of media selection and use were to be specified. Although this technology component was a major influence in the selection of an instructional problem, teachers identified a full range of instructional media. Chosen media-supported

projects that addressed current teaching (e.g., audio spellchecker, LEGO'sTM, maps, floral supplies), were mandated for future courses (i.e., graphing calculators), or were innovations (programmable logic controller, orientation video). No research was conducted on how these media choices supported learning. Instructional media rationales were frequently specified within lessons, but without many details on their use.

What Teachers Represented: Their Personal ID Models

Teacher's ID models were examined along two dimensions: the metaphors they constructed and their location in the ID process. Nineteen representations of instructional design included visual metaphors that included a circular cycle, signpost, flower (2), flower garden, kite, dart board, balancing scales, pizza parlor, billiards, passenger train (2), performance stage, triangular puzzle pieces, fish, baseball diamond, steps, and a story. Teachers' views of instructional design were grouped into four categories. The first category, accounting for four teachers, viewed ID as a "sequence," and included the two train models, a continuous cycle, and a four-step model. The second category grouped three teachers' "holistic" views of ID and included three teacher models with flowers as themes. One of these teachers used a flower to represent ID as a complex, dynamic, and systematic process, representing feedback, review, and revision with double-pointed arrows and intersecting lines. As one must be attentive to a flower's health, "good ID must be responsiveness to the learner's health." Another flower model equated an ID task with a garden design task, representing needs assessment as a plot plan and that an analysis of the parts as they relate to the whole plot was necessary. The framework to the plot was viewed as learning principles; however, the teacher viewed this framework as one to "plan, manage, and organize information."

The third category of how nine teachers viewed ID was labeled "process". Examples included a fish "eating" knowledge, sinking billiard balls, and hitting the curriculum "bulls-eye"; in this case, state learning standards, with a dart representing teaching approaches. Other activities included acting out roles on a stage, "running the bases" in baseball, writing a story, and running a pizza parlor. A fourth category, "balance," was used to characterize three teachers, including two special education teachers who viewed their daily teacher lives as unpredictable. One teacher used signposts to represent the decisions to turn left or right. "Turning left" meant facing issues she had no control over, including the demands of curriculum, teacher expectations, and state requirements, while "turning right" meant working with student strengths and weaknesses. The second special education teacher saw ID as a means to balance learner needs and teacher expectations.

Teachers' ID models were also categorized by how they viewed teaching and their location in the process. The first view of teaching was "disseminating knowledge," and included three models concerned with teaching practical skills (horticulture), knowledge (social studies), and meeting objectives (technology education). A second view of teaching was "addressing learner needs" and accounted for four of the 19 models. Models and narrative that matched this label included "growing a squash garden," "attending to a flower's health," designing a garden, and playing with puzzle pieces. A third category viewed teaching as "addressing external expectations," accounting for six models. These models included the teacher as cue ball; rounding the bases on a baseball field; being pulled by a train (the state's standards of learning); and sinking the striped billiard balls (instructional issues) avoiding the solid balls representing time, state standards, and interruptions (the "eight-ball"). The fourth category included the two special education teachers who viewed themselves as reactive, always in the middle, making decisions and balancing expectations for students with expectations of other teachers, parents, and the system.

What Teachers Said About Their Learning

At the end of the course, teachers were asked to reflect on the impact of the program on their professional and personal lives. The possibility of teasing out the impact of just the ID experience was deemed counterproductive given the seamless nature of the program. All 20 respondents reported that the activities made them more aware of their teaching, with 8 stated in an active way that they are agents of change (e.g., "I am more conscious about the choices that I make for instruction."). Four respondents reported a better understanding of the students within their design decisions. Eighteen teachers reported ways that the program had affected their students. While 13 infused ideas from the program indirectly, 5 reported that they showed their students their assignments, shared their struggles with papers, due dates, etc. and so forth. One stated that, "They like knowing I'm also a student – modeling life-long learning."

From a personal perspective, 10 recognized the time, financial, and energy commitment of engaging in reflective professional development. One found the program to be a social outlet. Another reported a newly found self-efficacy as a learner in a demanding intellectual endeavor.

Across their comments, the teachers commented about the revived respect they had for their own profession. One stated that, "My commitment to my job has increased. I really know why I do what I do!" These were the initial signs of individuals willing to critically examine their own teaching and gaining the confidence to share their voices.

Conclusions

Teachers cited a number of benefits of the course for their teaching: looking at planning in an in-depth fashion and creating something they could use in the classroom, improvements in communication, collaboration, problem solving, and creating thinking skills. In terms of instructional design, one student remarked having a “much greater appreciation of the design process now.” Teachers cited “different ways to think about the learners” and “forces the teacher to look at lots of details to designing instruction and curriculum.”

What these teachers designed and represented was also a product of the political and social constraints of school environment and their personal lives. Finding themselves in the role of student was a new experience for some of these teachers. Juggling a new set of demands on top of their already busy teaching lives challenged all of the teachers. Reflective activities that asked teachers to examine their teaching and learn a new process that scrutinized their teaching was for some a difficult experience. Even with experienced special education teachers who wrote goals every day, the question “What is a goal?” was frequently mentioned. One of us remarked, “We really put a lot of stumbling blocks in their way. They have to start thinking about it and it’s now becoming really awkward for them. We’re interrupting the flow of what they have and when you do that, they’re perplexed.”

We found that all of the ID projects relied on personal beliefs on ways to teach their content and to support their design decisions, including their instructional technology component. Furthermore, none of the reading done from a previous educational psychology course was cited in the projects. However, this was not a surprise as some of the teachers in the previous class struggled to see the connection between research and practice, and publicly dismissed the research as not relevant to their needs. While the teachers sometimes found it difficult to reflect on and write about their teaching, even representing their teaching with a model, moving to the next step and making changes in their practice is even more difficult considering the professional and political challenges they face.

The personal ID model task was structured to encourage teachers to represent their own model of ID components, rather than imposing ours or someone else’s. The value of visual representations for teachers is, as Elbaz (1983), cited in her study of teacher thinking, to invite, rather than compel, conformity. ID is known for its models on how instruction should be constructed, and we believe that teachers can learn from these models, but what is more productive is encouraging teachers to develop their own. Because the course was a first experience with the process, teacher understanding of the whole process and the relationship of the components to each other were not always understood and represented in their models. Teachers’ representations of instructional design tended to adopt aspects of our representation of the process and what we valued. However, their models used personal metaphors that illuminated not only instructional design components but also views of their teaching, as well as their views of students and the school environment. Metaphors provided teachers with a means for “clustering images for exploration and analysis of teacher thinking” (Bullough & Gitlin, 1995, p. 66). Metaphors within these models helped teachers to explore who they think they are, although it was not clear that to us that they were aware of the significance of these representations. Several of the teachers who viewed their teaching lives as balancing the expectations of students and the expectations of other teachers or schooling may not be aware of their loss of voice due to their perceptions of their positions or their preferences for taking responsibility.

One limitation from this brief research summary was not being able to describe in more detail the contexts in which these teachers led their teaching lives, for it is out of these contexts which give rise to teacher voices (Hargreaves, 1996). On the other hand, we have been conscious not to generalize or romanticize what teachers designed, represented, and said into one teacher’s voice, a danger in some educational research (Hargreaves, 1996). In this study we tried to include data that represented different aspects of the teachers’ voices, including what teachers designed and represented. However, the use of representation needs its own context to more accurately characterize its use. As one teacher remarked from Bullough and Gitlin’s (1995) use of written metaphor for teacher examination, “I think the metaphor is actually restrictive in describing ourselves. Maybe a multiple metaphor” (p. 71). Although we have not conducted a careful study of teachers’ ID models with the teachers, the task appears useful for the next steps in enabling reflection and voice. Moreover, writing school history, based on Bullough and Gitlin’s (1995) guidelines, might be a useful technique for cohort in-service programs to continue teacher examination and to contextualize themes that might emerge from a collaborative analysis of this history.

Significance

Our approach to teaching instructional design consisted of examining a teacher’s basis for action, one’s learning beliefs, as a key component of the design process, as well as a systematic use of the ID process to analyze, design, and evaluate responsive approaches to instructional problems. Initially, some teachers viewed instructional design as a complex algorithmic procedure. One request from a teacher was illuminating and represents one of instructional design’s most mis-characterized issues: “Tell how you can condense instructional design and still be as effective.” We admit that a systematic examination of instruction requires time and effort; however, as cited by one teacher at the end of the course, “I now have different ways to think about learners,” suggests that the effort is worth it. Instructional design’s potential has gone unrealized by its depiction as merely a procedural tool for teachers.

Rather, we advocate ID as a thinking tool, one that supports systematic teacher re-examination and complements existing teacher thinking and practices. The ID course provides teachers with the time, while the ID process provides teachers with tools for reflection on their teaching (Wildman & Niles, 1987). The course provides teachers with a forum to talk openly about the environment in which they work in and how this context may limit the kind of teaching they want to practice. Thus, what is a pragmatic process for action, also represents a tool for critical inquiry.

Another important benefit from our reflexive approach is its co-participatory nature, in which both instructor and student are considered as learners and both continually strive to learn from each other and to continually examine our teaching and learning, and to honor participant thinking and activity. Our efforts have been to improve communication with and between teachers, learn from teachers, set the stage for sustained teacher reflection and examination, and develop habits of systematic inquiry.

ID Instruction represents a significant challenge to anyone who has taught it, owing to the range of systematic components that comprise ID and the investment of time and attention needed to support student learning, particular with authentic design activities. If the view of teachers is that of reflective practitioners (Schön, 1983), then the beliefs and concerns of teachers need to be incorporated somehow within the ID process, as well as within ID instruction. Instructional design can be presented to teachers in ways that honor their beliefs and experiences, prompts a re-examination of their teaching, and encourages heuristic responses to instructional problems. Thus, ID instruction represents not only a significant teaching challenge, but a significant opportunity to help teachers re-examine their teaching and for teachers and designers to learn from each other.

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MOTIVATION: GOALS, AGENCY BELIEFS, AND EMOTIONS IN WEB ASSISTED LEARNING

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Abstract

This study first examined the motivation construct with personal goals, agency beliefs, and emotions in a web assisted learning environment. It also investigated the influence of personal goals, agency beliefs, and emotions on the students' learning achievement from fundamental biology courses assisted with web pages. Finally, it examined the relationships among personal goals, agency beliefs, and emotions. A survey questionnaire was designed to measure goals, agency beliefs, and emotions (Appendix A). Learning achievement was measured by the course grades.

Three research questions were addressed: (1) Are the responses to the questionnaire for measuring personal goals, agency beliefs, and emotions consistent with the three-component motivation model proposed by Ford? (2) Do students' personal goals, agency beliefs, and the emotions of using the web pages relate to their learning achievement? (3) Do students' personal goals, agency beliefs, and emotions relate to each other?

Three hundred and fifty six students have participated in the study. These students have taken undergraduate fundamental biology classes in which the instructors used web pages as supplemental tools to assist student learning. After the final exam, the students filled out an on-line questionnaire in order to measure their personal goals, agency beliefs, and emotions in using web pages to assist learning. Students' course grades were used to measure their learning achievement.

A confirmatory factor analysis with Lisrel VI was used to examine the construct validity of the questionnaire (Question 1). Cronbach Alpha reliability values on personal goals, agency beliefs, and emotions were calculated with SPSS 8.0 to indicate the internal consistency of the questionnaire (Question 1). The causal paths among the personal goals, agency beliefs, emotions, and learning achievement were examined using structural equation modeling with Lisrel VI (Question 2 and Question 3).

The Cronbach alpha reliability coefficients on 12 selected items of the motivation instrument for students' personal goals, agency beliefs, and emotions were 0.84, 0.85, and 0.89, respectively. The confirmatory factory analysis on 12 selected items of the motivation instrument showed a fairly good fit of the theoretical model of motivation proposed by Ford (1992). These indicated that the motivation instrument with 12 selected items has moderate reliability and fairly good construct validity.

The data from the structural equation modeling analysis supported that there were significant and direct causal links from students' personal goals to their course grades, from personal goals to emotions, and from emotions to personal agency beliefs.

Introduction

Classroom use of the World Wide Web (WWW) is seen as a new learning tool to reach students (Quinlan, 1996). The Computer Center at a northeastern university has initiated a web-based learning resource, the Virtual Classroom. The Virtual Classroom is a listing of courses that use web pages as a supplemental tool to enhance students' learning. Instructors who join the Virtual Classroom have created their own instructional web pages. The pages usually include class syllabi, practice exams, and related instructional materials, displayed the form of text, graphics, and hyperlinks. In or out of class, students are able to browse and download the web pages from any location with an Internet connection at their convenience.

Some important issues in such web assisted learning environment are: (1) whether the web pages motivate students to learn; and (2) how much motivation factors contribute to learning achievement. The theoretical model of motivation in this study is based on Motivational System Theory (MST), proposed by Ford (1992).

Theoretical Background

Motivational systems theory

On the basis of Motivational Systems Theory (MST), the concept of motivation is defined as the organized pattern of an individual's personal goals, personal beliefs, and emotions" (Ford, 1992). It is implied that motivation represents an integrated construct that provides the direction a person is striving for, emotional energy to support or inhibit behavior change toward the direction, and expectancies a person has about whether he or she is able to reach the destination.

According to Ford (1992), personal goals have two properties, content and direction. A personal goal's content represents the consequences a person is aiming to achieve. Goal direction guides a person to produce the expected consequences. A goal also provides "the regulatory process with criteria for evaluating the effectiveness of the person's activity" (Ford, 1992, p. 73). In addition, personal goals work with personal evaluation criteria to identify and prioritize goal options within and across behavior episodes. Goals are always within a person and are often constructed from the context. Because a goal cannot be imposed on a person (Ford & Lerner, 1992), it must be adopted as a personal goal for someone to perform a desired behavior.

Personal agency beliefs are "evaluative thoughts involving a comparison between a desired consequence and an anticipated consequence" (Ford, 1992, p. 125). According to Ford, there are two types of personal agency beliefs, capability beliefs and context beliefs. Capability beliefs are evaluative expectancies about whether a person has the necessary skills to achieve the goal; context beliefs are evaluative expectancies about whether the person's context will support or facilitate the process of goal achievement. According to Ford (1992), four elements are needed to ensure optimal responsive environment: (1) the environment is congruent with an individual's agenda of personal goals; (2) the environment is congruent with the person's biological, transactional, and cognitive capabilities; (2) the environment has the material and informational resources needed for goal achievement; (4) the environment provides an emotional climate to support or facilitate effective functioning. Directed by a personal goal, capability beliefs, and context beliefs "together provide the person with the information needed to decide whether to initiate, maintain, amplify, or inhibit some pattern of goal-directed activity" (Ford, 1992, p. 74). Personal agency beliefs play a crucial role in reaching those goals that are challenging but reachable.

Agency beliefs can be measured by people's self-reports concerning their confidence in a certain behavior. When they have strong confidence in doing something, they will have higher expectations about whether they can do it and whether they will have a supportive context.

In Ford's view (1992), emotions consist of three integrated components, an affective component, a physiological component, and a transactional component. Emotions influence behaviors that are important to the individual's goals. They are major influences on initiating and shaping goals and personal belief patterns. They provide energy to increase ongoing behavior patterns related to the goal.

A person's interest in doing something reflects an affective component of a person's emotions. An aroused interest toward a specific behavior will be accompanied with physical satisfaction while it triggers the transactional component of emotions. Therefore, emotions can be measured through how much interest a person has in doing a certain behavior.

Based on Ford (1992), personal goals, personal agency beliefs, and emotions are interdependent, and their relationships are complex and nonlinear. "Each component is necessary, but none are sufficient for the activation of strong motivational patterns" (Ford, 1992, p. 80).

Stated by Ford (1992), human effective functioning is represented by achievement and competence in a specific context. Achievement is defined as "the attainment of a personally or socially valued goal in a particular context" (Ford, 1992, p.66). The concept of competence is defined as "the attainment of relevant goals in specified environments, using appropriate means and resulting in positive developmental outcomes" (Ford, 1992, p. 67). To ensure effective functioning, a person must be motivated, have relevant skills to attain the goals and the competence, and supportive biological and behavioral capabilities used to interact with an environment that has the relevant resources to facilitate goal attainment.

In this study, the three components of motivation, personal goals, agency beliefs, and emotions will be tested. The relationships among the three components and the learning achievement will be examined.

Overview of MST application and research

The MST has been applied to several educational domains, such as competence development (Ford, 1995), social intelligence development (Ford, 1983), adoption of microcomputers in early childhood education (Ford, 1988), and infant attachment (Ford & Thompson, 1985).

For competence development in special and remedial education, 17 principles were used for motivating students (Ford, 1995). The goal-directness and perception of control have been studied in developing social intelligence (Ford, 1983). The motivational factors involved in decision making were examined in adoption of microcomputers for administrative and instructional use in early childhood education. A study has been conducted

to investigate the nature and implications of individual differences in perceptions of personal agency and infant attachment (Ford & Thompson, 1985).

Although the MST has been applied in educational fields by its proponents, there is not sufficient evidence to support the validity of the theory in motivating human behaviors. More research needs to be done in various educational contexts to provide theoretical and empirical evidence about the validity of the model.

Overview of on-line resources application and research

Since the World Wide Web (WWW) was developed, educators have used such resources to serve as learning tools in many educational settings. On-line Writing Labs have been used to provide sources and personal contacts for college students to practice writing skills in composition classes (Bergland, 1996). Science and math skills instruction have been supported by scientific labs on the WWW (Friedman et al., 1996). Simulation software provided on the WWW has been developed to support collaborative learning across institutions (Neilson & Thomas, 1996). The WWW has been used by special educators to discuss current issues about practices, policies, and research in special education (Kerr & Dworet, 1996).

Even though WWW on-line resources have been used in many educational settings to enhance learning, little research has been done in terms of effectiveness of these resources in facilitating learning or regarding how motivational factors such as goals, agency beliefs, and emotions, function in such a rich learning environment.

Rationale for employing confirmatory factor analysis and structural equation modeling

As stated in the *Standards for Educational and Psychology Tests*, the validity of an instrument refers to the appropriateness, meaningfulness, and usefulness of the specific inferences made from the test scores. Arguments for instrument validity are based on judgmental evidence and empirical evidence (Gable & Wolf, 1993). According to Gable and Wolf (1993), judgmental evidence is acquired before the administration of the instrument to the target group through examining the adequacy of the operational definition of the construct. Empirical evidence is obtained after the instrument has been administered to the target group. Evidence is provided by relationships among items within the instrument as well as the relationships to instruments measuring similar and different constructs.

Three commonly identified types of validity include content, construct, and criterion-related. According to Cronbach (1971), content validity answers the question: To what extent do the items on the instrument adequately sample from the intended universe of content? The evidence of content validity is generally judgmental and is mostly gathered before the administration of the instrument. The conceptual and the operational definitions of the affective characteristics are the focus of the evidence of content validity. The theoretical basis for the conceptual definitions is provided through a comprehensive review of literature done by the instrument developer. It is also suggested that content experts review the adequacy of the conceptual definition of the instrument. Operational definition is the design of items based on the content specified by the conceptual definition. It is essential that the operational definitions be reviewed by the same five content experts. Their assessments provide evidence that the sampling of items adequately reflects the intended universe of content (Gable & Wolf, 1993).

Construct validity addresses the question: To what extent do concepts or constructs explain covariation in the responses to the items on the instrument? The construct validity argument focuses on response data variation among items to provide evidence that the proposed content categories actually reflect constructs (Gable & Wolf, 1993). Evidence of construct validity is obtained from administering the instrument to a representative sample of respondents for which the instrument was designed. Many statistical techniques can be conducted to provide evidence of construct validity. One of the analysis techniques is confirmatory factor analysis.

In a confirmatory factor analysis, the researcher postulates a theoretical model that the data are expected to fit. The model describes the number of factors to be derived and which variables are related to each factor. The results of the analysis indicate how well the empirical data fit the proposed model. The advantages of CFA over Exploratory Factor Analysis (EFA) include: (1) yields unique factorial solutions, (2) defines a testable model, (3) indicates the extent to which a hypothesized model fits the data, (4) specifies data on the model parameters to aid in improvement of the model, and (5) can test factorial invariance across groups (Marsh & Hocevar, 1983). For these reasons, the study has used CFA to examine whether the data fit the theoretical motivation model proposed by Ford (1992).

Structural equation modeling (SEM) analysis provides evidence for causal relationships among different constructs by disconfirming causal paths. It may be applied to demonstrate the relational paths with directions among variables, the inter-correlations among independent variables, and the amount of contributions independent variables to dependent variables (Kenny, 1979). Although a multiple regression analysis is commonly used to find out contributions of independent variables to dependent variables, it does not postulate the causal paths among independent variables and dependent variables. Additionally, the results of a multiple regression analysis are trustworthy when there are strong multicollinearity (correlations) among independent variables (Tabachnick & Fidell, 1989). Better than a multiple regression, a SEM is robust to multicollinearity (Kenny, 1979). In this study, we attempted to find out the hypothesized causal paths and to minimize errors caused by the strong multicollinearity

among independent variables. Therefore, in this study, a SEM was employed to examine contributions of personal goals, agency beliefs, and emotions to students' learning achievement.

Statement of the problem

This study addresses both theoretical and empirical concerns in three aspects. First, from an instrument development perspective, measuring motivation in the context of web-assisted learning has not been done in the past. In addition, although some instruments to measure motivation have developed (Ford, 1995), no one has employed confirmatory factor analysis to examine the structure of motivation instruments. This study endeavors to test how the students' responses regarding their personal goals, agency beliefs, and emotions will fit into the three-component model proposed by Ford.

Second, from a theoretical aspect, since MST was proposed, no research has been conducted to examine the model using Structural Equation Modeling (SEM). This study is intended to test the relationships among, personal goals, agency beliefs, emotions, and learning achievement in order to test the theoretical model of MST.

Third, from an empirical aspect, the verification and justification of a motivation instrument will lead other researchers to conduct future studies in regard to measuring motivation in the web-assisted learning environment. The instrument may also be used by instructional designers or instructors to assess motivation factors in web-assisted learning. The evidence on contributions of three motivation factors on students' learning achievement will provide instructional designers or instructors with guidance in the process of designing effective web-assisted learning materials.

Therefore, the problems addressed in this study are to provide both necessary theoretical and empirical evidence for the people who are willing to apply the MST in assisting learning through on-line resources.

The literature review of this study has three sections: theoretical framework of MST, an overview of research on MST and on web based learning, and the statistical rationale of using confirmatory factor analysis (CFA) to verify motivation instruments and using SEM to examine the MST model proposed by Ford (1992).

Research questions

Three research questions are addressed for the motivation concept and Motivation System Theory in web assisted learning. The first question focuses on the construct validity of the motivation. The last two questions are pertinent to test the theoretical model of MST, finding out how three motivation factors relate to the learning achievement and how much the factors relate to each other. The questions are stated as follows:

1. Are the responses to the questionnaire for measuring personal goals, agency beliefs, and emotions consistent with the Motivation System Theory proposed by Ford?
2. Do students' personal goals, agency beliefs, and emotions of using the web materials relate to learning achievement?
3. Do students' personal goals, agency beliefs, and emotions relate to each other?

Methods and procedures

An instrument was designed to measure three components of motivation: personal goals, agency beliefs, and emotions (Appendix A). The instrument has ten items with three parallel responses. The three responses measure personal goals, agency beliefs, and emotions, respectively. Personal goals are directly questioned in the instruction. Personal beliefs are indicated by the confidence students have in using the web materials in assisting their learning. Emotions are represented by how much interest students have in using the web materials to study the course. Learning achievement is measured by the course grade.

To ensure content validity of the motivation instrument, five content experts were invited to screen instrument items. Two of them have expertise in instrument development. Another two experts have experience in designing web pages to assist students' learning. One has expertise in instructional design theory relating to use of on-line resources to enhance learning. The finalized instrument was put on-line to allow students to fill it out at their convenience (Appendix B). By writing their full name, students granted their permission for the researcher to look at their course grades.

Three hundred and fifty six students have participated in the study. These students have attended undergraduate fundamental biology classes in which the designed web pages have the following features: (1) there are class syllabi to announce requirement and on-going status of the course; (2) there are hyperlinks to additional on-line resources in order to enhance understanding of biology concepts; (3) there are on-line interactive exams for students to practice before the semester quizzes and final exams (Appendix C). After the final exam, students filled out the on-line questionnaire linked right before the exam grade page. The questionnaire data were sent directly to the researcher's e-mail account.

Cronbach (1951) alpha reliability values for three components of the motivation were obtained by SPSS 8.0 to analyze the internal consistency of the instrument. A confirmatory factor analysis with Lisrel VI was used to examine the construct validity of the motivation instrument (Question 1). The causal paths among the personal

goals, agency beliefs, emotions, and learning achievement were tested using the structural equation modeling analysis (Question 2 and Question 3).

In this study, for judging whether the data model is consistent with the theoretical model, we used three indexes, X^2 goodness of fit, Tucker Lewis index, and Bentler Bonett index. The closer to 1 of these indexes, the better the data model would fit the theoretical model (Kenny, 1979).

Results

Initial data screening

The SPSS 8.0 statistical package was used to conduct the screening of data. For 30 items, there were 351 complete cases out of 365 participants. Two hundred and forty-nine students gave permission to the researcher to look at their course grades. First, the normality of the data was checked. The N: P ratio for the 30 items was 11:1. Twenty-five out of 30 instrument items and the course grades had good normality. Data transformation (Tabachnick & Fidell, 1989) was then conducted on items with poor normality. After the transformation, all items had good normality.

Cronbach alpha reliability analysis on 30 items was conducted with SPSS 8.0 on personal goals, agency beliefs, and emotions and resulted in 0.85, 0.89, and 0.91 respectively.

A confirmatory factor analysis with Lisrel VI was initially conducted on 30 items, but the data model did not fit regardless of specifications. A structural equation modeling with Lisrel VI was done on 30 items and the course grades. The original data model did not converge. These indicated that the designed motivation instrument and the empirical data did not match or correspond. We then carefully examined all 30 items on the instrument by comparing them with features of the web pages in all four courses. We found out that some features of the web pages in the four courses did not reflect a few items on the instrument. For instance, the web pages of three courses did not promote collaborative work as indicated on item 2, "collaborate with other students". We then selected 12 items for further analysis, four each for personal goals, agency beliefs, and emotions (Appendix D). These 12 items reflect common features on the web pages of all four courses.

Reliability of the motivation instrument

Cronbach alpha reliability analysis was conducted on 12 selected items for personal goals, agency beliefs, and emotions. It resulted in 0.84, 0.85, and 0.89 accordingly (Table 1).

Table 1 Factor Loadings in Confirmatory Factor Analysis

	Personal Goals	Agency Beliefs	Emotions
1. Know the key points.	0.832	0.848	0.773
3. Better understand concepts.	0.863	0.834	0.873
8. Prepare for exams.	0.633	0.760	0.663
10. Get a better grade.	0.695	1.036	0.653

Note.

N = 345

All loadings are significant at 0.01 level.

F1: Personal Goals, Cronbach Alpha Reliability Coefficient = .84

F2: Agency Beliefs, Cronbach Alpha Reliability Coefficient = .85

F3: Emotions, Cronbach Alpha Reliability Coefficient = .89

Construct validity of the motivation instrument

The confirmatory factor analysis with Lisrel VI was conducted on 12 items (n = 345). As shown on Table 2, the original model had poor fit (significance of X^2 (66) = 0.00, adjusted X^2 (66) goodness of fit was 0.69). After correlated errors were considered among items, the model had good fit. X^2 was not significant (p = .22). The adjusted X^2 goodness of fit index was 0.95, Tucker Lewis index was .99, and Bentler Bonett index was .99 (Table 2). The factor loadings are from .63 to 1.03 and they were all significant (Table 1)

Table 2 Confirmatory Factor Analysis Indexes

	X ²	Significance of X ²	Degree of Freedom	Adjusted X ² Goodness of fit
Null Model	2748.84	0.000	66	0.122
Original Model	381.73	0.000	51	0.692
Final Model	18.93	0.22	15	0.952

Note:

Tucker Lewis Index = .99

Bentler Bonett Index = .99

Causal paths among personal goals, agency beliefs, and emotions

The structural equation modeling analysis was then performed with Lisrel VI on the 12 selected items of the motivation instrument and the course grade (n = 245). As shown on Table 4, the original model did not fit (significance of X² (78) = 0.00, adjusted X² (78) goodness of fit = 0.15). After the paths were respecified by deleting the non-significant paths and the measurement model was considered with correlated errors, the model had good fit (significance of X² (38) = 0.06, adjusted X² (38) goodness of fit = 0.923). The Tucker Lewis index was 0.98, and the Bentler Bonett index was 0.97 (see Table 4). The factor loadings are from .64 to .87, and they were all significant (Table 3). As the path diagram shows (Figure 1), the Beta from personal goals to course grade was 0.30, the Beta from personal goals to emotions was 0.78, the Beta from emotions to agency beliefs was 0.82. These three paths were significant at 0.01 level.

Table 3 Factor Loadings in Structural Equation Modeling Analysis

	Personal Goals	Agency Beliefs	Emotions
1. Know the key points.	0.813	0.832	0.802
3. Better understand concepts	0.827	0.844	0.874
8. Prepare for exams.	0.644	0.766	0.700
10. Get a better grade.	0.660	0.742	0.665

Note:

All loadings are significant at 0.01 level.

Table 4 Structural Equation Modeling Indexes

	X ²	Significance of X ²	Degree of Freedom	Adjusted X ² Goodness of fit
Null Model	1992.91	0.000	78	0.146
Original Model	284.22	0.000	63	0.724
Final Model	53.02	0.06	38	0.923

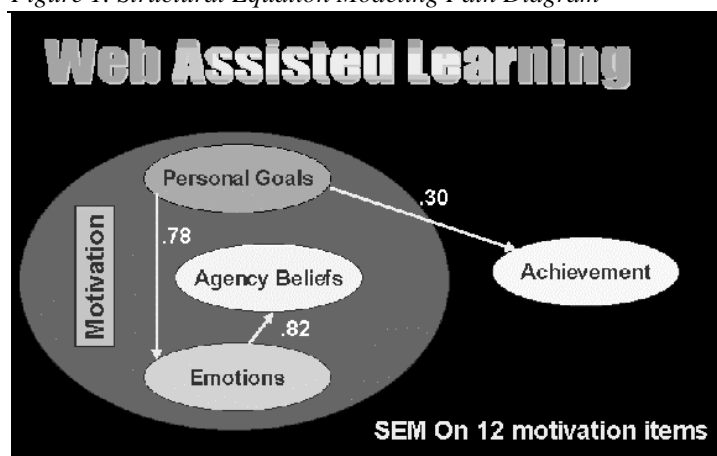
Note:

N = 245

Tucker Lewis Index = .98

Bentler Bonett Index = .97

Figure 1. Structural Equation Modeling Path Diagram



Relationships among personal goals, agency beliefs, and emotions

As shown on Table 5, the correlation coefficient between personal goals and agency beliefs was 0.55 ($p=0.00$). The correlation coefficient between agency beliefs and emotions was 0.73 ($p=0.00$). The correlation coefficient between personal goals and emotions was 0.61 ($p=0.00$). All the correlation coefficients were significant at 0.01 level. The correlation coefficients were correspondent with the results of the structural equation modeling analysis.

Table 5 Correlation's Among Personal Goals, Agency Beliefs, and Emotions

	Personal Goals	Agency Beliefs
Agency Beliefs	0.614 **	
Emotions	0.546 **	0.729 **

Note:

** Correlation is significant at 0.01 level.

Discussion

The Cronbach alpha reliability coefficients indicated that the motivation instrument with 12 selected items was moderately reliable. The results of the confirmatory factor analysis on the 12 selected items of the motivation instrument implied that the responses to the 12 items were fairly consistent with the theoretical motivation construct proposed by Ford. Therefore, from a theoretical perspective, Ford's concept of motivation with three factors, personal goals, agency beliefs, and emotions was supported.

Empirically, it is suggested that the motivational instrument with 12 selected items may be used by other researchers when there are common features on the web pages used in their studies. It is not recommended that the initial motivation instrument with items that were not selected for the data analysis be adopted for further studies.

The data through structural equation modeling analysis supported that there were significant and direct causal links between students' personal goals and their course grades, between personal goals and emotions, and between emotions and personal agency beliefs. These findings demonstrated that students' personal goals were the major contributor to their personal interests, their confidence, and their learning achievement in such a web assisted learning environment. Additionally, students' interests influenced by their learning goals directly impact their confidence regarding use of the web pages as learning tools.

The SEM results demonstrated a gap between the empirical data and Ford's theoretical motivational model. The empirical data model did not show significant causal paths between students' interests and their course grades and between their agency beliefs and their course grades. Several reasons might cause these findings. It might be due to the validity of the course grades in measuring students' learning achievement. The course grades might not truly reflect the students' learning achievement assisted by the web pages. As we went back to examine the course grades provided by the instructor, we found that the course grades included semester exams and the lab performance. The web pages used in four courses provided little help in improving students' lab performance. Therefore, it is more likely that the contributions of interests and agency beliefs in web assisted learning were minimized when the lab performance was considered to be part of students' learning achievement. If we had used solely the exam grades to measure students' learning achievement mainly assisted by web pages, we might have found different results. In

future studies, it is recommended that the validity of learning achievement should be carefully examined before the data analysis.

Another reason might be the reliability of the motivation instrument with the 12 selected items. As the reliability coefficients are around 0.85 for N:P ratio of 11:1, it showed relatively good reliability of the motivation instrument but not high reliability. The higher the reliability, the more accurate the results would be.

Finally, there was a lack of empirical support for Ford's MST in such a web assisted learning environment. It might be questionable that three components, personal goals, agency beliefs, and emotions, all worked together and contributed to learning achievement (Ford, 1992). It might be true that only the component of personal goals not agency beliefs or emotions is the major direct contributor to learning achievement.

Based on the evidence provided from this study, we are confident in saying that at least students' personal goals in web assisted learning were the major contributors to their learning achievement. Therefore, when they design web pages to assist students' learning, instructors or web designers should mainly focus on designing the features of the pages that would help students to achieve their specific learning goals. These learning goals are stated as, knowing the key points, better understanding concepts, preparing for exams, and getting better grades.

As the research study was conducted on four biology courses assisted by web pages, the results were not generalizable to other courses assisted by web pages or similar biology courses with different features from those in our study. To generalize the research findings to different courses, we would like to continue this study with the 12-item motivation instrument by recruiting more students from variety of courses, in which the assisted web pages have the common features of this study.

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Appendix A

Student Survey

This survey is designed to study your opinions about using **the web materials to assist your study**. For each of the behaviors, three questions are asked. Circle the responses that best describe your opinions. There are no right or wrong answers to these questions. Your responses are strictly anonymous. The data will be summarized so that no individual can be identified.

Please do not circle here.

1. How strongly do you think the following possible **goals** apply to you?

1 2 3 4 5

not strong<-----> very strong

2. How **interested** are you in using the web materials to help you do the following?

1 2 3 4 5

no interest<-----> high interest

3. How **confident** are you that you use the web materials to do the following?

1 2 3 4 5

not confident<-----> very confident

Please circle the following responses.			
	Goals	Interest	Confidence
1. Know the key points.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
2. Collaborate with other students.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
3. Better understand concepts.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
4. Preview content before class.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
5. Review content after class.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
6. Extend knowledge beyond class.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
7. Do homework or project.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
8. Prepare for exams.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
9. Have a general picture about content of the class.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
10. Get a better grade.	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

I grant permission for the researcher to look at my exam grade for the explicit purpose of this study.

Print your name _____

Sign your name _____

Appendix B: The On-Line Motivational Survey

Netscape - [Survey Page]

File Edit View Go Bookmarks Options Directory Window Help

Back Forward Home Reload Images Open Print Find Stop Netscape

Location: <http://www.sp.uconn.edu/~b102vc/102987/form102.html>

Mail Newsgroups Weather Sports SNET Support Account Usage

Please Fill Out The Survey

Before proceeding to course grades, please take a minute to fill out the following survey.

This survey is designed to study your opinions about using the web materials to assist your study. Circle the responses that best describe your opinions. There are no right or wrong answers to these questions. Your responses are strictly anonymous. The data will be summarized so that no individual can be identified.

First Name:

Last Name:

***Providing your full name allows the researcher to look at your exam grade from this course. If you don't want the researcher to look at your exam grade, please ignore this part.**

Your Email:

Class Name:

I. How strongly do you think the following possible GOALS apply to you?

strongly disagree <== 1 2 3 4 5 ==> **strongly agree**

	1	2	3	4	5
1. Know the key points.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Collaborate with other students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Better understanding of concepts.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Preview content before class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Review content after class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Extend knowledge beyond class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Do homework or project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Prepare for exams.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Have a general picture about the content of the class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Get a better grade.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

II. How INTERESTED are you in using the web materials to help you do the following?

not interested <== 1 2 3 4 5 ==> **very interested**

	1	2	3	4	5
1. Know the key point.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Collaborate with other students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Better understanding of concepts.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Preview content before class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Preview content after class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Extend knowledge beyond class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Do homework or project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Prepare for exams.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Have a general picture about the content of the class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Get a better grade.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

III. How CONFIDENT are you that you use the web materials to do the following?



Not Confident <== 1 2 3 4 5 ==> **Very confident**

	1	2	3	4	5
1. Know the key point.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Collaborate with other students.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Better understanding of concepts.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Preview content before class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Review content after class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Extend knowledge beyond class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Do homework or project.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Prepare for exams.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Have a general picture about the content of the class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Get a better grade.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please make sure you have circled all the responses.

Click to **SUBMIT** the survey and proceed to course grades.

Click to **RESET** your entry.

 Thanks for your help! 

Document: Done

Start Web B... Nets... Bookm... Micros... WY Micros... Adobe... 12:41 PM

Appendix C: A Sample Web Page

Netscape - [Biology 102 at UConn Fall 1998 Index Page]

File Edit View Go Bookmarks Options Directory Window Help

Back Forward Home Reload Images Open Print Find Stop Netscape

Location: <http://www.sp.uconn.edu/~bi102vc/102f98/home102.html>

Mail Newsgroups Weather Sports SNET Support Account Usage

Biology 102: Foundations of Biology -- Fall 1998

Professors Ted Taigen, Tom Terry, and Alice Villalobos
The University of Connecticut
Last revised: Tuesday, December 22, 1998

Course Resources

- Course Announcements and Updates
 - [10 a.m. Lecture Section \(Taigen & Terry\)](#). Last updated on Tuesday, December 22, 1998.
 - [Noon Lecture Section \(Taigen & Villalobos\)](#). Last updated on Tuesday, December 22, 1998.
- Updated Lecture/Reading List
 - [Ted Taigen's Lectures](#) (both 10 a.m. and noon sections). First half of semester.
 - [Tom Terry's Lectures](#) (10 a.m. section). Second half of semester.
 - [Alice Villalobos' Lectures](#) (noon section). Second half of semester.
- [Study Guides index page](#)
- [Practice exam index page](#)
- [Exam Answer Keys](#)
- [Grades ^{Updated?}](#)
- [Lecture Syllabus and Course Requirements](#)
 - Lost your syllabus? Print out a copy from this file.
- [Laboratory Syllabus](#)
 - includes lab schedule and lab policies, how to contact your TAs, and more.
- [Ask a Question or send a Comment](#)

Useful Links

- [About Ted Taigen](#)
- [About Tom Terry](#)
- [About Alice Villalobos](#)
- [Web resources in Biology](#)
 - Explore different resources available on the Web. C'mon, give it a try! I guarantee you'll find something to knock your socks off.
- [Web Access at UConn](#)
 - Still trying to find a computer terminal without waiting? Here are some places to try.

"What characterizes the living world is the basic unity that underlies its tremendous diversity. The living world contains bacteria and whales, viruses and elephants, organisms living in polar areas at -20°C and others living in hot springs at 70°C. All these creatures, however, exhibit a remarkable unity of structure and function. Similar polymers fulfill similar functions. The genetic code is the same and the translating machinery very nearly so. "

Francois Jacob. **The Possible and the Actual**. 1982. Pantheon Books.

Visiting educators: please visit the "[Resources for Biology Educators](#)" page to learn about additional resources for the use of the Web in teaching biology.

This page has been accessed **9465** times since Aug. 21, 1998.

- To send e-mail to the instructor: taigen@uconnvm.uconn.edu; Dr. Taigen
- To send e-mail to the instructor: terry@uconnvm.uconn.edu; Dr. Terry
- To send e-mail to the instructor: villalobos@uconnvm.uconn.edu; Dr. Villalobos
- To send e-mail to the Virtual Classroom: virtualclass@uconnvm.uconn.edu

Document: Done

Start Web Budd... Netscap... Bookmark... Microsoft... Adobe Ph... 11:46 AM

Appendix D

Student Survey

This survey is designed to study your opinions about using the web materials to assist your study. For each of behaviors, three questions are asked. Circle the responses that best describe your opinions. There are no right or wrong answers to these questions. Your responses are strictly anonymous. The data will be summarized so that no individual can be identified.

Please do not circle here.					
1. How strongly do you think the following possible goals apply to you?	1	2	3	4	5
not strong<-----					> very strong
2. How interested are you in using the web materials to help you do the followings?	1	2	3	4	5
no interest<-----					> high interest
3. How confident are you that you use the web materials to do the following?	1	2	3	4	5
not confident<-----					> very confident
Please circle the following responses.					
*1. Know the key points.	1	2	3	4	5
2. Collaborate with other students.	1	2	3	4	5
*3. Better understand concepts.	1	2	3	4	5
4. Preview content before class.	1	2	3	4	5
5. Review content after class.	1	2	3	4	5
6. Extend knowledge beyond class.	1	2	3	4	5
7. Do homework or project.	1	2	3	4	5
*8. Prepare for exams.	1	2	3	4	5
9. Have a general picture about content of the class.	1	2	3	4	5
*10. Get a better grade.	1	2	3	4	5

I grant permission for the researcher to look at my exam grade for the explicit purpose of this study.

Print your name _____

Sign your name _____

* Item 1, 3, 8, and 10 were selected for confirmatory factory analysis and structural equation modeling analysis.

PROBLEM BASED LEARNING: A HISTORICAL ANALYSIS

Alan Januszewski
SUNY Potsdam

Robert Pearson
Performix, Inc.

Background

In recent years there has been much interest in the Instructional Design field around the concept of constructivism (e.g. Jonassen 1991, Wilson 1996, Driscoll 1994, Duffy and Cunningham 1996). Problem based teaching and learning strategies are among the most frequently used constructivist design approaches (e.g. West, Farmer, and Wolff 1991, Bednar, Cunningham, Duffy, and Perry 1991, Duffy 1996). Problem-based teaching and learning strategies have been used successfully with a variety of learners in a variety of contexts (see Duffy and Cunningham 1996 including business and industry (Dunlap and Gibson 1997), higher education (Harper and Duffy 1997, Duffield and Grabinger 1997), and K-12 settings (Fosnot 1989). Problem-based teaching and learning strategies are becoming well established as a method and an area of study within the field of instructional design.

Problem

An important but overlooked aspect of the study and use of problem-based teaching learning strategies is its history and the philosophical/theoretical implications of those strategies in a broader history. At first this may not appear to be cause for concern. Problem-based learning can be seen as simply an instructional strategy. But there are no value neutral actions in instruction (Yeaman 1990, Kwan and Anglin 1990). Values and the philosophical study of values have existed all through history. Therefore philosophical questions can be analyzed through studying history (Koetting 1996). Studying history can help us to understand why we are the way we are. It can also help us to maintain our traditions, help individuals and members of the field to stick to their roots. But it can also provide us with more options and help us to break out of past patterns if it seems important to do so (Januszewski 1996).

Purpose

The purpose of this paper is to examine, through historical analysis, the values and beliefs underpinning the early theories and applications of what is now called problem-based learning and contrast these with current theory and practice. This study will focus on the first three decades of the twentieth century because during this time period the use of projects in education became popular and because this was a period of time when ideas from business and industry began to be used in educational contexts. This analysis will, as Januszewski (1996) suggests put our current practice in a more meaningful context and potentially suggest new options and interpretations for the future application of problem based learning and teaching strategies.

The project

The literature dealing with the field of education in the first three decades of the twentieth century shows that there were many interpretations of the use of the term "project" in the educational context. As one might expect, considerable and critical discussion of the meaning and implications of these conceptions followed.

The following review of this discussion was offered by a graduate student.

The term project carries a variety of meaning: to some, fad; to some, certain misconceptions involving, for instance, a confusion between process and result, as when a tabourette is itself called a project; to some a sound, but limited method of education needing generous supplementation from other methods, such as drill; and to others, a valid, inclusive method, long in incidental use, but now to be consciously extended. It is not difficult to see in each a share of truth. A history of the movement would read at times a faddish aspect; in its core of meaning it is doubtless very old; it cannot, alone of all theories have escaped misconception; and when conceived as a partial method, it of course needs to be supplemented from without itself. While some disapprove of the use of the term itself, they will perhaps admit that the main trend seems to favor both the term and the practice (Herring, 1921).

The differences among the various conceptions of the project method were both philosophical and applied, or perhaps put another way, both strategic and tactical.

The historical backdrop to the “project”

There are two individuals, E. L. Thorndike and John Dewey, whose scholarship had a profound influence on those that promoted the use of projects in education as it did many educational issues. Thorndike and Dewey, while they had substantial disagreements, were part of a new emphasis on the scientific method as a mode of inquiry when investigating the subject of teaching. Science and scientific applications would soon stand side by side with philosophy in determining the educational process.

E. L. Thorndike was a prominent psychologist who sought to create a science of education on which all teaching could be based. Thorndike maintained that there were three psychological laws of learning: readiness, exercise and effect. The formulation of these laws were based on his emphasis on learner outcomes, outcomes which could be quantified. Thorndike’s other contributions included work with student evaluation, the choice, design and organization of instruction. He was also an early advocate of the investigation of individual differences among learners (Thorndike, 1911, 1913).

John Dewey wrote and commented extensively in all areas education, science, and philosophy. His work was often cited by writers on opposite sides of the same educational issue, the project debate has proven to be no different. This may be due to the fact that it was common place that everyone talked about Dewey and no one read him. Perhaps a more accurate statement would be everybody talked about Dewey but few people understood him.

The citations of the works of Dewey were bound to add credence to almost any academic position. A cynical observer may liken these frequent, but uninformed, citations to trotting out artillery and cannonading the opposing position in an attempt to dislodge their philosophical base of support. But this is a compliment to Dewey. No other figure in educational thought held so much notoriety in the American education community. It can be argued that Dewey has influenced more educators than any other individual of that time period. A giant in a field may attract disciples who in turn interpret the original work into something that was not necessarily the original intent. Dewey’s writing style has often left him in a position to be interpreted in a distorted manner (Cremin, 1961).

It is particularly important to be aware of the potential for influence of Thorndike and Dewey on the use of projects in education because they had substantially different perspectives on the role of science in education. Also, attempts to infuse projects into education were done in the name of science.

What A Project Is Not

J. A. Stevenson provides a useful treatment of the project in educational settings. He proposes his own definition of a project. He compares the definitions and uses the term by others up to the time of his writing. The result is a “meta-definition”. He comes to his definition through the analysis of common terminology and includes as valid, the use of the term by most of the popular proponents of the project at the time. To be sure not all whose definition he reviewed would agree with the conclusion he draws. They would, for the most part, agree with his determination as to what a project is not. We include a discussion of what is not a project because it will reveal some of the common ground that is held by all proponents of project use in education. This will also provide a point from which we can embark on the explanation of the uses of the term project in education. Stevenson’s definition – “A project as a problematic act carried to completion in its natural setting” (Stevenson, 1925). In so defining a project he is able to eliminate the following practices as not being projects: problems, questions, topics, drills, tests, reviews, applications, demonstrations, experiments, and practicums. His elimination of these terms as a substitute for projects is based on the fact that they would all need some qualifying adjective which would change their meaning from the way they were popularly used in that day. The majority of these other methods stressed information over action, the subjugation of problem to a principle, and the inferred emphasis on an artificial rather than natural setting.

Early Project Use in Education

Prior to 1900 the word project had been used for many years in business and in some specialized forms of education, most notably architecture, with a vague meaning. In 1908-1910 the unmodified word project was used by R.W. Simson and David Snedden in their report to the Massachusetts legislature regarding agriculture courses in vocational schools. In approximately the same time period (1908-1910) the term project had begun to be used in professional school programs such as medicine, engineering, and journalism. Soon after the term project was creeping into the vocabulary of educators at all levels. As the use of the word gained in popularity it was inevitable that many uses and definitions of the term would be developed.

Various Definitions of the Project in Education

Some of the proposed definitions of, and explanation of, the use of the word project in education are as follows:

J. A. Stevenson's definition – “A project is a problematic act carried to completion in its natural setting”. Explanation: 1) There is implied in an act carried out to completion a desire for action rather than a “passive absorption” of information; 2) the insistence of a problematic situation demands reasoning over memorization; 3) by emphasizing a problematic aspect there is a priority of problem over principle which infers a discovery rather than an application approach; 4) the natural setting places value on the more life-like environment as opposed to an “artificial” setting (Stevenson, 1925).

W. W. Charters definition – “The project is considered to be an act carried to completion in its natural setting and involving the solution of a relatively complex problem. (Charters, 1918). Explanation – “The prime essentials of the project are, that it must involve the solution of a problem and that it must culminate in action.” Other advantages of the project are that “. . .it gives training in locating and solving problems, it gives training in the technique of action, and it teaches subject matter in connection to life situations.” (Charters, 1917). There is much agreement between Charters and Stevenson on this issue except for the amount of complexity in the problem to be solved. Stevenson does not share Charters's notion that a project must solve a complex problem.

C. W. Stone definition – “A project is a Life Topic in which processes and objects of learning are largely manual.” Explanation – Stone defines Life Topics as units of experience that are worthy of value. Stone also places an emphasis on finishing a product. It also seems clear that this limits project use to performing physical or manual work rather than solving a problem (Stone, 1921).

D. Snedden definition – “. . .To be an educational project such as a job (e.g. . wiring a room, growing a half acre of potatoes, etc.,) must be of such a nature as to offer large opportunity, not only for the acquisition of new skill and experience in practical manipulation, but also for applications of old and learning of new related knowledge.” (Snedden, 1916). Explanation – the use of the project as outlined by Snedden is also limited. It seems that, like Stone, Snedden considers projects only acts that require manual activities. He has a strong emphasis as objective standards for the judging of the final product of the project. Project use for Snedden requires the building of new knowledge upon older, related knowledge.

J. A. Randall definition – “School Project – A problem the solution of which results in the production of some object, or knowledge of such value to the worker as to make the labor involved seem to him worth while.” Explanation – Like Charters and Stevenson, Randall sees a project as solving a problem. There is an emphasis on the production of some object, although obtaining knowledge is included in his definition. There is no seen objective standard for outside evaluation discussed by Randall, only that the “worker” involved believes that the activity was worthwhile. The evaluation is performed by the individual learner (Randall, 1915).

W. H. Kilpatrick definition – “Project – A wholehearted purposeful activity proceeding in a social environment.” (Kilpatrick, 1918). Explanation – This definition has three features that are thus far unique: 1) that the action be determined by the individual learner; 2) that the act need not necessarily be carried out to its completion; 3) that the act take place in a social setting. Kilpatrick identifies four possible types of project but admits that there may indeed be the possibility of overlap among them. “The first type represents those experiences in which the dominant purpose is to do, to make or to effect.” “The second type of project may be defined as one which involves purposeful experiencing or appropriation of an experience.” “The third kind of project is one in which the dominating purpose is to solve a problem, to unravel and so compose some intellectual entanglement or difficulty” “The fourth type includes experiences in which the purpose is to acquire some item or degree of knowledge or skill, or more generally, experience in which a person purposes his own education at a specific point. (Kilpatrick, 1925). There are three aspects of a project that can be identified: 1) the presence of a purpose (the desire); 2) the activity itself (the doing); and 3) the outcomes of the activity (the result of the doing).

J. F. Hosis Definition – “I understand by project a complete unit of experience. The essential aspects or elements of an experience are, in the simplest form, a situation and a response to it. This, however, will not describe adequately what is meant by the type of experience called complete. Such a unit includes the following phases: situation, problem, purpose, plan, criticism of the plan, execution, judgement of results, appreciation. This is, of course, not a chronological order strictly speaking as a feeling of appreciation will spring up in anticipation of the outcome, while on the other hand, purpose persists and the plan is modified to the very end. (Hosis, 1924). Explanation – Hosis, like Kilpatrick, places an emphasis on the purpose of the project. He uses the terms criticism, judgement, and appreciation to show that a particular project need not be carried to the completion of some object. In his definition, as I have provided it, he enumerates the phases of the project. For Hosis, the purpose of a project can be defined in terms of a problem.

There are a number of definitions, uses, and conceptions of the project in education. Those seem to fall into two basic categories. The first is the uses of projects in the areas of Agriculture, Home Economics, Industrial Arts and Science which view projects as a manual activity which is aimed at a pre-specified result. In performing the activity and obtaining the result it is believed that the “doer” will acquire additional knowledge and/or training from the process. The second are definitions which are very similar to the Kilpatrick/Hosis conception of project, which saw project use as the basis to establish the entire curriculum.

The two positions on project usage in education are part of broader theories on the role of the school and curriculum development, these are the social-efficiency movement in education and child-centered education. The

social-efficiency orientation was demonstrated by the project conception of Charters and Snedden. They hoped to systematically arrange parts of the curriculum into projects in such a way that it fit into their "scientific curriculum building" mold. Kilpatrick and Hosis are considered part of the child-centered approach in their conception and development of project use.

Agreements on Definition

Despite the marked differences between these two camps, there are some similarities. First, both groups agree that when using the project style of teaching the problem or purpose that is to be addressed in the project should be determined before any of the principles or knowledge to be learned are introduced. The introduction of the principles or knowledge prior to the problem changes the activity to an application or practicum, it is no longer a project.

Second, that principles should be developed as they are needed to complete the project. Introduction of principles prior to the project is to eliminate any change from the "organized and systematic treatments" of this subject matter. This would defeat areas of the agreed upon purposes of project usage which is to avoid presenting the learners with dictated information and exercises.

Third, it is agreed by members of both groups that projects will be most successful and will show the highest degree of effectiveness when the learner chooses to take ownership of the project. The project must hold the students' interest to be educative. There does not appear to be a substitute for intrinsic motivation. Members of both groups agree that such a motivation is most desirable and should be capitalized on "whenever possible."

Fourth, one of the great advantages of the project style of instruction is that it most resembles real life. Students will become more involved in project style work because they will be able to see the tangible results of their work. This will in turn encourage more learning through a greater effort. A learning spiral will result as tangible results build on one another.

Fifth, both groups see the use of projects as being an efficient and effective way of promoting student learning. Students will learn how to think, how to do, and how to complete work once begun. A number of desirable skills could be cultivated using projects in education.

Finally, problem based learning could be either individual or group based. It need not be one or the other.

Examples

One of the authors has recently worked on two instructional development assignments that illustrate how modern instructional design strategies have embraced emerging problem centered and constructivist perspectives. In each case, clients actually use the term "problem-based learning" to describe the underlying instructional design approach. Each deals with radically different content and target audiences. One is an initiative in the public school system the other in business and industry. Interestingly, both assignments reflect many of the characteristics of "projects" as summarized above.

The New Brunswick Alcohol Awareness Project got its start in 1997 with a large grant from the Brewers Association of Canada. The Brewers Association designates monies each year to support education and awareness programs in the community around responsible alcohol use. After extensive collaboration with stakeholder groups the Brewers Association decided to earmark funds for an alcohol awareness program aimed at middle school kids. The effort will result in a set of curriculum materials that supplements the meager offerings currently available around this topic in Canadian Schools. Another important project goal is that the final product leverage communication and computer technology available to kids at home and in their classrooms. The finished curriculum materials will be piloted in the province of New Brunswick and then made available to school boards across the country by late 1999. A group of curriculum specialists, content experts, instructional designers and multimedia specialists has been charged with building an engaging, effective technology based set of curriculum materials.

From the outset, everyone involved felt strongly that technology should not be used to simply deliver alcohol related facts and figures to learners through their classroom computers. Instead, the program developers believed that learners should be engaged through a series of collaborate activities or "projects". Project descriptions (as well as support materials for teachers would reside on a web site. In addition, the web site would contain a rich repository of material related to alcohol use in society. These materials will include graphs showing patterns of alcohol use across different groups, audio clips of people describing the reasons they use alcohol or helping professionals describing their interactions with problem drinkers. Learners would be encouraged to work collaboratively both within the classroom and with learners at other schools. Projects would culminate with an "artifact" of some kind -- a poster or newspaper article -- that would, in turn, be posted to the "gallery" section of the web site. Two other sections of the site will be designed specifically for teachers and parents. The teacher's section will include a variety of strategies around effectively deploying the web resources in the classroom. The parents section will, among other things, provide information about how to discuss alcohol related issues with preteens.

The second example of "problem based-learning" is a technology based learning product for a large national police service. The police service's training efforts have slowly been adopting a problem based focus over

the past five years. This particular project represented the first time the police service's problem based approach would be realized through technology-based, self-study learning materials. The finished product will be used with pre and inservice police officers. The police service wanted a learning product that would challenge officers to reflect on the way they resolved challenging and potentially life threatening situations. Learners would always gain access to foundation content within the context of authentic scenarios.

The prototype, now in development, is constructed around five video scenarios. Each scenario unfolds based on the decisions a learner makes. At each decision point, learners are directed to foundational content that will help them see how their real-life actions are instructed by underlying principles. At the conclusion of each scenario, learners receive feedback on their decisions through the eyes of an expert colleague. This gives the debriefing exercise an enhanced sense of credibility. A collaborative element will also be developed. Learners will have the opportunity to write an actual report based on their handling of the scenario. Reports will be posted to a web site where peers will have an opportunity to comment.

Conclusion

Much of the language of the field of education in the early twentieth century is consistent with the language that is used in the field of instructional technology, instructional design, and constructivism today. Examples include the need for efficiency, the use of objectives, systematic design of the curriculum, the need to manage instruction, individualizing instruction, projects, and problem based learning.

Modern Problem Based Learning evolved out of early conceptions of the project method. Just as there were different conceptions of the project method in education there are different usage's of Problem Based Learning in instruction, both in K-12 settings and in business contexts.

Modern day problem based learning might best be viewed on a continuum where prespecified outcomes determined by instructors/clients to the creation of environment where learners determine their own expectable outcomes. Both of these pole have roots in the project method. In order to effectively make decisions about where on this continuum a problem based intervention should lie, one needs to understand the philosophical underpinnings of the project method at that point on the continuum and one needs to understand ones own philosophical position regarding teaching and learning.

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SECONDARY TEACHERS' PROFESSIONAL USES OF COMPUTERS

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The purpose of the study described in this paper was to investigate teachers' perceptions of the role computers play in their workplace performance. Subjects were 142 secondary public school teachers who responded to a 71-item questionnaire. Follow-up telephone interviews were conducted with 15 carefully selected subjects to provide more depth. Data were analyzed to provide a multifaceted description of teachers' current professional computer uses, their perceptions of the effects of the computer on their work, and what most facilitates or impedes their computer use. Subjects generally use the computer for typical tasks, such as creating instructional materials and performing administrative tasks. Most perceived their computer use as having a positive impact on their work, making them more professional, more creative, better informed, and generally better educators. Surprisingly, improved interaction with colleagues did not emerge as a particularly important use of the computer. Accessibility to e-mail and Internet access was moderate or high for only 33.8% of the subjects and few use the computer to communicate with colleagues, a use that might ease the isolation of teachers and foster professional development.

Introduction

"As state after state has to re-create schools so that they can meet 21st century demands, it has become apparent that their success depends fundamentally on teachers. What teachers know and can do is the most important influence on what students can learn" (The National Commission on Teaching and America's Future, 1996, p. 2). How teachers go about accomplishing their daily tasks influences their current effectiveness and their continuing improvement. There are currently concerns regarding the performance of teachers (The National Commission on Teaching & America's Future, 1996) and acknowledgment of the increasing importance of teaching-related tasks in addition to classroom instruction (Hargreaves, 1994). Despite empirical support that computer use improves teacher productivity (Rockman, Pershing, & Ware, 1992) and increases feelings of professionalism and effectiveness (Wilson, Hamilton, Reslow, & Cyr, 1994), there is limited research that focuses on how teachers are integrating computer practices to accomplish the many aspects of their work.

The purpose of this study was to expand the knowledge base concerning secondary teachers' perceptions of computer integration into their work, the effects of computer practices on their work, and what most facilitates or impedes their effective computer use. This knowledge base provides a foundation for further investigation of ways in which the computer might support teachers' efficiency and effectiveness on the job.

Conceptual Framework

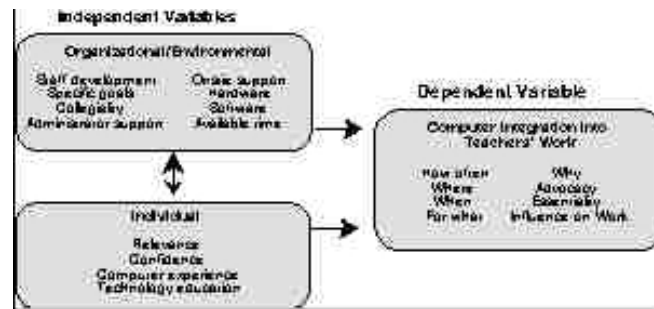
Critical to investigating teachers' professional computer use is capturing the essence of the meaning of *computer integration* in the context of teachers' professional activities. This exploratory study incorporated a comprehensive approach, conceptualizing computer integration as a multidimensional phenomenon. It used a framework based on sociotechnical systems theory and informed by other human performance models from the organizational development literature as the basis for identifying the individual, organizational, and environmental factors that might influence teachers' professional uses of computers. The sociotechnical systems framework also complements and extends other conceptual frameworks in the literature on teachers' work and on computers for educational purposes.

Variables Used in the Study

The dependent variable in the study was teachers' integration of computers into their day to day work. A major focus of the study was to identify and investigate the many facets of this variable. Eight a priori dimensions suggested by results of research on computers in educational and other organizational contexts were used to provide a learner and more complete measure of the dependent variable.

The independent variables were the facilitators of and barriers to computer use. A range of individual, organizational, and environmental factors consistent with sociotechnical systems theory and empirically supported in research on computers in education were included. Figure 1 shows the independent variables and the dimensions of the dependent variable.

Figure 1. Variables used in the study



Review of Relevant Literature

A study to identify and investigate the dimensions that provide a comprehensive picture of teachers' professional uses of computers draws from the literature in a variety of areas, including the occupation of teaching, the integration of integration into both educational and organizational contexts, and the analysis and improvement of workplace performance.

Measuring Computer Integration

Prior educational research on computer integration, although primarily emphasizing instructional uses and curriculum integration provides useful and relevant information that serves as a springboard to this study. Many studies have used a single measure to operationalize computer integration into educational settings. Measures among the studies vary and include frequency (Pelgrum & Plomp, 1991; Zammit, 1992), continuums or levels (Carrol & Perin, 1994; Marcinkiewicz, 1993-94; Moersch, 1995), developmental stages (Baker, Gearhart, & Herman, 1993), and styles of use (Evans-Andris, 1995).

A more comprehensive approach to conceptualizing computer integration is not without precedent, however. For example, to describe exemplary computer using teachers Hadley and Sheingold (1993) proposed a variety of profiles, and Becker (1994) suggested an index based on five components.

Dimensions of Teachers' Professional Uses of Computers

Because teachers routinely perform a wide variety of tasks, identifying the activities for which they use the computer is an important dimension. Reynolds (1992) found that middle school teachers spend one half of their time on tasks directly related to instruction. The other half of their workday is spent on other tasks, such as planning and preparing for instruction (20 percent), evaluating student learning and instructional effectiveness (15 percent), and administrative responsibilities and professional development (15 percent). Results of studies (Reynolds, 1992; Rosenfeld, Reynolds, & Bukatko, 1992; Shedd & Bacharach, 1991) have categorized teaching responsibilities and substantiated the notion that teaching involves a wide variety of complex tasks.

The notion of whether teachers consider their use of the computer essential to their day-to-day work is another dimension of computer integration. According to Carr (1992) one of the characteristics that describe a task is the value it adds. A task can directly add value, be ancillary to tasks that add value, indirectly add value, or be wasteful. The degree to which a task directly adds value is related to its essentiality. Researchers studying computers in the schools generally conceptualize integration as use for tasks that are critical to successful teaching (Becker, 1994). Results of studies often indicate that use for such consequential activities is not prevalent (Hadley & Sheingold, 1993; Marcinkiewicz, 1993-94).

The literature on technology in organizations other than schools provides valuable insights into a variety of reasons for using computers in the workplace and the potential impact of the computer on humans and work. Perspectives on the purposes for using computers range from improving efficiency to expanding human capacity by providing expertise, advice, and external storage of information. Zuboff (1988) envisioned two possible scenarios for companies integrating smart machines into the workplace. In the first scenario, which she termed *automate*, the intelligence was located in the smart machine at the expense of the human capacity for critical judgment. In the second scenario, termed *informate*, smart machines create the need for new skills and knowledge to exploit the potential of these technologies.

Sociotechnical Systems Theory and Computer Integration

Sociotechnical systems theory stresses the importance of both the requirements of the job and the organizational culture. According to this theory, job performance is a function of an appropriate combination of the technical requirements of the job and the social and psychological needs of the people (Pasmore, 1988; Trist, 1993).

Schein (1994) examined his research into the dynamics of organizational culture and concluded that a sociotechnical model is necessary to understand what really goes on in organizational domains and to arrive at better concepts and theoretical insights into the characteristics that support the introduction of information technology. Hart (1995) examined the implementation of technological innovations in education and asserted that “the slow integration of technology into schools despite large infusions of resources into hardware and software may in part have resulted from a failure to recognize the sociotechnical nature of these innovations ” (p. 188).

Facilitators and Barriers to Computer Integration

The influence of social and psychological needs on workplace performance is consistent with research that indicates the importance of collegiality in the implementation of innovations in the schools (McLaughlin, 1993). Additional factors influencing the implementation of technology in school settings are summarized in Table 1. Empirical support is provided by studies in which results suggested the significance of the factor as a facilitator or barrier to computer use.

Table 1. Summary of Facilitators and Barriers Identified in Studies of Computer Use

Facilitator/ Barrier	Empirical Support						
	Becker (1994)	Hadley & Sheingold (1993)	Hart (1995)	Pelgrum & Plomp (1991)	Marcinkiewicz (1993-94)	Rockman, et al. (1992)	Bacharach, et al. (1986)
Time	X	X	X	X			X
Staff development	X	X		X		X	
Hardware, software availability	X	X		X			
Onsite Support	X	X		X		X	X
Administrator Support		X	X			X	
Specific goals				X			
Group Values/Collegiality	X	X	X			X	
Confidence/ Perceived expertise		X		X	X		
Relevance				X			
Technology Education	X	X					
Computer experience	X	X		X	X		

Method

The study used both quantitative and qualitative data. Quantitative data were collected from a survey administered to secondary public school teachers. Subjects in the study were 142 middle and high school public school teachers at ten schools in a single district. Random sampling was not used. Surveys were distributed to all secondary teachers in the district. The district recently developed and is beginning to implement a technology plan.

Survey Instrument

The survey consisted of 78 items which measured the eight a priori dimensions of computer integration, facilitators and barriers, individual characteristics, and demographic information. Answers were primarily in the form of Likert-type responses or multiple choice, with a few short-answer questions.

Teaching tasks included were based on the literature on teaching, particularly Reynolds (1992), and from the questionnaire used by Rockman, et al. (1992). Items to measure reasons for using the computer were based on previous studies (Rockman, et al., 1992; Hadley & Sheingold, 1993; Pelgrum & Plomp, 1992). Resources and barriers were consistent with sociotechnical systems theory as well as with prior research on computer integration in education. The instrument was revised several times based on comments from various educators. It was pretested using six middle-school classroom teachers. A final revision incorporated their comments.

Data Collection

A copy of the survey was distributed to 410 teachers at ten schools. Of this total, 142 (34%) were returned. Participation was voluntary and responses confidential. Because of unanticipated administrator concern, follow-up reminders were not sent.

The 67 respondents who indicated they were willing to participate in a follow-up telephone interview were grouped into four categories: (1) infrequent use and low expertise; (2) frequent use and low expertise; (3) infrequent

use and high expertise; and (4) frequent use and high expertise. Four subjects were interviewed from groups two through four and three individuals were interviewed from group one.

Data Analysis

Frequency distributions provided descriptive information on demographics, on the eight dimensions of computer integration, and on facilitators and barriers. Multiple regression analyses were used to provide information regarding combinations of facilitators and barriers that predict two aspects of computer integration, frequency of use and essentiality.

Results

Demographic Information

Of the 142 individuals who completed the questionnaire, 58.5% were female and 41.5% were male. Ages ranged from 25 to 71 years with an average age of 43.26 years. The number of years of teaching experience ranged from one to 46 years with an average of 16.13 years. The average number of years of experience using the computer was 7.3 years with a range of from zero to 29 years.

Most subjects had access to a computer both at school and at home, but had limited electronic mail and Internet access, as evidenced by the 66.2% of subjects who rated the availability of these resources as none or low. When asked how they would rate their overall computer expertise, 23.2% rated themselves nonusers or novices, 40.8% said they had moderate expertise, and 35.9% rated themselves as above average or experienced.

Dimensions of Computer Integration

Three-fourths of the subjects (75.4%) used the computer for work at least two to three times a week; 45.1% used it daily. Subjects who use the computer do so both at school (79% during prep time and 84.3% before or after class and at school (69.3% evenings or weekends and 58.5% during vacation periods). A majority (52.9%) of the subjects indicated that they routinely use the computer to create instructional materials. A majority did not use the computer for two of the tasks, interacting with colleagues (52.5%) and analyzing the effectiveness of specific lessons.

When asked to rate how essential computers are to their work, 48.6% of the subjects indicated that they couldn't imagine doing their job without it. At the other end of the spectrum, 8.5% said that they would do just as well without it. Respondents also rated how essential they considered the computer for specific teaching tasks. Table 2 shows responses from highest (essential) to lowest (not important) mean score.

Table 2. Essentiality of the Computer for Specified Tasks

Activity	Not Important N (%)	Somewhat Important N (%)	Important N (%)	Essential N (%)	Mean
Instructional materials (N=127)	8 (6.3)	19 (15.0)	47 (37.0)	53 (41.7)	3.142
Administrative tasks (N=122)	16 (13.1)	14 (11.5)	39 (32.0)	53 (43.4)	3.057
Develop units/lessons (N=126)	16 (12.7)	23 (18.3)	43 (34.1)	44 (34.9)	2.913
Gather information (N=123)	20 (16.3)	28 (22.8)	44 (35.8)	31 (25.2)	2.699
Professional growth (N=120)	24 (19.7)	25 (20.5)	37 (30.3)	36 (29.5)	2.697
Monitor, assess learning (N=125)	26 (20.8)	27 (21.6)	34 (27.2)	38 (30.4)	2.672
Present lessons (N=119)	32 (26.9)	31 (26.1)	37 (31.1)	19 (16.0)	2.361
Interact with colleagues (N=120)	46 (38.3)	26 (21.7)	27 (22.5)	21 (17.5)	2.192
Analyze lesson effectiveness (N=116)	59 (50.9)	23 (19.8)	20 (17.2)	14 (12.1)	1.905

Of the 101 who responded to the item which asked them to indicate a single activity they would fight for if they were limited to only one computer activity, the largest number (29) listed word processing followed by record-keeping (28) and grading (23). Interview subjects would give a high priority to technology if they were in charge of allocating financial resources, although most hesitated to name it number one. Those interviewed mentioned other important competing needs, for example, "right now we'd love to have air conditioning." Another commented that the school, which used to be an elementary school, was in need of a gym. The teacher continued, "I'd rather have smaller classes than computers. I'd chuck my computers for smaller classes."

Teachers surveyed were asked to rate the importance of eight reasons for using the computer. Table 3 shows the distribution of responses from highest (very important) to lowest (not important) mean score.

Table 3. Importance of Reasons for Using the Computer

Reason	Not important N (%)	Somewhat important N (%)	Very important N (%)	Mean
I can create more effective materials.	11 (7.7)	27 (19)	104 (73.2)	2.65
It saves time.	10 (7.1)	31 (22)	100 (70.9)	2.63
I can keep better track of student performance and records.	38 (27)	35 (24.8)	68 (48.2)	2.21
I can use the Internet to access information & ideas.	46 (32.6)	39 (27.7)	56 (39.7)	2.07
It can help me do things I don't currently know how to do very well.	47 (33.1)	59 (51.5)	36 (25.4)	1.92
It helps me find valuable information on students.	63 (45)	39 (27.9)	38 (27.1)	1.82
I can communicate and collaborate with others regardless of where they are.	67 (47.2)	42 (29.6)	33 (23.2)	1.76
I get lots of ideas and help from other teachers.	61 (43.6)	57 (40.7)	22 (15.7)	1.72

When asked to rate various ways in which using the computer might influence their own work, a majority of subjects agreed or agreed strongly that they were more productive (76.7%), more professional (72.3%), more creative (66%), better informed (54.7%), and generally better educators (60.6%) as a result of their computer use. Only 31.4% agreed or agreed strongly that they have more time with students and 21.5% that they collaborate more with other teachers.

Subjects who were interviewed responded positively when asked for their general opinion about computers and their work. One subject did describe them as a “mixed blessing” and another responded “I love them for what I use them for. I don't care about techie stuff.” One teacher mentioned a change in attitude over the last seven years. “I first refused to use them because I didn't know how. The kids used them so I had to learn.” Another mentioned the importance of being a role model. “For the kids to see me use the computer a lot encourages them to use it. They appeal to kids I would feel handicapped without one.”

Facilitators and Barriers to Teachers' Computer Integration

Availability of specified resources was rated either moderate or high by a majority of respondents except for three: (1) release time to observe examples (17.1 %); (2) E-mail and Internet access (33.8 %); and (3) opportunities for voluntary inservice (43.9 %). Hardware and software were the most available resources with the accessibility of each rated at moderate or high by 73.6% of respondents. The only barrier a majority of respondents reported as having either moderate or high importance was “I have too many other responsibilities” (56.4%). The importance of not enough staff development opportunities was rated as moderate or high by 39.1% of those responding. Table 4 compares how subjects rated the accessibility and the value of each resource. The table shows mean ratings for accessibility and value, differences between the means, and the results of paired t-tests for each resource.

Table 4. Comparison of Mean Scores for Value versus Accessibility of Resources

Resource	(Accessibility)	Mean ¹		Difference	t-value
		(Value)			
Computer hardware		3.088	3.404	.316	-2.70*
Computer software		3.007	3.228	.221	-2.63*
School administrator support		2.985	3.126	.141	-1.62
Help with hardware or software problems from other teachers		2.956	3.252	.296	-3.98*
Formal onsite technical assistance (such as a technology coordinator)		2.918	3.328	.410	-4.38*
Conversations among teachers about uses of computers		2.724	2.873	.149	-1.80
Computer-related district or school inservices		2.699	2.949	.250	-2.70*
Specified goals for teacher computer use in a School Improvement Plan		2.672	2.844	.172	-2.03*
Opportunities for voluntary inservice classes		2.466	2.985	.519	-5.35*
E-mail and Internet access		2.237	2.771	.534	-4.92*
Release time to observe good examples of computer use by other teachers		1.731	2.692	2.961	-8.97*

¹ 1=None 2=Low 3=Moderate 4=High

* p<.05

When asked why they thought teachers didn't use computers more, interview subjects mentioned fear, age, and lack of understanding and knowledge most often. Although few specifically stated training when asked this question, the importance of inservice was mentioned by most subjects at some time during the interviews.

Results of Multiple Linear Regression Analyses

Facilitators and barriers included in the regression analyses were available resources, perceived barriers, and selected individual characteristics. Individual characteristics included were age, gender, education level, years of computer experience, years of teaching experience, amount of prep time, and self-perception of expertise.

For each regression, free entry stepwise method ensured that only significant predictors remained in the regression. Dichotomous variables where one of the two responses received more than 90 percent of the total are not included. Tolerance protection of .30 was used to prevent excess multicollinearity. The mean value substitution for any missing items resulted in N=142 for all analyses.

Six of the variables entered the regression equation to provide a strong prediction ($R^2 = .5247$) of frequency of computer use (see Table 5). An individual's self-perception of expertise is the most powerful predictor. The negative beta for age suggests that younger teachers are associated with more frequent computer use. The negative beta for relevance indicates that disagreement with the statement "I can do my work as well without a computer" is associated with more frequent use. The negative beta for "no convenient access to a computer" indicates that a higher rating of the importance of this as a barrier is associated with more frequent computer use.

Table 5 Frequency of Use Regressed on Individual Characteristics, Facilitators, and Barriers

Variables in the equation	Beta	T	Sig T
Perception of expertise	.5448	7.504	<.0001
Availability of specific goals	.1295	2.113	.0364
Age	-.1732	-2.789	.0061
No access to a computer	-.2275	-3.427	.0008
Software too complicated	.2175	3.041	.0028
Relevance	-.1675	-2.543	.0121
R = .7244	$R^2 = .5248$	F = 24.85	Sig F = <.0001

To guard against the argument that frequency and relevance as separate measures is tautological, an additional regression analysis was performed omitting relevance as a predictor. Results show four predictors in this equation. The availability of specific computer goals did not enter when relevance was excluded. Perception of expertise is still the most powerful of the predictors. Table 6 shows the results of that analysis.

Table 6 Revised Frequency of Use Regressed on Individual Characteristics, Facilitators, and Barriers

Variables in the equation	Beta	T	Sig T
Perception of expertise	.5899	8.097	<.0001
Age	-.1978	-3.120	.0022
No access to a computer	-.2909	-4.465	<.0001
Software too complicated	.2065	2.810	.0057
R = .69959	$R^2 = .4894$	F = 32.83	Sig F = <.0001

Three of the facilitators and barriers provide a strong prediction ($R^2 = .4469$) of the essentiality of computer use (see Table 7). As with the prediction of frequency of use, an individual's self-perception of expertise is the most powerful predictor.

Table 7 Overall Essentiality of Computer Use Regressed on Individual Characteristics, Facilitators, and Barriers

Variables in the Equation	Beta	T	Sig T
Perception of expertise	.5215	6.958	<.0001
Relevance	-.3882	-5.782	<.0001
Software is too complicated	.1933	2.645	.0091
R = .676	$R^2 = .457$	F = 38.71	Sig F = <.0001

Once again to guard against the argument that essentiality and relevance as separate measures is tautological, an additional regression analysis was performed omitting relevance as a predictor. In this analysis, perception of expertise was still a significant predictor, but gender and the barrier of few other interested teachers also entered the equation. Table 8 shows the results of the analysis.

Table 8 Revised Overall Essentiality Regressed on Individual Characteristics, Facilitators, and Barriers

Variables in the equation	Beta	T	Sig T
Perception of expertise	.5868	8.583	<.0001
Gender	.2139	3.098	.0024
Few interested teachers	.1432	2.078	.0395
R = .6045	R ² = .3654	F = 26.4904	Sig F = <.0001

Discussion and Implications

This study focused on teachers' perceptions of their computer practices in various aspects of their work. Its comprehensive conceptualization of *computer integration* was used to provide a clearer picture of the complexities of this construct.

Although a predominant pattern of dimensions did not emerge from the results, the various dimensions contributed to a more complete picture of the facets of teachers' professional use of computers. Teachers in the study generally perceived computer use as having a positive impact on their work. A majority felt they were more professional, more creative, better informed, and generally better educators as a result of their computer use. Results suggest that subjects have somewhat conventional vision regarding the possibilities for using the computer to support their day to day work. Creating more effective materials and saving time were rated as the most important reasons for using the computer.

Surprisingly, collegiality and communication with colleagues did not emerge as particularly important factors. Subjects did not view "I can communicate and collaborate with others" as an important reason for using the computer. A majority currently used the computer to create instructional materials, while few (11.3%) used it to communicate with colleagues, a use that might potentially ease the isolation of the profession. The low percent of computer use for communication might be attributed to the accessibility to e-mail and Internet access which was moderate or high for only 33.8% of the teachers who responded.

Results of this study reflect the dynamic nature of computer integration and raise further questions regarding how changes in accessible resources will alter the nature of teachers' computer integration, their reasons for using computers and their perceptions of how the computer influences their work. This is particularly evident in the area of using the ability of computer to access the Internet and to communicate with others. The teachers in this study had limited Internet and email access. As this access increases will it increase collegial communication and facilitate professional development? Will this access expand the vision of teachers of the ways in which the computer might support their workplace performance? These are among the questions that will provide insights into ways that teachers might more fully utilize computers to support their ongoing development as effective and professional educators.

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RESEARCH ON TECHNOLOGY COURSES AT COLLEGES OF EDUCATION

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Teachers of the 21st century must know technology. The number of colleges of education that offer technology courses is drastically increasing. Preservice and inservice teachers are hoped to use technology in their classrooms. In order to provide them with the best instruction on technology use, it is important to explore the technology courses at colleges of education. The purpose of the study is to investigate the one course that is often called "The Technology Course." Structures and contents of the course at twenty-five colleges of education are examined.

Overview

Since 1980, we have been experiencing a rapid change in our society due to the advance of technology. Technology is influencing our education, schools, and training of teachers who will be teaching in the classrooms of the 21st century.

The business world demands schools to prepare the students for effective use of technology in their future work places. The president and vice president of the United States have publicly addressed that every child in the nation should feel comfortable on the Information Super-Highway. Moreover, the increasing number of computers at schools clearly speaks for the trend. In the past ten years, more than 300,000 computers have been added (Northrup and Little, 1996). According to a report released by the National Council for Accreditation of Teacher Education (1997), computer-to-student ratios have dropped consistently from 1:50 in 1985 to 1:20 in 1990 to an estimated 1:9 in 1997.

All these facts indicate that new technology is affecting our classroom practice and the culture of the schools. The technological influence is challenging our teachers and will challenge the two million new teachers who will be hired over the next decade. Teachers should feel comfortable with the new culture of the schools and be ready to teach in the "Information Age." Do teacher education programs prepare their students to face the challenges? Unfortunately, the answer is no; most programs "have a long way to go" (NCATE, 1997, p. 1).

To answer the urgent need, the NCATE task force is assisting colleges of education to help their students take advantage of technology for instruction: new understandings, new approaches, new roles, and new attitudes (NCATE, 1997). The teachers need to understand the deep impact of technology on the nature of work, on communication, and on the development of knowledge. They must use a wide range of technological tools and software as part of their own instruction. They must help students in the use of technology to gain information that goes beyond textbooks and teachers. In addition, they should be fearless in the use of technology and be life-long learners.

In response to the call, colleges of education across the nation become equipped with new technological tools. Many programs are offering technology courses to help their students to take advantage of these tools and to utilize them for enhanced learning. However, there has been little discussion on what skills and knowledge students must have to take advantage of the technological tools (Old Dominion University, 1998). There is a need to investigate the courses offered in the colleges.

The following research focused on the one course that is often called "The Technology Course." It is a computer course commonly offered at colleges of education. The study investigated how the course was taught and what was instructed in the course at different colleges of education.

Procedures and Methods

A pilot study was first conducted involving nine universities: Arizona State University, Florida State University, Harvard University, Indiana University, Massachusetts Institute of Technology, Pennsylvania State University, Stanford University, University of Virginia, and Yale University. They were selected because they were either considered to be prestigious universities or had good reputation of offering outstanding educational technology programs.

First, phone calls were made to the college of education of the universities to find a course that was preparing undergraduate education students on using technology for their future teaching career. During the same time, an Internet search was conducted to look for the course syllabi of the nine colleges.

The initial phone interviews and webpage searches revealed that each university had its own way of preparing their students for the use of technology in instruction. Some universities, such as Stanford University, did not have education programs for undergraduate students. Therefore, the preliminary research focused on four of the universities that offered a similar computer course: Arizona State University, Indiana University, Pennsylvania State University, and University of Virginia. The preliminary research examined how the course was taught and what was

instructed in the course. Phone call interviews were conducted to obtain detailed information on this specific course at each university, and the course webpages were downloaded for analysis.

Based on the findings of the preliminary study, the researcher expanded the study and collected data from a larger number of universities. First, the researcher collected data at two professional conventions: Association for Educational Communications and Technology (AECT) at St. Louis, Missouri in February 1998 and Society for Information Technology and Teacher Education (SITE) at Washington, DC in March 1998. Personal interviews were conducted in the conventions, and e-mail communication followed. Course syllabi were collected via e-mail and downloaded from the Internet.

Data was also collected from other universities that were convenient samples. They either had course syllabi on the Internet or were accessible by the researcher and her graduate students. No random sampling was involved in the selection. The data collection involved collecting syllabi via e-mail and the web, phone interviews, and personal interviews.

The study included a total of 30 universities: Appalachian State University, Arizona State University, Brigham Young University, California State University at San Bernardino, East Central University, Eastern Michigan University, Idaho University, Indiana University, Mankato State University, Michigan State University, Northwestern Oklahoma State University, Oklahoma City University, Oklahoma State University, Pennsylvania State University, San Diego State University, Southwestern Oklahoma State University, State University of New York, Texas Tech University, University of Alaska at Anchorage, University of California at San Diego, University of Central Florida, University of Central Oklahoma, University of Georgia at Athens, University of Houston, University of Iowa, University of Northern Iowa, University of Oklahoma, University of Southern Indiana, University of Virginia, and Valley City State University. Detailed course descriptions of 25 of the 30 universities were available. They were employed to construct the report in Table 1. URLs of some on-line course syllabi available during the research were no longer accessible when the paper was written. The references list URLs still active at the time of publication.

The data collection and analysis focused on structures and contents of the courses. Different course structures were recorded. Content topics like word processing and spreadsheet that were examined in the pilot study were employed for the research. Content topics were coded and categorized. During the analysis, other topics like video and traditional media emerged. The researcher and her graduate assistants recorded and analyzed the data using spreadsheet; they afterwards independently checked the data to ensure the accuracy.

Results and Discussions

The technology courses of the 25 universities were similar overall, but the details of the structure and content still varied from one university to another.

Structure

The technology course was a required course for students at most colleges of education, but not required for students at some colleges. Some faculty members thought that the course should be required while others did not. A faculty member at Appalachian State University discussed in an interview that no technology course was required in her college but starting 1999 there would be a "requirement for passing a technology competency test as one criterion for certification." She noted that it was a weakness having a competency test without offering a required technology course. A faculty member at Pennsylvania State University expressed different opinions. He mentioned that his college offered several computer courses to undergraduate education students and that "The Technology Course" could be a one-credit, two-credit, or three-credit course depending on the interest of the individual student. He thought that it was not necessary to require a specific course.

Should "The Technology Course" at the colleges of education be required? It depends on the philosophy of the faculty members and nature of the individual college. According to NCATE, teachers must have technology skills and knowledge. It is beneficial to offer a required course so that the students can systematically learn the skills and knowledge. Nevertheless, some students might have mastered the skills and knowledge before taking the course; they would get bored or impatient in class. It is suggested that a competence test be administered and that students be given a waiver for the course if they pass the test. For the colleges without such a required course, it is recommended that the colleges at least conduct a competence test to ensure quality of the graduates. Michigan State University sets an example. Students at this university are given the opportunity to choose a course or a competence test.

A competence test can easily evaluate students' computer skills and knowledge. Can it effectively assess students' abilities of integrating technology into classrooms? Is it beneficial to have a required course focusing on technology integration after students master the computer skills? Or is it possible to blend integration into the technology course? Faculty member J. Bauer at the University of Northern Colorado used "anchored approach" (Bauer, 1998) to blend integration into his educational technology course. The idea is promising. However, can students really learn a lot of information like word processing, spreadsheet, database, presentation, multimedia,

telecommunications, webpage development, and technology integration within one single course? It might be useful for students to take a technology integration course after the technology course. In the technology integration course, the instructor can focus on integration and at the same time review what students have learned in the technology course.

Two main types of teaching structures were found at the universities. The similarity of the two structures was that both structures consisted of lecture and lab. In the lecture, students learned computer concepts, and they conducted hands-on activities in the lab. The difference between the two structures resided in where the lecture was conducted. Arizona State University (ASU) and Indiana University (IU) were examples of the two structures.

At ASU, the lecture was conducted in a big lecture hall, which could accommodate numerous students. The concepts were taught there to approximately 100 students simultaneously. The hands-on activities were conducted at a computer lab in a small group, with approximately 25 students. Students had two different instructors, one for the lecture and one for the lab. The lecture syllabus corresponded to the lab syllabus. The course instructors used identical syllabi, assignments, mid-term, and final examinations. They also conducted weekly meetings to maintain consistency of the course.

At IU, the course was conducted in a computer lab where the instructors taught both computer concepts and skills. The course instructors were advised to teach similar content. However, they neither used identical syllabi nor conducted weekly meetings. They were free to design and construct their own lessons.

Both structures had their advantages and disadvantages. The structure at ASU was organized, and the course content was very consistent throughout different sections. This structure allowed the same content to be taught to more than 300 students each semester. In addition, this structure encouraged graduate students who were more likely able to catch up with updated computer skills to teach lab sections while faculty members provided expertise in concepts and theories during the lectures. The disadvantage of this structure was that the learning with numerous students in a big lecture hall might be less effective compared to the learning with only 25 students in a computer lab.

Unlike the structure at ASU, students at IU could access a computer at any time in class. They could also receive more attention from an instructor compared to students in a big lecture hall. The disadvantage of this structure was that students might not learn the same information from the same course. With enrollment of about 500 students per semester at IU and involvement of many instructors, one might wonder what students learned in the “same” course. An instructor of the course at the university addressed in a phone interview that the course content varied because each individual instructor emphasized different concepts and skills.

The structure at University of Georgia was similar to the one at IU. An instructor at University of Georgia said in an interview that some students learned video and webpage development in the course while the others did not. The instructors at both institutions did not seem concerned about consistency of the course.

Content

At all universities, the course content contained concepts and skills. Concepts included knowledge of computer technology, such as basics of hardware and telecommunication. Students were also expected to be able to demonstrate and master skills. For example, they should be able to type a paper using a word processor, record their students’ grades using a spreadsheet, and keep the students’ records using a database.

The table below (Tab. 1) reports topics that appeared in the courses at the 25 universities. The percentage indicates the ratio of the universities where the topics were taught. For example, telecommunication was taught at 21 out of the 25 universities; hence 84% was listed.

Some topics were clear and interpretative, such as word processing and spreadsheet. Other topics like telecommunication, computer issues, traditional media, and curriculum integration were comprised of subtopics. For example, telecommunication included Internet search, e-mail, and related topics; computer issues involved issues like copyright and security; traditional media consisted of lamination, paper-based bulletin board, and transparencies; curriculum integration covered lesson plan and activities integrating technology. If one of the subtopics was taught in the courses, the topic was marked. Therefore, it was possible that “telecommunication” was marked while “Internet search” was not taught in the course.

Table 1. Topics Included in the Courses and Percentage of the Universities That Taught the Topics

Topics	Percentage
Telecommunications	84%
Multimedia	80%
Spreadsheet	76%
Webpage development	72%
Word processing	68%
Presentation	60%
Software evaluation	60%
Database	56%
Curriculum integration	52%
Computer issues	48%
Hardware and software	44%
Video	24%
Desktop publishing	20%
Traditional media	8%

It was found that the courses were skill-based and usually started with basic tool applications. They consisted of word processor, spreadsheet, and database. Many universities used package software like ClarisWorks or MSWorks containing these three applications. Few universities employed Word, Excel, and FileMaker Pro. Students were expected to demonstrate efficient use of these three applications. There was a trend of the course away from word processing because students had previously mastered the skill.

Beyond the three tool applications, students were instructed in the use of multimedia and presentation software. Many colleges utilized HyperStudio for multimedia and PowerPoint for presentation. Telecommunication like Internet search and e-mail became important components, especially since more and more schools progressively have set up their networks. The advance of technology constantly causes the change of the course content; more and more colleges were including webpage development into the courses.

While many instructors were following steps of technology advancement and included webpage development and multimedia production into the courses, few instructors advocated the importance of teaching traditional media, such as lamination and transparency. Although in this study a low percentage (8%) of the colleges was found to teach traditional media, the instructors' rationale of teaching them was valid. They mentioned that technology in many public schools was very behind and that teachers needed to know how to use available technology, such as lamination and Apple II computers. Their statements pointed out a gap between technology preparation and technology use in real classrooms. The gap drew professionals' attention to the importance of the linkage or collaboration between university faculty members and schoolteachers.

University instructors should help students to effectively integrate technology into classrooms. NCATE has voiced the importance of technology integration (NCATE, 1997). Partnerships between colleges of education and local schools can help education students to understand technology need and use in real educational settings. The partnership among San Diego State University, O'Farrell Community School, and Morse High School sets a good example (San Diego State University, 1998). Dialogues between university faculty members and schoolteachers (superintendents and administrators) are essential.

Conclusions

Technology development is affecting our schools. Teacher education programs are required to prepare students to understand their new roles, use new approaches, and have new attitudes for teaching in the Information Age. "The Technology Course" is strongly suggested to be offered to students at each college of education. A competence test is recommended to be available for students with good computer background. Integration of technology into instruction is definitely needed for preparing professional teachers.

Two main structures are employed at the universities, and each structure has its own advantages and disadvantages. It is suggested that a college choose a structure, which fits its individual institution. The course content consists of computer concepts and skills. The primary components include word processing, spreadsheet, database, multimedia, presentation, telecommunications, and webpage development. With NCATE's directions, partnerships of colleges with local schools, and dialogue between university faculty members and schoolteachers, educators will provide students with skills of using technology and with abilities to integrate technology into curricula and instruction. Students with these skills and abilities will become qualified teachers who can prepare the children of the nation to face the challenges of the modern world.

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PORTRAYING THE WORK OF INSTRUCTIONAL DESIGNING: AN ACTIVITY-ORIENTED ANALYSIS

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Research on the practice of instructional designing has taken a variety of forms, from the elaboration of process models to retrospective case studies. Seldom has the research provided portrayals of design work as it happens, nor has it integrated in a coherent way the interaction of social, cultural, and historical influences on the way the work unfolds. Activity theory, based on the work of Vygotsky and Leont'ev, has provided researchers in fields as varied as software design, teaching, and organizational analysis with a way of studying work that integrates context and the factors mediating action into a representation of human activity. This study tested the usefulness of an activity-oriented approach in describing and explaining the work of designing an international distance education course in business entrepreneurship at Indiana University. Multi-faceted views of the object/outcomes of work emerged, which led to both breakdowns in the processes of the work activity and to innovation and modification. The sets of assumptions embraced by the communities of practice to which participants belonged strongly influenced what each individual considered correct and appropriate behavior. Concrete, empathetic ways of doing guided by an ethic of care emerged as the more influential forces in gaining knowledge and guiding action in this case. The researcher suggests that accepting these forces as the set of assumptions underlying design practice creates new potential for re-shaping and renewing the practice of instructional design, its research agendas, and design education.

Activity theory

The focus of activity theory, as elaborated by Leont'ev (1981) is on the objects of human activity—both as products of activity and as mediators of it. This theoretical view emphasizes the transitional and multifaceted nature of the objects of activity, the key role of perspectives in understanding human activity, and an activity's situatedness within a cultural and historical context. An activity-oriented analysis emphasizes a view of process as primarily a set of ongoing negotiations and relationships. These interactions, which are often evident as disturbances or communications "glitches," spur creativity, innovation, effort, and conflict, which, in turn, move work activity to another "state of being." Letting disturbances guide data collection and analysis has great potential to show how new activity structures evolve, not solely through individual action but through collective action. Another principle of an activity-oriented analysis is the adoption of a historical perspective in the interpretation of the observed disturbances and underlying contradictions. In this study, I adopted a developmental view of the practice of instructional design consulting as it has evolved since the 1930s. By regarding the community of practice of instructional designers as an evolving "place" of development, design paradigms may be viewed in a new way. Instead of viewing them as oppositional poles (e.g., either viewing design as procedural and linear, based on a "normal" view of science; or as intuitive and purely empirical), they can be viewed as factors necessary to the development of design as a work activity. By using activity theory as a framework for studying design work, context and the dynamic interactions that drive the design process forward are in the foreground of the depiction of work activity and provide the structure for a coherent description.

The Hong Kong Distance Learning Project

The subject of this case study was the design, development and implementation of a distance education component for an existing undergraduate business course in entrepreneurship. The dean of undergraduate studies in the business school had approached the instructor, who had taught the course for at least three previous academic years, with the innovative idea of team-teaching the course with an instructor at the City University of Hong Kong (CUHK). Video conferencing and Internet-based technologies would be used to facilitate collaboration among the students and between the two teachers. Administrators at both schools were very keen on the idea, especially since the planning of the course coincided with publicity about the "handover" of the former Crown Colony to the People's Republic of China. The goals of the Hong Kong Distance Learning Project were to involve students in a cross-cultural learning experience, expose them to and train them in the use of distance learning technologies, develop their capabilities in global and international business, and provide a learning opportunity for IU faculty and staff.

Nearly 30 of the 90 students enrolled in the course volunteered to participate in the distance project. The majority of the US volunteers were freshmen and sophomores, while all of the Hong Kong students were the equivalent of juniors and seniors. The instructor formed ten teams of three US students each, and each team was matched with three of the Hong Kong students. The six-member teams developed business plans together and presented their plans via three video conferences and jointly-constructed web sites. They used chat, e-mail, and Alta Vista Forums as communication and collaboration tools.

In June, when work began on the project, eight people attended the project's initial meeting. In attendance were: the undergraduate dean who had arranged for the project, the US teacher who would act as the project manager, instructional designer, and teacher; the assistant director of instructional technology services in the business school; the business school's instructional consultant who would design and execute an evaluation of the project; an independent instructional technology consultant who had been the teacher's graduate student; a representative of the School of Continuing Studies, which would provide technical assistance and some funding; the business school's director of international programs; and an instructional technology consultant from the Teaching and Learning Technologies Lab (TLTL) who was conducting a campus-wide pilot test of Alta Vista Forums. As the project progressed, the working group became smaller, including only the teacher, the independent consultant, the evaluator, and the instructional technology consultant. The IU teacher communicated directly with the Hong Kong teacher, whom he had met on a trip to Hong Kong in May.

Method

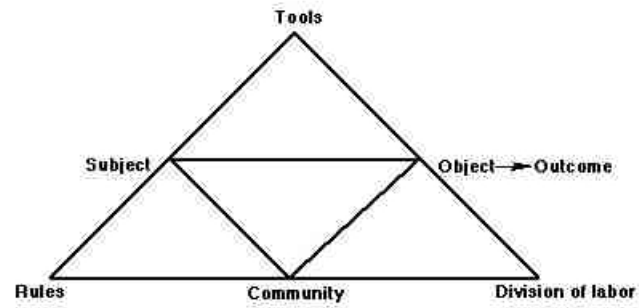
Between June and November I recorded in-person *observations* of work meetings among staff and faculty on audiotape and made transcripts afterward. A set of focusing questions guided my initial observations. In addition to observing work meetings, I observed a rehearsal for the first video conference, a training session for students in the use of a Web-based conferencing system, three video conferences, two American class sessions, and a faculty debriefing of a pilot test of a Web-based conferencing system. I also observed a meeting concerning contract negotiations between the faculty and the School of Continuing Studies. These observations provided background essential to understanding the intent and content of ongoing communications, and the actions of participants as they planned and carried out project work activity.

I conducted individual *interviews* with each participant as soon as our schedules permitted (within 3 to 10 days) after each observation. In some cases, for mutual convenience, at the participant's request, or because of the location of the participant (e.g., Hong Kong), the follow-up interview was conducted via e-mail or telephone. Whenever possible (including e-mail interviews) I used the transcript, notes, and artifacts of the observation to stimulate recall of the observed event. The purpose of the interview was to gain the participant's perspective of the event and the project, to check the accuracy of my observations, and in later interviews, to test my interpretations of events against the participant's own. Before each interview I identified what appeared to be disturbances by marking them in color on the printed transcript. Three types of disturbances quickly emerged as the most frequently occurring: change in thinking, surprise, and misunderstanding/disagreement. I directed the participant to these portions and asked him or her to comment. I asked respondents to make any additional comments they wished, and to point out other disturbances they perceived. I generally followed this procedure in all follow-up interviews.

Document review, particularly of the printouts of e-mail or student conferencing sessions, felt like the posthumous observation of a "live" activity. The distinction between a document and observing an event was thus blurred, but much activity that might otherwise have remained invisible was made visible. When a set of Internet exchanges represented a collaborative work activity that could have taken place face to face, I used the messages as transcripts on which to base brief Internet interviews, again letting perceived disturbances guide my questions.

I coded the disturbance-producing exchanges into six talk types: Advising/Consulting, Delineating/Assigning, Authority/Control, Framing, Technical Talk, and Scenarios (Narratives). The next step was to understand the underlying contradictions in the activity system that led to disturbances. I returned to my analysis of each example, first from the perspective of the Object, then from the perspective of Subject. Using the activity system model developed by Engeström (1987) (see below) to guide the first levels of analysis, I compared the examples of talk, seeking out fundamental similarities that might help describe and explain underlying contradictions in the activity system. I then used the activity system diagram in writing my conclusions, supported by appropriate research in a variety of fields.

Figure 1. Structure of Human Activity, (Engestrom, 1987)



Definitions of components of activity system

Subject: individual or subgroup whose actions are being analyzed

Object: problem or material receiving the action, and which is molded into an outcome

Rules: norms and conventions, both implicit and explicit that constrain action

Tools: mediating instruments and signs used by subject on object to achieve outcome

Community: multiple individuals and sub-groups sharing same object

Division of labor: horizontal division of tasks and vertical division of power and status

Further analysis of the data from a historical perspective acted as a "cross-examination" of the data using a different framework. I needed a tool that would integrate changes over the years in the way people perceive and arrange design activities with a generic description of what actually happens when two or more people perform design activities together. Finding no suitable pre-existing tool, I developed an analytical tool in the form of a matrix "Analysis of the work activity from a historical perspective." I then re-examined each talk type example and sorted it into an appropriate cell in the table.

Four activity systems and their underlying contradictions

Using the intended outcomes of the work activities I observed, and working back toward the persons or entities (Subjects) involved, I identified four distinct concurrent sets of relationships.

- the activity system of course design/implementation
- the activity system of evaluation
- the activity system of consulting
- the activity system of relationship building

Disturbances occurred in each activity system. I looked beyond the disturbances to first determine the factors (Subject, Object, Outcome, Tools, Rules, Community of practice, Division of Labor; see activity system diagram above for a definition of each factor.) generating the disturbance. I then attempted to pinpoint the underlying contradiction that might have caused the disturbance, and to explain the source of the contradiction. I will highlight in this article three fundamental contradictions that emerged in one or more of the activity systems.

The interplay between technical and practical human interests

Disturbances in the activity systems of course design/implementation and evaluation arose from participants' different perspectives of the Object and Outcome of work, and from the type of knowledge (a mediating Tool) most appropriate to achieving the Outcome. From one perspective the work Object (the course) was a process (e.g., a learning experience). The primary alternate perspective of the work Object was "course as product" (a consumable commodity or well-functioning machine). The primary perspectives of knowledge as a Tool emerged as either a set of facts (e.g., software features or theories) or as a narrative (e.g. hypothetical scenarios of use, narratives of past experiences). Not knowing or not agreeing on which representation of the Object, Outcome, or Tool was appropriate at a given moment caused disturbances. The contradiction behind these disturbance can be expressed as an interplay between a technical human interest and a practical human interest, as described by Habermas (cited in Streibel, 1991) and adapted in recent instructional design research (Grundy, cited in Streibel, 1991; Li and Reigeluth, 1995). These interests represent orientations toward the world, born of individual experience, professional training, membership in an ethnic group, the mores of a society, and so on.

Table 1: Dispositions in the various types of human interest, from Streibel's adaptation of Grundy (Streibel, 1991)

	Technical interest	Practical interest
Orientation	Controlling self, other, and environment for external purposes	Understanding self, other and environment through interaction
Outcomes	Correct behavior	Meaningful action
Authority residing in	Plan	Practitioner
Forms of Logic	Instrumental logic	Consensual

The technical human interest, represented in this study by the product view of the Outcome and a view of knowledge as a set of facts, implies a way of knowing that is based in empirical study of phenomena and experience for the purpose of prediction and control. In the realm of technical human interest, theories are at first descriptive and subsequently used to predict. Knowledge, represented as facts, laws, procedures, is viewed as an instrument in gaining control over objects, processes, and phenomena.

The practical human interest, represented here by a process view of the work Object and a narrative view of knowledge, implies a way of knowing that is emergent. In the realm of practical human interest, knowledge is experience as expressed in narratives of what has been done or said. This view of knowledge aligns itself with the human condition: humans *have* to find a way to be in the world and knowledge is negotiated in the course of seeking and establishing meaningful interaction with other humans in the world. In the practical human interest, theories that predict and control are viewed as useful insofar as they contribute to the practical goal of coming to terms with one's lived experience.

One of the most striking examples of the conflict and interplay of the technical and practical human interests in this case study was the emergence of two evaluation activity systems. The two co-existed and came into conflict with each other, shaped by different perceptions of the appropriate Object and Outcome of evaluation. Disturbances arose because of 1) differing views of the how the outcomes of the evaluation study would be used, and because of 2) different concepts of the meaning of "evaluation" in the context of teaching and learning.

The business school's instructional consultant designed an evaluation according to the rules of an experimental study, choosing dependent and independent variables and using statistical means in analyzing the data. Faculty and staff expended much effort on the creation and administration of the project evaluation and on accommodating the constraints and the "rules" of an experimental study design, particularly the requirement of randomly selected control and treatment groups. The original course design called for students to volunteer for the Hong Kong project. In return for the extra work this might require, volunteers would not have to take the second exam. Non-volunteers would not work in groups as the Hong Kong students would. The teacher change the design of the course in an attempt to meet the requirements of the experimental design, most significantly by requiring all of the students to work in groups (which doubled his workload), and by deciding to form the experimental groups from the pool of volunteers. The design fell apart when only 20 volunteers came forward. The teacher did not wish to deny 10 students the opportunity to participate in the project for the sake of forming a control group.

The other activity system of evaluation, embedded in course design and delivery, was the evaluation activity implicit in the notion of "pilot study." The teacher's "pilot study," unlike the point of view adopted by the business school's consultant, prescribed neither data collection instruments nor analysis and interpretation methods. It prescribed only a "frame of mind" that permitted experimentation and forgave failure. The Rules guiding action in this embedded evaluation activity required judgment, good will, and a willingness to negotiate meaning and compensation (e.g., no second exam, "easier grading" for the Hong Kong project volunteers) with students. In this view, evaluation was an activity oriented toward practical interests, guiding and guided by the teacher's meaningful action, and employing consensual logic. At the same time, meaningful, defensible, usable results were produced and informally shared among the evaluation team.

The interplay of ethical and moral value systems: Justice, rights, or care?

Because of the large size of the class, only a portion of it was involved in the Hong Kong project. The IU teacher was acutely aware of his institutional obligation to deliver the course described in the catalog and of the scrutiny his experimental, Web-based syllabus and course materials were likely to receive from his colleagues. His anxiety arose from knowing that he would have to make changes in order to maintain fairness among students in the class, to motivate and enable students, and to get them to trust that he knew what he is doing, though he admitted he was "in over his head." But the deeper cause of his anxiety was the competing set of rules that guided the enactment of his contract with students and the university.

One set of rules can be identified as "professional rules of conduct" and the other set might be characterized as what has recently been called an "ethic of care" or a "feminist ethic" (Gilligan, 1982; Noddings, 1984). On the one

hand, a standard professional code of conduct presumes disclosure, diligence, and disinterestedness (Shapiro, cited in Moberg, 1994). Much effort is devoted to evening out inequalities.

On the other hand, Moberg observes that in the feminist model "valued actions can flourish in a climate of inequality" (Moberg, 1994). Within the feminist framework the obligations are to care, enable emotional work, and build authentic trust. Moberg further notes that the professional code strives to mitigate or prevent action, focusing on the work itself, while an ethic of care focuses on relationships between and among work and workers, and provides a basis for acting. The professional code of ethics is inflexible and rigid while an ethic of care appears more fluid and responsive to emerging situations. In this case study an interesting paradox arose. The syllabus was a public and accessible document, emphasizing the organizational obligation, a legal contract, to deliver a product/service, yet the web format allowed changes brought about by the teacher acting on his moral obligation to care for those he had placed in a difficult and potentially unfair situation.

A related set of disturbances arose from accommodating the vantage points of students as consumers and students as "co-developers" and/or "experimental subjects," and the vantage points of teachers as both providers of a service/product and experimenters/test subjects. Accommodating the view of the Subject as a guinea pig with the view of the Subject as either a service provider or consumer stimulated "emotional work" (Hochschild, cited in Moberg, 1994). Because the experimental, uncertain nature of the innovations being tried made teachers, staff, and students vulnerable to harm and threatened the successful completion of the institutional contract between them, many project participants sought to ameliorate harmful effects through responding to personal needs, doing emotional work, and taking trust-building action. In this case study, participants performed emotional work by comforting each other when performance fell short of expectations. For example, the IU teacher commented on the independent consultant's patience and persistence in trying to solve technical problems that arise during the AVF training. Other staff reassured the teacher that the outcome of the project was not unusual for courses incorporating intensive technology use for the first time. The teacher protected and encouraged his "kids" when they had difficulties communicating with CUHK, and when teamwork and goodwill were in scarce supply, coming to their defense when he thought they had been unjustly maligned.

Cultural conditioning of the choice between doing right or doing good

In this case study, how an individual perceived his or her work was connected to his or her identification with a culture or community of practice. In my examination of disturbances occurring within the activity systems of consulting and relationship building I found evidence of participants' acceptance of some implicit, culturally embedded rules which guided their behavior. Culture and community of practice were strong influences when combined with personal styles and personalities, on how individuals interpreted the object and outcome of work activity, decided which tools to select, and what rules of action to follow.

A culturally-defined ethical divide

For example, in the United States, professionals and business people are guided in their work by a traditional code of ethics (Cavanaugh, Moberg, & Velasquez, 1995), which is taught and reinforced in schools, churches, and other social groupings, such that the code becomes an invisible part of the fabric of culture. The Chinese participants in this study, as well, appeared to accept this code as the correct ethical standard to meet. Moberg lists as characteristics of this code:

- Relations between equals
- Emphasis on abstract principles
- Moral agent is detached and rational
- Value on rights and justice
- Unilateral giving as virtuous altruism
- Partiality is suspect

Two participants in particular placed highest value on the "good of the project," and believed that if they stayed within their perceived roles, they could not achieve the highest level of good. At the same time, they were conscious of assuming roles and authority beyond the scope of their publicly acknowledged roles and sought to protect themselves and their clients from any negative effects of their appropriation of tasks and responsibilities. In this case study, participants privately put emotional effort into understanding their relationships to each other and to their work, but at great sacrifice. They tended to privilege duty to "the project" and to their profession, over duty to each other. Doing what was "right" or "correct" often came into conflict with doing what was appropriate to the situation or supportive of trusting relationships. As Moberg points out, writing about ethics in business management (Cavanaugh, Moberg, & Velasquez, 1995), the traditional formulation has long ignored questions of the "moral importance of interpersonal relationships in business."

When in Rome...?

The community of practice provides a set of shared values, instilled in its members through similar work experiences, "enculturation emanating from theory", or the personality characteristics of people attracted to the field (Seels & Richey, 1994). Lave and Wenger (1991) elaborate:

A community of practice is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice. A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage (p. 98).

I identified the following communities of practice in this case study:

- the community of computer technologists
- the community of experimental researchers
- the community of college/university teachers
- the community of "integrators," such as instructional technology consultants
- the community of school administrators, with US and Chinese sub-groups
- the undergraduate business student community, with US and Chinese sub-groups

Participants often tried to use the language of a different community of practice in order to build relationships, learn and understand viewpoints, or share knowledge. The disturbances caused by trying to move in and out of practice communities, each with its own set of rules, models of behavior, and language forms raised difficult questions for the participants, who were mindful of the project's institutional and faculty/staff development objectives. Disturbances occurred from efforts to accommodate or work around the differences in each community's rules in order to accomplish the goals of the project and the institutions involved. For the "cause" of relationship building, participants had to choose between following the rules of their own respective communities of practice and adapting to the rules of other communities, depending on how explicit and public the differences were, and the pain or cost of not adapting.

Analysis from a historical perspective

A developmental view of day-to-day practice allows a researcher to accommodate and explain the change and contradiction that comprise the lived experience of design work. The activity systems described here represent a point in time through which developments prior to their existence resonate. Prior conceptions of work are detected as "traces" or "layers" within the current activity system structure and potentially give rise to disturbances. Below I single out the developmental changes I believe most crucial to understanding the evolution of design work as we know it today: changes in who participates in design work and how it is led; and concurrent changes in the complexity and organization of design work.

Changes in participation in the design process

In the last 30 years there has been increasing acceptance in many design fields of the appropriateness of the involvement of non-designers in design work. Non-designers, such as clients and users, are viewed as not only the owners of a problem and sources of data input, but as active participants in the design and implementation of the solution (Dorsey, Goodrum, & Schwen, 1997; Ehn, 1993; Mitchell, 1990; Schrage, 1995). The concept of "stakeholder" participation, meaning the consultation and involvement of relevant individuals, units, and organizations (or collectivities) during the life of a project, has become widely accepted as a benefit to designing, though frequently ignored in practice (Clancey, 1993; Goodrum, Dorsey, & Schwen, 1993). As a result of the expansion of participation in designing wherein clients, users, and stakeholders are required to play new and unfamiliar roles, professional designers (and most other professionals, for that matter) have had to shift some of their attention from tasks and objectives to the nature and quality of the process engaged to accomplish them (see, for example, Coscarelli & Stonewater, 1979; Davies, 1975; Tovar, Gagnon, & Schmid, 1997). Attention to process includes close examination of interpersonal, inter-organizational, and intercultural relationships (as in Campbell-Bonar & Olson, 1992). As a result, questions arise as to 1) the definition of "expert" and "expertise", connected to the explicit requirement that the professional facilitate, teach, and learn with others; 2) the professional's choice and deployment of tools; and 3) the appropriate and proper criteria or standards for regulating or guiding these relationships (see, for example, Li & Reigeluth, 1995; Wilson, 1995).

Changes in complexity (specialization) of work

For his long-term study of doctor-patient interactions in Espoo Finland Engestrom (1993) chose two of the dimensions identified by organization analyst Perrow (1984): complexity of the work activity and the degree of centralization of control. He arranged types of work activity on a continuum of development, from low specialization

in the organization of work with centralized control, to highly specialized work organization with de-centralized control. Low specialization (low complexity) means that an individual who exerts a high degree of control over assistants (e.g., apprentices) accomplishes all of the processes. An example of a more complex organization of work is the modern industrial factory and bureaucratic offices where the work requires complex interactions and coordination; control is highly centralized in order to maximize efficiency. A hybrid form of craft work and bureaucratized work is "humanized activity" where work remains complex and requires a high level of coordination, but control of the work is decentralized and moves downward in the hierarchy. A fourth category projects a type of work activity where workers are empowered to change the fundamental tasks, goals, products, and values, contradictions of their work. It is a developmental category that may grow out of solutions to difficulties produced by the conflict between the rationalized activity type and humanized activity type.

Historical types in the development of instructional design as a work activity

I identified six possible historical types in the development of instructional design as a work activity based on the complexity of the work and how work is organized (Perrow, 1984). The categories and ranking scheme are made only for clarity in presentation. The practical reality is that within each historical type are characteristics of other types. Here I have tried to highlight the defining characteristics of each historical type. The order of presentation is roughly from work that is the least specialized in its organization, under centralized control, to work that is complex in its organization and under de-centralized control.

Craft activity

Hollywood director Frank Capra's direction of training films in World War II might be a prototypical example. His vision and his artistry are what led the design of these highly successful training interventions. The researcher/experimenter designing audio-visual interventions in this period relied heavily on craftpersons, but also applied his own "craft" of experimental design. Observation, surveys, and interviews were used mainly as evaluative tools after the initial design was complete.

Systematic design

The Dick and Carey (1996) model of instructional development is probably the best known example of the application of systematic process management to instructional design. Systematic design is characterized by formal knowledge elicitation and integration procedures, and emphasizes product efficiency and effectiveness as measures of success. The process is typically viewed as occurring in phases: research (analysis) preceding development of a product, followed by implementation and evaluation.

Usability and "user-centered" design

Usability studies and a user-centered design movement gained momentum in the 1970s and re-focused the design process on the needs, interests, and capabilities of the individual who might use the product. With the advent of authoring software and scripting languages, instructional designers often became software designers, and the language and techniques of usability engineering became part of their practice. Developers invite members of the target user group to test a version of the product before it is completed. The conclusions drawn from early testing are then used to modify the product. Sugar and Boling (1995) observe that the principles and methods of user-centered design roughly correspond to the needs analysis, learner analysis, and formative evaluation stages of the Dick and Carey (1996) model, but that usability evaluations are a novel addition to instructional design processes.

Rapid prototyping (RP)

RP is another technique borrowed from software development. Researchers in the field of instructional design (Tripp & Bichelmeyer, 1991; Dorsey, Goodrum, & Schwen, 1997) have explored rapid prototyping as the foundation of an alternate approach to instructional design. The making of a product serves as a way to both define and solve the problem. Research on needs and objectives proceeds in parallel with the development of the product. A usable product may thus be available much earlier in the process and be used to explore implementation questions. The evolving prototype provides a focus for designer-client communication earlier and more frequently in the design process.

Socio-technical design

The instructional design process is viewed as an activity situated in a changing environment which includes people, technology, and constantly evolving work-practices (Goodrum & Schwen, 1994). Clancey (1993) points out that the socio-technical approach includes views commonly associated with the systematic, but goes beyond them. Highly collaborative instructional design projects such as those reported by Cennamo, Abell, Chung, Campbell, & Hugg (1995), and Grisdale and Campbell-Bonar (1991), are examples of attempts to put the socio-technical view into practice. In both, teachers (the content experts) and designers simultaneously focused on the major tasks of the

design project, and all were actively involved throughout the life of the project. There was a conscious effort on the part of designers and clients alike to enter each other's community of practice.

Emancipatory design

An emancipatory instructional design process is focused on "the uncovering of factors that prohibit and prevent the autonomous actions of learning, instruction, and design respectively (Li & Reigeluth, 1995)." The designer's role is to nurture throughout the design process critical awareness of social and cultural assumptions. The aim is the empowerment of participants to break "old molds" and restructure the learning environment so that ongoing dialogue and critique are encouraged. Students, teachers and designers alike should be enabled to design their own learning. Complete membership in another's environment is integral and fundamental to the emancipatory design approach.

Changes in work activity as indicated by aspects of the designer's deployment of expertise in a group context

The table below provides a brief overview of the historical types in terms of five aspects of any relationship the designer is likely to enter into during the course of instructional design projects:

- the source and nature of the expertise the designer employs (e.g. technical/discipline knowledge, pragmatic, interpersonal);
- who has the responsibility/is accountable for doing the designing (including development, evaluation, and implementation);
- the types of conceptual tools used and when they are used;
- the predominant orientation of designer toward product, process, or context;
- the ethical principles (the "oughts" and "shoulds") guiding the designer's actions at any given moment.

Table 2: Changes in ID work activity as indicated by aspects of the designer's deployment of expertise in a group context

Historical type	Nature of expertise	Focus of responsibility for designing	Tools	Orientation	Ethical Principles guiding designer's actions
Craft activity	artistic, technical	designer	intuition, experience; experimental design principles; holistic evaluation	product	work for hire, produce results contracted for
Usability /User-centered	technical tempered by pragmatic	designer (users are inputs to designer-led process)	qualitative research methods; iterative process model; holistic evaluation	product, process	observe protocols for protecting human subjects; place user needs/wishes first
Rapid prototyping	pragmatic, technical	designer (user involvement to inform designer-led process)	"analysis by doing" (analysis by synthesis); iterative process model; holistic evaluation	process, product	place user needs/wishes first; suspend commitment, withhold judgment
Socio-technical	interpersonal, pragmatic, technical	shared among designers and stakeholders (including users)	variety of tools (see above); facilitative strategies and tactics	process; context	see all of above
Emancipatory design	interpersonal, pragmatic, technical	shifted to those "designed for"; user's are inputs to their own process	facilitative strategies and tactics	process; context	moral obligation to empower others

E. General observations

Three prominent historical categories

In this case study three historical categories described the majority of the work activity. Those categories were: craft activity, systematic design, and usability. Historical differences in the source and in the nature of the expertise used and in the tools employed in craft activity and systematic design activity created disturbances and required participants to negotiate and invent.

The teacher's previous design and delivery of the entrepreneurship course had been conducted as a craft activity. The teacher was the "honcho" (the Dean's characterization of his general management philosophy) of the course, operating within a bureaucracy that left him alone as long as teaching and learning outcome measures were within acceptable limits. The technology itself and the increased visibility that technology drew to the course required the teacher to acquire and manage a greater variety of resources. With the management requirement and the visibility came accountability, and the need to be more systematic about how the course was to be planned and

executed. Disturbances therefore arose because of changes in how the work activity had historically been organized (an individually directed craft activity) and because of an increase in its complexity.

At the beginning of the project the teacher had bemoaned his additional role (he was instructional designer and teacher, as well) of "project manager" and the complexity of orchestrating the work of 8 or 9 people. By the end of the project, he was relieved that in reality he worked with far fewer individuals. Concurrently, Bob resisted any attempts at systematizing his design process and his implementation of the course (except for the formal evaluation component). Illustrated here are some classic philosophical notions. One is the romantic notion of the "individual as the source and purveyor of creativity" (Coyne & Snodgrass, 1993), exemplified in the characterization of design as a craft activity carried out using artistic expertise. Another is the equally romantic notion of the individual as rational and objective, rendered so through the use of logical analysis and its tools (e.g., explicit models of reasoning). Underlying these notions is the classical conflict between the belief in rationalism as a route to gaining and using knowledge and the belief in pragmatism as a means to the same ends.

Traces of past and future conceptions of work

Engestrom (1987, 1993) has suggested that the coexistence of various stages of development in a work activity create conflict and potential for further development. The frequency of speaking "scenarios of use" among technologists in this case study might be considered an indication of the influence of the user-centered design movement on the day-to-day practice of instructional technology consulting and instructional design. In some cases the scenarios in this project facilitated hypothetical usability testing. The use of narratives in which students and teachers were the main characters also indicated the relative importance the speaker gave to students and teachers in design activities. The teacher and the TLTL consultant spontaneously generated the most scenarios, consistent with their social and pragmatic orientation toward the object of their work. Although the independent technology consultant was the self-proclaimed champion of the user, he did not seem as successful in creating narratives of use. He approached user-centered design from the "usability engineering" perspective, in which the users are necessary inputs or variables to consider, reflecting a rationalistic orientation.

The methods, practices, and orientations characteristic of the usability stage of development are a bridge to "humanized" stages of the development of instructional design, such as participatory design, and to "emancipatory design." A technical orientation toward usability testing and user-centered design is at this point in time well ensconced in the theory and practice of instructional software design and instructional design training. The flexibility of the scenario or narrative in representing different orientations toward the object of work and its ability to incorporate the salient aspects of people acting in a socio-technical environment make the scenario an important, multi-edged design tool. For example, John Carroll's investigations (Chin, Rosson, & Carroll, 1997; Carroll, 1994) of creating scenarios of use with users early in the design process expands the purpose of the scenario beyond capturing input for designers on functionality and requirements to the co-designing of new work activities. Suchman (1995) pushes the scenario's role in user-centered, participatory design even farther. When scenarios are preserved on videotape, for example, additional propositions arise connected to the user's and the designer's voice, authority, and will. Suchman suggests:

- ...the aim of representing work is to provide workers/users with a richer presence or stronger voice in sites of professional design;
- representation involves the artful crafting of people's stories;
- workers' perspectives are made available, present through representations, they speak in their own voices;
- representations may become resources for workers' own use in negotiations with management; and
- representations work against automation based on simplified notions of work. (p.60)

The concepts of usability and user-centered design, expressed through the scenario of use, or user- and designer-created narratives, can be viewed as a bridge from previous developmental forms of design work activity, such as craft and rationalized work forms, to humanized and emancipatory forms. In this case study, the teacher most frequently made statements that exhibited the pragmatic and social characteristics of historical types in the lower part of the matrix. The teacher could be seen, by setting an example, as leading the way across the bridge. Had participants been more conscious of the role that narrative could play in their development work, the bridge might have been crossed.

None of these points reveal anything new about our knowledge of people engaged in design process, or the way that teachers work when designing and delivering courses. However, the matrix provides a different vantage point and a way of articulating knowledge about this case of instructional design that puts what we know in a context--a historical one--that is not frequently examined in case studies of this kind.

VI. Implications for practice, research, and design education

The findings and conclusions of this case study have implications for instructional design practice, the conduct and presentation of research on design practice, and design education.

Implications for practice

The method and research perspective used in this study provide simultaneously a diagnosis of what is wrong and a suggestion as to what to do. In this study I observed how people work through the disturbances and deal with the systemic contradictions underlying them. I saw potentials for future development of the work activity of instructional design emerge from the people performing the activity in context. Future development of instructional design as a work activity would be affected by acknowledgement of:

- the importance of “designing the designing”, in part by coming to know the cultural rules, tools and goals of collaborators and other participants, and by understanding the communicative quality of one’s choice of rules, tools, and goals;
- the pre-eminent importance of an ethic of care in the design and implementation of instruction;
- the importance of being able to understand and use narrative in instructional design work;

Implications for research on practice

I have demonstrated that a coherent account of practice can be constructed which includes and focuses on social, cultural, and historical factors. Using the nodes of the activity system model I still risked shattering the experience into a million pieces. Two key factors acted as the “glue” to keep the analysis whole: the focus of the analysis on interaction of the Subject with the Object and its Outcome, and the analysis was guided by disturbances, which are evidence of interaction.

The historical analysis presented here suggests a way of tracking the influences of the historical development of the practice of instructional design on day to day design work. An historical analysis allows the practitioner to understand that the values and assumptions of a community of practice arise from the accumulated experience over time of individuals accommodating contradictions, and therefore that they are constantly in a state of change. Such a view of one’s role in the community and the role of community in one’s work engenders, I believe, a greater acceptance of conflict and change in one’s immediate experience, and provides an impetus toward greater flexibility in the application of methods and techniques. Such an attitude is important to inculcate in future practitioners if instructional design field is to have future viability.

Implications for design education

The activity system model provides an alternative model of design process that incorporates the social factors without the usual “mess” and without isolating them in order to deal with them. It is a model that can accommodate the variety of perspectives instructional design researchers write about, and most importantly, can represent and help resolve the tensions that practitioners experience in their everyday work. An understanding of instructional design work built around a more inclusive, more richly explanatory model is important in representing instructional design work to those who work with instructional designers (e.g. clients, content experts, teachers). It is important in the education of new designers, whose most earnest questions often have to do with *how* to do this work with others in real contexts.

Lastly, and most importantly, the education of future instructional designers must be more fully and explicitly understood as acculturation because the values and assumptions of the community of practice are the most powerful influences on individuals acting in a group context.

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DEVELOPMENT RESEARCH APPLIED TO IMPROVE MOTIVATION IN DISTANCE EDUCATION

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Abstract

Learners in distance education courses often drop out because they lack the motivation to go on. A study which aimed at enhancing existing student support with motivational guidance in the form of motivational communications, the Motivational Messages Support System (MMSS), resulted in completion rates that more than doubled. In the MMSS study developmental research has been used for the evolutionary development of the motivational communications and for addressing questions on the validity, practicality and effectiveness of the motivational messages.

Introduction

More and more learners are studying via distance education. Although a number of students are successful and complete their courses, there are still many students who drop out or do not complete their courses. Research has shown that lack of motivation is an important cause for dropout (Wolcott & Burnham, 1991; Zvacek, 1991). Contrary to conventional teaching/learning situations in which motivational problems can be, and often are, detected by a teacher or trainer, the motivational problems of distance education students mostly go undetected and there is thus no outside help for the students to increase their motivation. A way to help distance education students to become or stay motivated is to include motivational strategies in the learning materials. This was not feasible in the courses studied, as course updating, revision and/or rewriting is normally only done once every five to ten years and is very costly. Another possibility to help learners to become or stay motivated is extending existing student support with motivational strategies. It is recognized that being motivated is an autonomous disposition, something that is done by the interested person him- or herself (J. Visser, 1990). Thus an 'outsider' can only intervene in motivational processes as far as the other person will let it happen. It is therefore a challenge to develop a student support component that aims at improving the motivation of distance education students so that they finish distance education courses successfully. This challenge is even greater when one tries to support the many distance education learners, mainly living and working in developing countries, who still study without having access to fax and or e-mail.

The study aimed at introducing motivational strategies in the student support system of a distance education program that prepares international students for a Diploma or MA in Distance Education. It is offered by the University of London and implemented by the International Extension College (IEC) in Cambridge (England). The students are accepted on a yearly basis; about 50-70% of them comes from developing countries. The limited access these students have to e-mail and fax makes that the courses, which are still print based and enriched by audio cassettes, are attractive for them. To enroll in the MA program students first have to finish the four Diploma (Foundation) Courses of 200 hours each. The actual MA part consists of two courses and a research study. Course completion rates are around 35% in the Foundation Program. Only a handful of students continue with the MA part. Student support, in the form of tutoring, consists of feedback on a minimum of two and a maximum of four assignments. No other institutionalized motivational student support is provided. The duration of each course is eight months.

Research question

The study, which was carried out in 1996 and 1997 (L. Visser, 1998), aims at extending existing student support with motivational strategies in the form of motivational communications which should serve to help distance education students to become or stay motivated, so that they will complete their courses successfully. The study seeks to answer the following question:

Is it possible to design and develop a motivational component, in the form of motivational communications, which will result in a significant increase in the percentage of students who finish the course successfully?

Review of the literature

Briggs (1980) is one of the authors who emphasize the important role motivation plays in the successful completion of courses. He is of the opinion that our theories or models of design do not sufficiently take motivation

into account. According to Keller (1998) motivation is one of the main influences on performance. Zvacek (1991), referring to distance education, observes that the role of motivation cannot be overstated, while Moore and Kearsley (1996) mention that tutors in distance education have to pay a lot of attention to the motivation of their students.

Graham and Weiner (1996) define the study of motivation as the study of why people think and behave as they do. Motivation does not refer to what a person can do, but what a person will do; it refers to choices people make as to what goals they will set and the degree of effort they will exert in that respect (Keller (1983).

There exists a number of ways to change the motivational disposition of a learner. Motivation can be looked upon as a general state necessary for learning to be effective. This approach assumes that learners can create their own motivational state. Another approach is that motivation is a set of continually changing factors that influence the behavior of the learner. This approach aims at setting the motivational factors at appropriate levels so that optimal learning can take place (Keller, 1983; Wlodkowski, 1985). There is evidence that both approaches have positive effects and the two should probably be seen as complementary rather than as opposing (J. Visser, 1990). Wlodkowski's Time Continuum Model (1985) and Keller's ARCS Model of Motivational Analysis (1983) analyze the motivational needs of the learners in a number of different components. Wlodkowski uses an approach that requires that motivational strategies must be planned for each of the six components of the model in order to come to a continuous and motivational dynamic. Wlodkowski's model is primarily prescriptive, as it defines conditions and associated learning situations. Keller's ARCS model analyzes the motivational needs of learners in four components: **Attention, Relevance, Confidence, Satisfaction**. To use the model successfully an audience analysis has to be done to define motivational objectives. The motivational objectives will lead to motivational strategies. The ARCS model is geared towards a systematic approach to motivational interventions, which follows a general problem solving and design process (Keller, 1987). Böhlin (1987) stresses that the ARCS model is adaptable to a wide variety of teaching methods and processes. He claims that the model is especially vital in situations where an extreme variance in classroom processes is encouraged as it makes it possible to accommodate a wide range of learning styles and to develop individuality. The students of the Diploma and MA Courses of the University of London come from a variety of social and cultural backgrounds. They also have varying educational backgrounds and use different learning strategies in a distance education context. The systematic approach, which is an asset of the ARCS model, gives the distance education tutor⁸ a way to monitor the motivational state of the learners. As far as known neither Wlodkowski's model nor Keller's model has been used in a distance education support system. Keller's ARCS model has, however, formed the basis for the development of motivational communications in traditional education, which were successfully used to help learners to maintain or increase their motivation (J. Visser, 1990). The flexibility, the systematic approach and the fact that the model has earlier been successfully used in a comparable context, has led to the decision to opt for the ARCS model of motivational analysis in the MMSS.

The ARCS model of motivational analysis

The four components of the ARCS model (Keller, 1983) represent the most important dimensions of human motivation. They are briefly described and placed in the context of a distance education setting.

Attention:	Getting the attention of the student and getting the learner to focus on a learning task establishes the necessary conditions to learn. This is likely to be more difficult in distance education than in conventional education. A challenging, unexpected or even provocative message will stimulate the attention of the learner. Other motivational strategies include frequent communication, rapid feedback and real interest in the learner.
Relevance:	Students should be informed on what they can expect from a course and why the topic in question is relevant and relates to the larger scheme of a course. Just like in conventional education, distance education students should know why they study certain course sections and they should be given examples related to their daily work. Relevance is not expected to be a problem for the students of the courses taking part in the MMSS study, as learners are mostly working in distance education.
Confidence:	Rotter (1954) states that people have a tendency to attribute success and failures to external or internal causes. Following success, expectancy generally rises (confidence increases), while failure causes confidence to drop. In distance education fear of failure is generally high. Messages emphasizing that students can finish the course successfully if they work hard, are important. Providing frequent opportunities for students to be successful increases the chance that they really will be successful. Emphasizing that students, themselves, are responsible for success through their personal ability and effort builds confidence.
Satisfaction:	To allow a student to be satisfied, it is important to describe the task to be done carefully and to state the reward upon completion. Keller (1987) claims that effort rather than performance is most directly related to motivation. In distance education student support motivational tactics should aim at making students feel satisfied frequently. Frequent, timely, adequate and encouraging feedback is an important satisfaction strategy. Other strategies are personal praising remarks and informing the student on how far they have come already.

⁸ In the context of this paper a tutor is the person who academically accompanies the distance education student during the course period.

Keller's (1987) "Steps in Motivational Design", which is based on the ARCS model, has been used for the design and development of the so-called motivational communications developed in this study and used in the Motivational Messages Support System (MMSS).

The Motivational Messages Support System

The MMSS had to be designed recognizing that it had to function as a subsystem within the course delivery system the International Extension College has set up to provide distance education. Before the MMSS was introduced there was limited interaction between the various components (tutors and students) of the support system and there was not institutionalized direct communication between student and tutor and *vice versa*: all communication was routed via the Director of Courses. It was concluded that, if the ARCS model was going to be used, establishing the possibility for direct communication between student and tutor was a necessary condition for enhancing students' motivation. A motivational component was added to the existing student support system in the form of a structured set of written motivational communications. These communications, or motivational messages as they are called in the study, specifically target the motivational disposition of the learners so that they finish the course successfully.

Research approach

Against the above sketched background a developmental research approach was chosen. Developmental research is carried out to optimize and gain a sound basis for development activities, particularly the development of prototypical products and the generation of methodological directions for the development of such products (Van den Akker & Plomp, 1993; Richey & Nelson, 1996). The aim of the study is thus, through a sequence of prototypes, to come to a final quality product.

Van den Akker and Plomp (1993) and Nieveen (1997) discussing product quality, distinguish the following three criteria:

Validity:	the degree to which the product is in agreement with state-of-the art knowledge and is internally consistent.
Practicality:	the degree to which the product is functional for the target group.
Effectiveness:	the degree to which the product has an added value compared to already existing products.

The first two criteria, validity and practicality have to be dealt with before the effectiveness of a product can be assessed. In this study validity was realized by using a methodical design approach while building on a sound theoretical framework (Keller, 1987). Practicality is shown when students state that they appreciate the motivational messages and when tutors communicate that they can easily work with the messages. Effectiveness is shown when a significant higher percentage of students than the year before complete the courses successfully. The study consisted of two phases, a pilot study which aimed at developing the MMSS system and the main study which aimed at assessing the effectiveness and cost-efficiency of the MMSS.

Pilot Study

The pilot study addressed the following question:

Is it possible to design motivational messages, based on the ARCS model of motivational analysis, in such a way that they are effective in distance education courses?

In this phase, first motivational communications were to be developed as prototypical products along the lines of the ARCS model to be used in one course. A set of eight motivational messages was designed, based on a design process developed by Keller (1987). Each message had, as an individual prototype, a special function within the framework of the ARCS model and the framework of prototyping, as to characteristics of format, graphics, content and students' feedback. Each message could, however, considered to be a prototype for the next one in a sequence of prototypical messages to be developed, which equally dealt with characteristics of format, graphics, content and reactions of the students. The development of the motivational messages was also influenced by expert comments. All messages focussed on the motivational needs of the learners at that moment in time.

A second objective of the pilot phase was to investigate, through formative evaluation, the validity and practicality of the motivational messages and to explore their effectiveness. For this phase one of the Foundation Courses was selected, consisting of 19 students from 13 countries (five continents) of which the greater majority could only be contacted via the normal postal services. As a consequence the delay in the responses from the students to a certain message was too long to take their comments immediately into consideration when designing the next prototype of a message in the sequence. The feedback of the students was therefore only used in subsequent prototypes. In addition, in the evaluation of the motivational messages expert appraisal was applied by involving

staff of the college and other experts in the field of instructional design and distance education. The validity and practicality of the prototypical messages was measured by using the following instruments:

- *Enrolment forms* providing information on students' social and academic backgrounds.
- *Final questionnaires* which asked questions about appeal, relevance, layout and format of the messages.
- *Course completion records* of 1995 and 1996
- *Records* with information about tutoring time, frequency and duration of contact and number of communications sent out and received.
- *Telephone interviews* with the Director of Courses and the Executive Director of the IEC, as to implementation possibilities, reactions from colleague tutors and students and discussion of topics like course evaluation questionnaires.
- *Interviews* with two students of the course to discuss format, lay-out, frequency and content of the messages.

The effectiveness of the messages was explored by comparing the percentage of students that passed the exam at the end of the course year (1996) to that of the year before (1995). Qualitative remarks of the students were also taken into account.

The result of the pilot study has been the Motivational Message Support System (MMSS) ready to be assessed for its effectiveness and cost-efficiency. It was noticed that designing, producing and personalizing the messages had taken quite some time. As student support is already considered an expensive commodity in distance education (Bates, 1991; Threlkeld & Brzoska, 1994), it was decided, on the basis of the pilot study, to use two different versions of the motivational messages in the main study. One version used the same set of messages for all students (collective messages), while in the other version the tutor could personalize the messages by adding personal remarks to the 'standard' messages or design messages that were attending to the perceived motivational needs of the students (personalized messages).

The assessment phase

The main study addressed two questions.

To what extent are motivational messages, based on Keller's ARCS model of motivational analysis, effective in distance education courses?

What is the difference, if any, in effectiveness and cost-efficiency between the personalized and the collective process of enhancing motivation through motivational messages?

The first research question, which had already been explored in the pilot study, focuses mainly on the validity, practicality and effectiveness of the motivational messages. The second research question looks at the optimal use of the motivational messages and has an exploratory character.

Effectiveness in the MMSS study is shown when a significant higher percentage of students than the years before complete the courses successfully. Cost-efficiency is shown when a significant higher percentage of students than the years before finish the courses and when the time spent on tutoring (tutor costs) and overhead costs does not significantly increase. Cost-efficiency relates to the outputs realized as compared to the corresponding inputs.

It is likely that implementing the MMSS will increase the tutor costs in terms of hours spent on a student. Eight hours of tutoring time are budgeted for per student per course. Students who repeat a course can be expensive for the International Extension College as they may not only require extra tutoring time, but also extra time related to registering procedures.

For the main study a multiple case design was chosen (Yin, 1994). As shown in Table 1, all four courses of the Foundation Program were involved. Course B was split into two groups and Course A served as a control group: the tutor of that course was only to write down the time spent on tutoring according to the tutor contract.

Table 1: Overview of the courses involved in the MMSS study and the number of messages to be sent out.

Course code	# students	Type Message	# messages	Designer messages	Tutor
A	18	No messages	N/A.	N/A.	External
B1	13	Collective	8	Course tutor	External (researcher)
B2	14	Personalized	To be decided by tutor	Course tutor	External (researcher)
C	18	Collective	8	Researcher and tutor	Staff-member College
D	18	Personalized	To be decided by tutor	Course tutor	External

In those courses where personalized messages were used, it was the tutor who decided on how many messages would be sent out, as the messages were based on the perceived motivational needs of the students during the course. The tutors in Courses B2 and D decided beforehand that a minimum of four messages would be sent out. In order to establish habits and conditions for independent learning, the interval in time between the motivational messages became longer. When the main study was finished and collaborating tutors had to send their data to the researcher it turned out that the tutor of Course D, who was to use personalized messages, had only sent out one message. The MMSS had thus not functioned in Course D.

A variety of instruments were used in the MMSS main study.

Student related instruments

- *Initial questionnaires* aimed at getting information on:
 - Students' personal and professional circumstances.
 - Students' reasons for taking the course
 - Expectations of students as to support from IEC and tutors
 - Problems students expected while doing the courses.
- *Final questionnaires* aimed at getting information on:
 - Which messages students liked best and why.
 - Which messages were most relevant to students and why.
 - What the students thought the reason was for receiving the messages.
- *Telephone interviews* with two students (a reluctant enrollee and a repeater) to see how the messages were appreciated and if so, why.

The term 'motivational message' was never used in correspondence with the students, as this could have revealed the intended nature of the messages.

Tutor related instruments:

- Course completion records of 1995, 1996 and 1997
- Records to register marking and tutoring time, number and content of communications between tutor and student and vice versa.
- Telephone interviews with tutors and expert staff.
- Structured interviews with tutors.

While developing the instruments, an important concern had been to make sure that triangulation would be possible. Various methods of data collection were used which aimed at enhancing the reliability and the validity of the findings. In addition the researcher had designed a tutor guide to make sure that tutors could work independently of the researcher during the main study.

The MMSS pilot study

The principal aim of the pilot study was to come to a valid, practical and effective version of the motivational messages as well as to answer questions on design and distribution. During the prototyping phase the development of the product was carefully monitored. Feedback and comments (solicited and unsolicited) were used to improve the product and its distribution process. The research lasted eight months and aimed at answering the following question:

Is it possible to design motivational messages, based on the ARCS model of motivational analysis, in such a way that they are effective in distance education courses?

During the first month of the course a motivational needs profile was made which was based on a limited audience analysis (the names and addresses of the students only became available when the course had already started), on information provided by the student counselor and on research in the field of student support. During the courses, when more information became available about the motivational needs of the students, this profile was adjusted. A total of eight messages was sent out, which were often personalized by a remark or an observation that targeted the perceived motivational needs of the student. It was observed that qua format students liked motivational messages in the form of a greeting card best, qua content they preferred motivational messages that had a catching drawing on the outside and a reinforcing text on the inside. The last message they received was, according to the final evaluation questionnaire, the favorite. It had the format of a greeting card and showed a variety of students of different ages, gender and race on the outside. The inside consisted of a short text which stressed that they all belonged to a group of people working hard to finish the courses successfully. It also contained exam advice and stressed that students had a good chance to do well if they spend their last few weeks studying hard.

In summary it can be said that:

The students testified that the communications had motivated them.

The students reported that the motivational messages helped them to stay in the course.

The students liked the last prototypical message best.

It is thus concluded that the motivational messages helped students to stay in the course. This conclusion was confirmed by the course completion rates of 1996 which went up from 32% in 1995 to 53% in 1996.

It was, however, also seen that the use of motivational messages was labor intensive as it involved doing an audience analysis, defining motivational objectives, designing, producing and dispatching motivational messages. In addition the students' motivational needs had to be monitored. It was also noticed that tutors needed some home office equipment such as a computer, a printer and a photocopier to produce and send out messages. This led to the decision to expand the study by using a more standardized type of message which was to be prepared at the beginning of the course and based on a motivational needs analysis (collective motivational messages).

Further insights were necessary to determine whether the motivational messages that were personalized or custom-made were more effective than the collective motivational messages. In addition questions on cost-efficiency had to be answered.

Three different cases were to be assessed in the main study

- A first group of students would receive personalized motivational messages, based on an audience analysis, on the results of the pilot study and on monitoring the motivational needs of the students.
- A second group of learners would receive collective motivational messages, based on an initial audience analysis and on the results of the pilot study. These messages would be prepared during the first month of the course, so that the messages only had to be sent out.
- A third group of students would serve as a control group and would not receive the MMSS support. Tutoring in this group was done according to the tutor contract and time spent on tutoring was going to be recorded.

In the above sketched set-up it would be possible to decide which type of motivational messages is more effective and which more cost-efficient.

The MMSS assessment phase

The first phase of the MMSS, the pilot study, took place in 1996 and was followed by the main study in 1997. Two questions were addressed:

1. To what extent are motivational messages, based on Keller's ARCS model of motivational analysis, effective in distance education courses?
2. What is the difference, if any, in effectiveness and cost-efficiency between the personalized and the collective process of enhancing motivation through motivational messages?

In Table 1 the participating courses and the types of messages used in the MMSS study were given. Two months before the study took off the participating tutors received a number of articles on motivation and a copy of the pilot study, while a month before the courses started the tutors were personally briefed during a half-day session and received a tutor guide containing information on how to use the motivational messages and how to do the record keeping.

The first research question

The first activity the tutor carried out was sending all students an audience analysis questionnaire. On the basis of the outcomes of this questionnaire motivational messages were designed, produced and, during the course, sent out. The tutor of Course C requested the researcher's assistance in designing the messages, but the tutor of Course D worked on his own, while the researcher in her role as tutor also designed and produced messages for Courses B1 and B2. Care was taken not to interfere in the tutorial processes. Tutors had been asked to record exchanges they had with their students, the time spent on tutoring and remarks and details they wanted to communicate. Just after the exams, but before the results were known, a final questionnaire was sent to the students. The last involvement of the tutors in the research consisted of returning the records to the researcher. It was then that the researcher discovered that the tutor of course D had only sent out one message. It can thus be concluded that Course D did not participate in the research.

Due to the scope of this paper only a summary of the completion rates of the students of Courses B and C is given in Table 2 (L. Visser, 1998).

Table 2: Completion rates Courses B and C in 1995, 1996 and 1997. Bold figures indicate that motivational strategies were used.

		1995	1996	1997
Course B	# students	12	30	27
	# completors	4 33%	11 37%	18 67%
Course C	# students	20	19	18
	# completors	6 30%	10 53%	11 61%

The groups, which received the motivation stimulus have higher completion rates than the groups that did not receive the stimulus. Overall, this difference is statistical significant (Fisher's Exact Test, $p=.003$). For Course B and C, the p-values from the Fisher Exact Test are respectively .015 and .094, which means that when a critical alpha of .05 is applied, the difference is only significant for Course B. However, one might argue that we still can be quite confident that the difference for Course C is not due to chance fluctuations.

It was seen that students had appreciated the motivational messages. Of the 45 students who had received the final questionnaire 25 returned it. Of these 25 students, 22 said that the motivational messages had encouraged them to continue with the course, while 23 wrote that the notes had contributed to their pleasure

The second research question

Students generally did not perceive the personalized and collective motivational messages as being different. It is seen in Table 3 that those students who received collective messages had less contact with their tutor than those whom received the personalized messages.

Table 3: Number of exchanges between tutor and student and student and tutor

		Tutor student	Student tutor
Personalized messages	Average # exchanges	3.9	3.3
Collective messages	Average # exchanges	2.6	2.9

There was a difference in the tutor time between the two different types of messages. For the *personalized* motivational messages the tutor time (which did not include feedback time on Tutor Marked Assignments) was 184 minutes (Course B2). In Course B 1 and Course C, which used *collective* motivational messages, the time was 148 minutes. Collective messages were thus more cost-efficient as to tutor time. In two of the three courses the total time spent on each student stayed within the allocated 8 hours. In Course C it was almost 9 hours, but it should be noted that the tutor of Course C was new to the program.

The student completion rate over 1997 is given in Table 4.

Table 4: Course completion rates of students in 1997

1997	Total # students	Completed
Personalized messages	14	11 (79%)
Collective messages	31	18 (58%)

It is noted that the completion rates in 1997 were significantly higher for those students who had been enrolled for the first time that year than for those who were repeaters. For personalized messages the completion rate

was 100% and for collective messages it was 73%. It should be borne in mind that the numbers are small, so that more research should be done to confirm these data.

In conclusion

It is seen that the outcomes of the main study confirmed the major findings of the pilot study and that the messages have been appreciated by the students and have been effective. No significant difference between the use of collective and personalized messages as regards effectiveness was shown. The use of prepared messages, the collective system, made it easier for the tutors to use the MMSS and thus increased the chance of successful implementation. The latter were also more cost-efficient.

Although designing and using the motivational messages is something that is interesting and rewarding, it should be seen as a motivational process and cannot be looked upon in isolation. Implementing the MMSS means that new roles will have to be taken on by the tutors. They will no longer just be 'markers' who give feedback on assignments and write hints for improvement in the margin. The tutor must become much more personally involved in the tutoring and then should also be held accountable for what happens in the course in terms of tutor-student interaction and student performance. The role of the tutor will more match that of a good teacher in conventional education than that of a traditional tutor in distance education. This will increase the tutor costs and has implications for the providing institute.

The providing institute will have to make changes in two areas. The position of the tutor should be redefined as argued above. More responsibility should be assigned to tutors. The use of modern communication means should be made possible and should be encouraged. This may make it necessary to make the selection of tutors more rigid. Such change processes are not easy and often somewhat painful. Their effectiveness depends greatly on the extent to which the institution is able to learn.

The MMSS study has answered a number of questions related to student support in distance education. It has been seen that using motivational strategies in learner support has considerably increased the completion rates of the students. The MMSS has operated in a limited environment of only one specific college and with relatively small numbers of students involved. This calls for more research. In the study a case has been made that it is possible to increase the number of students who finish their distance education courses successfully and more in general to make the learning experience of the students in a distance education setting more enjoyable and rewarding. As the learning landscape is gradually changing and more and more learning opportunities are being offered through the distance education mode, it is important that increased attention be given to the motivational dimension of the interaction with distance education students.

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FROM ABILITY TO ACTION: DESIGNING INSTRUCTION FOR CRITICAL THINKING DISPOSITIONS

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Abstract

Perkins and Tishman (1998) found that people often do not detect the need for critical thinking even though they may be inclined to do so and have the ability. This dispositional aspect of critical thinking may be considered part of attitudinal memory, readily activated if sufficiently strong. We suggest that ill-structured problem solving can provide learners with motivating activities that strengthen critical thinking dispositions. The Jasper Series and Decision Making are reviewed as examples of instructional programs that incorporate important attitude-strengthening elements (Fazio, 1995) into such activities. Design principles for nurturance of critical thinking dispositions are also presented.

Introduction

Thinking critically in problem situations is a skill that has received increasing attention as an educational goal. Critical thinking is often described as an ability. Yet, ability is only one aspect of critical thinking. People behave more or less intelligently governed not only by abilities but also by predilections or tendencies. This additional aspect of critical thinking has been termed *dispositions* by a number of educational researchers and philosophers (Baron, 1985; Bereiter, 1995; Cacioppo & Petty, 1982; Ennis, 1986). As Norris (1985) points out, "One must have the disposition to think productively and critically about issues, or else no amount of skill in doing so will be helpful" (p. 40).

A number of taxonomies of good thinking dispositions have been developed (e.g., Ennis, 1986; Facione, Facione, & Giancarlo, 1996). They all go beyond analyzing ability to perform cognitive tasks. Their emphasis is on attitude and awareness. For instance, the dispositions that Taube (1997) identifies as characteristic of effective critical thinkers are open-mindedness, cognitive complexity, need for cognition, tolerance of ambiguity, and reflectiveness. Perkins, Jay, and Tishman (1993) describe seven dispositions they view as central to good thinking. Those are the dispositions: to be broad and adventurous, toward sustained intellectual curiosity, to clarify and seek understanding, to be intellectually careful, to seek and evaluate reasons, and to be metacognitive.

As Perkins and Tishman (1998) point out, taxonomies of thinking dispositions are normative. These taxonomies reflect the cultural orientation of the authors and their conceptions of how best to gain knowledge. In many cases, the focus of these efforts is on learners and how to nurture the development of critical thinking dispositions in learners. That is also the focus of the present paper. The purpose of this paper is to explain the importance of dispositions as an essential aspect of critical thinking and to suggest how instruction can be designed to promote learners' development of the dispositional side of critical thinking.

The Dispositional Bottleneck: Sensitivity to Occasion

Most authors treat dispositions simply as tendencies, for example the tendency to consider counterarguments to one's own position on an issue. However, Perkins, Jay, and Tishman (1993) have demonstrated that a full account of intellectual behavior requires three components: sensitivity, inclination, and ability. *Sensitivity* concerns awareness of occasion; *inclination* concerns motivation or leaning; *ability* concerns capability to follow through appropriately. For example, to attend seriously to the other side of an argument in naturalistic circumstances, a person would need to be sensitive to the occasion to seek otherside reasons, inclined to invest mental effort in examining the other side of the issue, and have the basic ability to do so.

Perkins and Tishman (1998) have conducted studies to explore the validity of their three-component model. Eighth graders read short stories which contained thinking shortfalls. A series of three tasks were used to measure the relative primacy of sensitivity, inclination, and ability as determinants of critical thinking. In the first task, which was designed to reveal sensitivity, subjects were asked to underline parts of the story they thought reflected poor thinking. The second task presented the shortcoming and then asked the subjects whether they thought it was problematic, and, if so, what should be done about it. This second task was meant to determine inclination to think through the potential problem. In the third task, after being informed that there was a problem, the subjects were asked to list several options for dealing with it. This final task focussed on the subjects' ability to generate alternative options, independent of their sensitivity or inclination to do so. Results indicated significantly greater performance on the ability task compared with the inclination task, and significantly greater performance on the inclination task compared with the sensitivity task. This result uncovered a construct that Perkins and Tishman termed the "disposition effect": A substantial gap exists between what people *can* do (ability) and what they *do*

(behavior). Furthermore, the principal dispositional bottleneck between opportunity and action is sensitivity: People do not detect shortfalls in thinking in the first place.

Attitudes and Spontaneous vs. Deliberative Processing

How do these findings pertain to learning and instruction? Focussing on sensitivity, we may ask, “How can people learn to identify occasions that call for thoughtful attention?”

We wish to frame our answer to this question by addressing the similarities between dispositions and attitudes. A disposition such as the disposition to seek and evaluate reasons can be recognized in a person by that person’s behavior. A strong, or well-developed, disposition to seek and evaluate reasons is manifested in situations where seeking and evaluating reasons is appropriate. This cause-effect relationship between disposition and action points out the similarity between dispositions and attitudes. Robert Gagné puts it even more clearly, defining an attitude as “a disposition or readiness for some kind of action” (1977, p. 236).

Through investigations into the influence of attitude on action, Russell Fazio and his colleagues have demonstrated that a person’s behavior is consistent with an attitude to the extent that the attitude is strong and therefore easily accessible from memory (Fazio, Blascovich, & Driscoll, 1992; Fazio, Herr, & Olney, 1984). These researchers conceive of an attitude as an association between an object (or issue, or event) and an individual’s evaluation of the object. The strength of this association determines the likelihood that the attitude will be activated from memory when the individual again encounters the attitude-inducing object (Fazio, et al., 1992).

According to Fazio (1990), a person’s judgments and action can stem from either of two processing modes—a spontaneous process or a more effortful, deliberative process. The *spontaneous* process requires that one’s attitude be activated from memory by an attitude-inducing object. The automatically activated attitude then serves as a filter that influences subsequent object-relevant information processing, judgment, and action. In contrast, during *deliberative* processing, individuals carefully examine the available information, analyzing the likely consequences of options before deciding on an intention to act in a certain way. Fazio’s model integrates spontaneous and deliberative processes by postulating *motivation* and *opportunity* as the two factors that determine which process will occur: To the extent that preexisting attitudes are capable of automatic activation, they will govern a person’s attention, judgments, and actions—unless he or she is motivated to engage in deliberative processing and is given sufficient opportunity to do so.

In situations where there is low motivation to deliberate over decisions, preexisting attitudes are activated from memory. These attitudes, although often biased, free the individual from the processing effort required for critical thought. Fiske and Taylor (1991) use the term “cognitive misers” to describe people exhibiting this very common tendency. In contrast, motivated individuals can overcome the potentially biasing influence of a strong, preexisting attitude—if they are given the opportunity to deliberately bring critical thinking processes to a problem situation.

Attitude Strength and Sensitivity to Occasion

The contrast between spontaneous processing and deliberative processing provides an explanation for Perkins and Tishman’s conclusion that sensitivity to occasion is the bottleneck to critical thinking. When a person does not apply critical thinking in a situation that calls for it, this does not necessarily reflect a lack of ability or even a lack of inclination to do so. Rather, it may be the case that the person is a cognitive miser in this situation, exhibiting spontaneous behavior influenced by an automatically activated attitude. The attitude activated is one that identifies the situation as not requiring any particularly deliberate thought.

Recognition of an occasion that calls for thoughtful attention may occur in one of two ways. On the one hand, an individual may not normally recognize a situation that calls for critical thinking. On a particular occasion, however, she may be motivated and have the opportunity to deliberate over the situation. Upon examining the options available, the individual’s inclination and ability to make thoughtful choices then come into play. On the other hand, a person may have already acquired a strong attitude of critical thinking in certain situations. On such situations, this attitude will be spontaneously activated and the person will recognize the need for thoughtful attention. She will then most likely be inclined to act thoughtfully and carry out her intentions.

Strong and accessible attitudes appear to have a functional value in that they serve to direct our attention to certain objects. Roskos-Ewoldsend and Fazio (1992) conducted a series of experiments in which they demonstrated that an individual’s attention is automatically drawn to attitude-activating objects, those objects toward which the individual has a strongly associated evaluation in memory. An attentional component of attitudinal memory was identified:

Collectively, these findings demonstrate that the extent to which objects attract attention as they enter our visual field depends, at least in part, on the accessibility of our attitudes toward the objects. If a strongly associated evaluation of the object exists in memory, then that object attracts attention. Hence, we are likely to notice those objects that we have personally defined as likeable—those that can provide some reward or satisfaction—those that

we wish to approach. Likewise, we are likely to notice those objects toward which we have a strongly associated negative evaluation—those that can hurt us—those that we wish to avoid. What we “see” appears to be influenced by accessible attitudes. By orienting our attention to objects that have the potential for hedonic consequences, accessible attitudes ready us to respond appropriately. (Fazio, 1995, p. 265)

Teachers and instructional designers can promote learners’ sensitivity to occasions that call for critical thinking. They can do this by providing sufficient opportunity for learners to engage in motivating and deliberative activities that entail identifying occasions for critical thinking. Learners may thereby develop good thinking dispositions that are strong and accessible. Through appropriate activities, these dispositions may become the default attitudes available during spontaneous processing. In other words, students might learn to detect occasions for critical thinking as a natural habit of mind.

Attitude Strength and Ill-Structured Problems

Development of strong attitudes, attitudes that are readily activated from memory when an individual encounters a situation associated with the attitude, depends upon a number of factors. Researchers in a wide range of investigations have identified a variety of determinants of attitude strength. In a review of this research, Fazio (1995) suggests that five factors are major determinants of attitude strength and accessibility from memory: (1) direct experience, (2) sensory experience, (3) emotional reactions, (4) freely chosen behavior, and (5) attitude rehearsal.

Consideration of thinking dispositions as attitudes that can be activated in certain situations suggests that to facilitate the learning of sensitivity to critical thinking occasions, instruction should incorporate into motivating problem-solving activities the attitude-strengthening factors Fazio identified. Solving *ill-structured problems* can furnish learners with activities that meet these conditions. Ill-structured problems are “the kinds of problems that are encountered in everyday practice” (Jonassen, 1997, p. 68). They are problems situated in the real world. Jonassen characterizes ill-structured problem solving as a design process in which “the problem solvers must frame the design problem, recognize the divergent perspectives, collect evidence to support or reject the alternative proposals and ultimately synthesize their own understanding of the situation” (p. 79). These problem-solving activities incorporate the above-mentioned five attitude-strengthening factors. They afford learners opportunities to (1) directly experience occasions for critical thinking, (2) engage a number of senses in the richness of real-world problem situations, (3) react emotionally to those situations, (4) freely choose a path to solution, and (5) engage in a series of activities that provide repeated opportunities to rehearse critical thinking dispositions.

Direct experience in opportunities for critical thinking

Attitudes based on direct experience are more likely to be activated and influence subsequent behavior than those based on indirect experience (Fazio & Zanna, 1981). In a direct experience, the individual interacts with an attitude object or commits himself or herself to an issue or event. This contrasts with an indirect experience, in which the person forms an attitude on the basis of nonbehavioral information such as reading about the attitude object. Solving ill-defined problems through authentic activities is one way to involve learners in direct experiences that incorporate situations that call for critical thinking. Brown, Collins, and Duguid (1989) describe authentic activities as “the ordinary practices of the culture” (p. 34). A problem solver involved in authentic activities addresses a problem within the framework of the context that created it. Authentic activities provide in-context learning similar to that available to people participating in craft apprenticeships. Solving ill-structured problems through authentic activities can facilitate the learning of sensitivity to critical thinking occasions by providing situations in which the learner directly experiences the context of a problem. By committing to critical thinking activities in such situations, a learner can form strong associations between the situations and the need to think critically about problems manifested in those situations.

The role of sensory information

Incorporating a rich variety of sensory experiences into problem-solving situations may also strengthen critical thinking dispositions. Wu and Shaffer (1987) provide evidence that attitudes based on sensory reactions may be more accessible from memory than attitudes formed less directly. Sensory experience of a situation contributes to formation of strong attitudes towards the situation, attitudes which are then more likely to influence decision making in similar situations. Again, authentic tasks that include the context for ill-structured problem solving can provide learners with advantageous conditions. Visual, auditory, olfactory, tactile, and kinesthetic stimuli may all be part of the “peripheral features” of authentic tasks. Brown, Collins, and Duguid argue for the importance of peripheral features:

These features are often dismissed as “noise” from which salient features can be abstracted for the purpose of teaching. But the context of activity is an extraordinarily complex network from which practitioners draw essential support. The source of such support is often only tacitly recognized by practitioners, or even by teachers or designers of simulations. (1989, p. 34)

Granted, school tasks are by nature to some extent inauthentic because students are *not* practicing members of communities within which school tasks are embedded (e.g., Lave & Wenger, 1991). For example, in one of the curricular innovations reviewed in this paper, students are expected to take on the role of urban planners. While the unit attempts to be as faithful to the real activity of urban planning as practicable, it cannot truly capture the complexity and structures of discourse that professional urban planners engage in. Nevertheless, technology has the potential for increasing the authenticity of experience by providing sensory information (in the form of video, audio, and kinesthetic experiences) reflective of, or even recapitulating, real phenomena.

The role of emotions

The emotional reactions that a learner has to a task situation can greatly influence the learner's attitude toward that task and its context. Stronger object-evaluation associations are formed when the emotional reaction to an attitude object, such as a task situation, is stronger. More so than other sources of information, people trust their emotional reactions as indicative of their attitudes (Fazio, 1995). From a number of studies, Schwarz and Clore (1988) provide evidence that individuals use their affective reactions as relevant information when making evaluative judgements. The emotional components of memory appear to play an important part in an individual's response to current emotion-inducing situations. The second author of this paper has remarked earlier on the significance of emotional memory to a person's evaluation of the value of involvement in a current situation:

When a student faces an opportunity to engage in an activity, he or she may experience an emotion previously induced by a similar activity. Since her feelings *index* or *signify* a plethora of eliciting conditions from past experience, the emotion serves as a means for unpacking memory, revealing potentially important information about the value of participation. (Middleton & Tolum, in press)

Sinnott (1989) used think-aloud protocols to describe and model the processes involved in solving everyday ill-structured problems. She found emotional memory to be an important component of these processes. Emotions were often the impetus for determining what the nature of the problem was as well as for generating and choosing solutions. From its importance in relating past experience to current situations, the emotional reactions of learners to a situation can have a strong impact on forming and strengthening dispositions towards critical thinking.

Free choice

People view their own freely chosen behavior to be a highly reliable and relevant indication of their attitudes or dispositions. One may come to rely on one's own behavior as an attitude indicator in the same way that observers would rely on how they see an individual act to infer the dispositions that the observed individual might possess (Bem, 1972). Behavior that an individual willingly chooses, that thus allows for self-perception, has been shown to promote formation of strong attitudes (Fazio, Herr, & Olney, 1984). Since ill-structured problems typically do not have a single solution, an important component of the process of solving ill-structured problems is to assess the viability of alternative solutions. To do this, a learner needs to construct an argument for a preferred solution or against alternative solutions. In order to support or reject different perspectives, the learner must gather evidence. He or she eventually develops a personal position about a preferred solution (Jonassen, 1997). Constructing arguments and articulating personal beliefs during this solution process engages the learner in numerous situations during which choices are freely made. These activities thus provide occasions for forming and strengthening critical thinking dispositions.

Opportunity for rehearsal

Any object, issue, or event that calls an individual's attention to the evaluation he or she has formed towards that class of objects, issues, or events serves as an additional instance of associative learning and strengthens the individual's attitude (Fazio, 1995). Repeated expression of an attitude in this manner has been shown to enhance the accessibility of the attitude from memory and thus increases the ease, speed, and quality of decision-making (Fazio, Blascovich, & Driscoll, 1992). As described earlier, in the process of solving ill-structured problems learners have to weigh possible solutions. This involves them in constructing arguments and considering alternatives. Before reaching a solution, they often proceed through iterations of restricting the alternatives and refining their arguments (Jonassen, 1997). A learner attempting to solve this kind of problem thus engages in a series of actions that provide successive opportunities with similar attitude objects for rehearsal of critical thinking dispositions.

A comparison of sorts...

A variety of instructional programs include ill-structured problem solving as the approach taken for instructional design and implementation. We focus on two of these programs: The Jasper Woodbury Problem Solving Series (Cognition and Technology Group at Vanderbilt, 1992a), and Decision Making, a unit on problem solving through algebra (Middleton & Roodhardt, 1997). The design of these programs affords learners with opportunities to engage in activities that can be related to Fazio's attitude-strengthening factors. In addition, published descriptions of implementations of these programs provide examples of positive changes in learners'

critical thinking dispositions. In the following sections we will describe these instructional programs in relation to the attitude-strengthening factors described above and how those factors might relate to changes in learners' critical thinking dispositions, especially in terms of sensitivity to occasions that call for critical thinking.

The Jasper Problem Solving Series

The Jasper Woodbury Problem Solving Series (Cognition and Technology Group at Vanderbilt, 1992a) is a set of video-based adventures, with each adventure presented as a 15- to 20-minute story on videodisc. At the end of each story, a challenge faces the main characters. Students are given the task of solving this challenge before they are allowed to see how the characters in the story solved it.

"Rescue at Boone's Meadow" is one of a pair of Jasper adventures that deals with issues of trip planning. This story involves an ultralight airplane pilot, one of his students, and their friend, Jasper Woodbury. During flying lessons the student pilot, Emily, as well as the viewers learn a lot about the ultralight, such as the plane's fuel capacity, speed, and payload limits. While on a fishing trip, Jasper finds a wounded bald eagle and radios Emily for help. The adventure ends with Emily posing this challenge to herself: What is the fastest way to rescue the eagle, and how long will that take? Students presented with this problem can go back and search through the video, which contains all the data needed to solve the problem. This challenge is a complex problem which requires the students to generate the kinds of subgoals that Emily must consider in order to decide which is the best way to rescue the eagle.

The Jasper Series provides learners with richly detailed ill-structured problems. In describing their series, the designers explained that their goal "was to create interesting, realistic contexts that encouraged the active construction of knowledge by learners" (CTGV, 1993, p. 52). Some of the components of Rescue at Boone's Meadow that may promote sensitivity to occasions for critical thinking are described in Table 1. These appear to incorporate the attitude-strengthening factors that Fazio (1995) described.

Recall that Fazio's model of the influence of attitude on action identified both opportunity and motivation as necessary for the deliberative processing needed to establish a disposition towards critical thinking. Students using Rescue at Boone's Meadow receive extensive opportunity to identify occasions where critical thinking is appropriate. For example, to have a good shot at solving the story's challenge they must generate a series of subgoals based on the contextually embedded data.

As far as motivation is concerned, the Jasper Series provides the motivating conditions that Jonassen (1997) describes as an inherent component of instruction that incorporates ill-structured problem solving:

Because they are situated in everyday practice, [ill-structured problems] are much more interesting and meaningful to learners, who are required to define the problem and determine what information and skills are needed to help solve it (p. 68).

Evidence of the motivational effects of the Jasper programs comes from the developers' assessment of student attitudes and the comments provided by teachers (CTGV, 1992b). Fifth- and sixth-grade students in nine states were given a questionnaire at the beginning and the end of the school year during which they used at least three Jasper adventures, spending approximately one week on each adventure. Compared with students in control classrooms, the Jasper students were less anxious toward mathematics, more likely to view mathematics as relevant to everyday life, more likely to describe it as useful, and more likely to appreciate complex challenges. Teacher comments about the Jasper program included some impressions of its motivational effect on students. Typical is one teacher's comment:

We wrote letters to the new fifth graders coming up—giving them tips so it will make their year better. In all of them, I was looking over them, they wrote about Jasper: "Just wait until you get to Jasper," "It's not just fun, you'll learn so much." (CTGV, 1992b, p. 308)

Is the Jasper Series effective in making critical thinking dispositions strong and accessible? The developers of the series (CTGV, 1992b) give examples of learning transfer in which students spontaneously made connections between classroom activities and activities in other classes or outside of school. Some project teachers reported that several parents noticed when they stopped at gas stations that their children began to ask questions about the fuel capacity and efficiency of their car. Teachers also described the way students came to label complex everyday problems as "Jasper problems." In one example of this kind of problem, students picked up on how a substitute lunchroom staff failed to anticipate the meals it needed to prepare. Though these reports are anecdotal, they indicate that far transfer of these dispositions may occur in a variety of situations.

Decision Making

"Decision Making" is a mathematics unit designed for use in Grade 7. The unit presents students with a dilemma: Two parties with competing points of view are negotiating on rezoning a reclaimed landfill to build new residences for the city center. One party wants to maximize the number of people who can live in the area, and so wants to build high-rise apartment houses. The other party wants to rezone the land to accommodate the need for

new home buyers, and therefore wants single-family houses. As the two parties negotiate, students are asked to develop feasible plans for making decisions on just how the land will be zoned and to make recommendations as to how these plans can be carried out. The major mathematical content of the unit centers on the graphical representation of linear inequalities—the basis for linear programming. However, the abstraction of the graphical information into systems of algebraic inequalities was not emphasized in the unit. Rather, the concepts of “fair exchange” and “trade-off” were used to help students understand the linear relationship between x and y values.

Students were encouraged to take the position of one of the parties and argue their position with their classmates. By the end of the unit, students develop a plan for rezoning the land given certain city regulations.

Decision Making involves students in the application of math to difficult real world problems with multiple solutions. Through the process of designing and developing their zoning plans, as well as defending their recommendations, the students are clearly engaging in ill-structured problem solving. A number of components of the unit appear to promote sensitivity to occasions for critical thinking. Table 2 describes some of these components and the attitude-strengthening factors they incorporate.

Opportunities for deliberative processing occur at many points in Decision Making. Through engaging in the real world problem solving in their roles as urban planners making fair-exchange decisions, students repeatedly encounter occasions that require critical thinking.

The motivation necessary to bring about and maintain deliberative processing is also evidenced in the activities of students using this unit. Middleton and Roodhardt (1997) studied the implementation of Decision Making by 17 middle school teachers and their students in four Midwestern school districts. They observed that students were willing to work beyond their teachers’ expectations for the sake of creating quality projects. In most of the classes, the students were not allowed class time to construct their choice of final projects—models of their rezoning plans. Yet, they met after school and on weekends to develop high quality, mathematically correct scale models.

When asked what they thought of the unit, most students agreed that it was hard, but not too hard to do. They felt it was interesting because it dealt with real-life issues that they had heard about before. They understood the application of the context to the fields of architecture and urban design, and several students expressed a desire to learn more about these professions. The students also expressed a desire for more mathematics of this type.

Although the novelty of the situation certainly added to their enjoyment, the sustained effort students demonstrated over four to six weeks of work would suggest that the unit structure and content tapped into the structure of students’ intrinsic motivations. That is, the unit provided them with a level of stimulation by the tasks and a level of control over those tasks that kept them intrinsically engaged (Middleton & Toluk, in press).

The authentic tasks provided by Decision Making appear to be effective in developing critical thinking. Examples of near transfer were reported by the observers. When students were questioned with regard to their problem-solving strategies, they often referred back to the context of the rezoning conflict and said, “Oh, it’s just like...,” and used their previous strategies as analogies to communicate their present thinking. When the observers asked the students what the mathematical constraints to the systems of inequalities meant, the students used the relationships in the rezoning context to come up with a general solution. As for the dispositional side of critical thinking, observations did not disclose evidence of transfer to other contexts. Although this unit provides the conditions needed for development of strong and accessible dispositions, the implementation study did not reveal any instances supporting far transfer.

Concluding Remarks

The Jasper Series and Decision Making are just two of a number of instructional programs that incorporate ill-structured problem solving into their design. Through the use of activities focussed on solving ill-structured problems, teachers and instructional designers may have a good shot at promoting positive changes in learners’ thinking dispositions. With involvement in authentic activities, learners can more directly experience problems within real-world contexts. Appropriate use of technology can add realistic richness to the context. Instruction incorporating ill-structured problem solving also encourages learners to emotionally invest and freely choose as they construct arguments and articulate a personal position on a problem. In addition, this kind of instructional design promotes repeated expression of critical thinking dispositions through the give and take of considering possible alternatives and developing support for arguments.

From our examination of these two prototypical instructional innovations, we can abstract a number of design principles that pertain specifically to the nurturance of dispositions for critical thinking in the field of mathematics and to the stimulation of subsequent achievement:

Development of attitude strength takes time. Just as development of the ability to think critically in a domain takes considerable experience solving problems in that domain, so does the development of attitude strength. Both of the programs take two to four weeks to complete, revisiting common mathematical and contextual themes over the course of instruction, as opposed to traditional approaches to mathematics instruction, which allow fewer experiences with concepts and contexts, and less time to

go in-depth. In instructional design, familiarity does not breed contempt. In our cases, it appears to breed strong positive attitudes to learn.

Students need to have a stake in their learning. Both innovations provide consistent and coherent experiences that attempt to enculturate the learner into the ways of thinking and acting, as authentically as possible in a school mathematics environment, of actual communities of practice. In Rescue at Boone's Meadow, learners have a stake in the outcome of the rescue. In Decision Making, students must choose a perspective on urban planning that potentially would have real consequences for the ultimate design of the new development. In each of the experiences students encounter, the perspective they have chosen impacts on the learning activities they engage in.

Multiple perspectives on problem solving are built into the design. In both innovations, students are able to develop their own ways of solving the problems, and multiple perspectives are fostered. A visually-oriented student can utilize graphical analysis, a symbolically-oriented student may use algebraic notation and operations, while a numeric thinker might use number patterns in a table. These multiple methods are encouraged and fostered as bringing unique information to the endeavor of solving the ill-structured problem. Diversity of modes of thought is not an afterthought, but part of the design of the activities.

While just a terse list, these three principles run counter to most current approaches to curriculum design. Considerable renegotiations of the conditions of learning is required for environments such as these to be integrated into the everyday practice of education that currently does not allow enough time, integration of multiple ways of knowing, or personalization of activity to really amount to much in terms of critical thinking or dispositions to think critically.

A lingering concern is whether the critical thinking dispositions that this type of instruction appears to promote will actually transfer to contexts beyond the context of the instruction itself. This question addresses a broader problem for the use of authentic activities. Situating problem solving within a specific context apparently limits the ability of a learner to transfer what is learned to solving problems in other contexts. As Bereiter (1995) points out, when learners are given an analogous problem—a problem in a different situation that can be solved in the same way—they typically do not put to use what they learned in the first situation unless they are prompted in some way. This may be true for transfer of attitudes in general and critical thinking dispositions in particular.

One avenue of future research, then, could address aspects of the transfer of learned dispositions. Perhaps critical thinking dispositions are activated by rather broad classes of attitude-inducing situations. If that were the case, dispositions might transfer more readily among contexts than some other kinds of learning (such as the conceptual or procedural knowledge needed to solve a problem).

In every learning situation or other context where critical thinking is important, a person's ability is not sufficient to predict how he or she will act. Teachers and instructional designers should keep in mind that learners are also more or less disposed to good thinking. Our efforts need to address this attitudinal aspect of critical thinking as well. Some years ago, Gordon Allport expressed in simple terms the importance of such attitudes:

Attitudes determine for each individual what he will see and hear, what he will think and what he will do. (1935, p. 806)

Table 1. Critical Thinking Components in “Rescue at Boone’s Meadow”

Attitude-Strengthening Factor	Components Promoting Sensitivity to Occasions for Critical Thinking
Direct Experience	Students become participants in the story as they assume Emily’s role. To solve their problem, they must generate relevant sub-problems, argue their positions, and select among alternatives. They do this by working directly with the same information available to the character in the story.
Sensory Experience	The data needed to solve the problem are embedded in the video as a natural part of the story. The sights and sounds contextually integrated into the story provide rich sensory information.
Emotional Reactions	Students become emotionally engaged by their role in solving the challenge. Their arguments about how best to attempt saving the eagle are often emotion-laden.
Freely Chosen Behavior	After viewing the story, students must find and define the problems to be solved. They make choices among realistic alternatives when gathering evidence and reaching positions about the solution.
Attitude Rehearsal	The students need to consider a number of alternatives and proceed through a series of steps to solution of the problem. Opportunities for critical thinking occur at each of these steps. They can also work on the second of the pair of adventures to get additional practice on the core schema of trip planning.

Table 2. Critical Thinking Components in “Decision Making”

Attitude-Strengthening Factor	Components Promoting Sensitivity to Occasions for Critical Thinking
Direct Experience	Students take on the role of architects and urban planners. To design and develop plans, they must apply mathematics to a realistic situation. In negotiating with the opposing party, they explore the feasibility of different plans and engage in trade-offs to reach a workable solution.
Sensory Experience	Students apply the mathematical concepts by graphing data and creating scale models of their housing proposal. This kinesthetic experience authentically reflects the work of architects and urban planners.
Emotional Reactions	In the process of defining and presenting their position on how the land should be zoned, students become stakeholders with an emotional investment in their plan. Emotions become heightened as students on one side work through the negotiations process with the other party.
Freely Chosen Behavior	While engaged in planning, making recommendations for, and negotiating over the zoning change, students frequently must make choices and develop personal positions. Multiple models embodying the underlying mathematical concepts in the unit allow students to choose a preferred mode of representation for solving each problem at hand.
Attitude Rehearsal	During the four weeks typically spent on the unit, students encounter many occasions where critical thinking is desirable. These occasions occur in the context of a real world problem that motivates students to continue to engage in applying good thinking.

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PLANNING AND IMPLEMENTING WEB-BASED INSTRUCTION: TOOLS FOR DECISION ANALYSIS

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This paper discusses issues and factors involved in making decisions on whether to use web-based instruction. Five levels of web-based instruction are discussed, and eleven factors are identified to consider before making a decision to put your classes on-line.

We were talking with some colleagues the other day when one made a comment about what free thinkers academics were. After all, the whole purpose of tenure was to protect academic free speech. But on closer examination, it seems that the free thinking associated with the academy does not carry over into considerations of technology for learning and instruction. In this arena, a herd mentality seems a better descriptor. Take for example the current rush in academia toward implementing Web-Based Instruction (WBI). How many of your institutions are scurrying as fast as they can to get courses and content on the Web? How many times in the last year have you engaged in a discussion of educational technology with a colleague where the topic of the Web has not come up? How many times have you engaged in that same discussion with an administrator where the topic has not come up? If your organization is like ours then the answer to the first question is very few, and the answer to the second is almost none. We in academia are not alone in this rush to judgment, schools and corporations are equally engaged in a frenzied drive to the Web-based cliff.

Granted, the Web is, or at least appears to be, the most significant development in educational technology, and for that matter communications technology in general, in our lifetimes. Bran Ferren (1996), executive vice-president of Disney's Creative Technology and Imagineering division notes that significant increases in communications bandwidth throughout history have been accompanied by significant changes in civilization. The most familiar of these is the tie between the development of the printing press and the renaissance in Europe. Ferren holds that the Web, or more generally the Internet, is the most recent significant increase in communications bandwidth. He suggests that society as we know it will soon become society as we have only begun to imagine it. So let us stipulate that we believe the Web is the future not of educational technology, but of education.

Still, that future is not yet here. The current rush to conduct education and training on the Web is at best ill-advised and at worst could create a backlash of the disillusioned masses when the Web in its current state fails to deliver the magic educational bullet everyone expects. We argue that the Web will be incredibly valuable for education in the near and distant future, and can be incredibly valuable for education today if used appropriately. Part of this depends on the technical future of the web, and part of it depends on how we implement the technology in education. While we may not participate directly in the Web's technical future, we do have a respectable say in its implementation in education. So among the questions we need to be asking is how can we use the existing tools effectively?

The Web is not appropriate for all things in all situations. Instead educators should examine their own needs and resources, and determine individually whether to employ Web-based instruction. This paper presents a tool for determining whether, and more importantly, to what level use of the Web is advised in a given situation. We present five levels of Web use and a variety of factors that should be considered to determine which level is appropriate. We hope that educators and administrators will pause in their headlong rush to the Web and consider these factors before adopting it as a learning medium. To paraphrase Aristotle "the unexamined course is not worth giving."

Contrary to the belief of the general populace, the Web is not a neat, orderly, well-designed place. Because of the way in which the internet was originally designed, it is out of necessity amorphous, messy, and chaotic. Thus, dividing it into categories can be a frustrating, counterproductive, and often impossible task. Fortunately, if we consider only aspects of the Web intended to be used for education, or perhaps more accurately uses of the Web intended to the educational, the task becomes more manageable. We suggest five levels of use of the Web common in schools, colleges, and corporations. These levels represent a continuum from basic occasional use to advanced continual use. They are: informational, supplemental, essential, communal, and immersive.

Level 0: No Web Use

To begin though, we offer a definitional Level 0. By default, this level implies no use of the Web at all. We believe that this level of Web use, though standard now, will eventually become as uncommon as level five. This transition will occur if for no other reason than to save paper.

Level 1: Informational Web Use

The informational level of Web use is the most common and easiest to manage. Informational web use consists solely of providing relatively stable information to the student. Typically this information is administrative in nature and may not convey course content directly. Students may access this information from time to time during the course for reference purposes, but would not be expected to review it on a frequent basis. Level one Web use typically consists of the instructor placing items such as the syllabus, course schedules, and contact information on the Web for student review. This sort of information is easily created by the instructor or an assistant, requires little or no daily maintenance, and takes up minimal space and bandwidth.

Level 2: Supplemental Web Use

The supplemental level of Web use is becoming more common, is more useful than the informational level, and is only slightly more difficult to manage than the informational level. The key difference between level two and level one is that the supplemental level actually provides course content information for the learner. As the name suggests however, this information is not critical to course; it is intended as an addendum to the core content. In this level the main part of the educational experience is provided in a classroom setting. Students may access this information frequently if not on a daily basis. Level two consists of the instructor placing course notes and other handouts on the Web. A typical example would be a PowerPoint presentation saved as an HTML document and placed on the Web for students to review later. Level two use requires a bit more technical know-how by the instructor, daily or weekly maintenance, and low to moderate space and bandwidth depending upon the nature of the material placed on-line. For example, a textual outline of course notes would require very little bandwidth compared to a 30-slide, graphic-rich PowerPoint presentation. One point to consider in using supplemental web use is the timing of placing the information on-line. One colleague found that if they placed lecture notes on the web before class that course attendance dropped significantly.

Level 3: Essential Web Use

Essential refers to the fact that the student cannot be a productive member of the class without regular web access to the course. The essential level of Web use is still fairly uncommon today. At this level the student obtains most, if not all of the course content information from the Web. At this level one might think, for lack of a better example, of the Web replacing the textbook in of course. (We suggest that this thinking, while convenient, is ultimately counterproductive to the effective use of the Web and education. It is indicative of a traditional, direct instruction approach to education and may limit more effective and creative uses of the technology. It also suggests that simply changing the media makes a significant impact on the course content.) Course content may be created by the instructor or compiled by the instructor, but is likely a combination of both. It requires the instructor to have good HTML skills, good instructional design skills, good graphic design skills, good information literacy skills, and ample course development time. If the instructor does not have these skills, the instructor needs access to somebody who does have these skills. Classes still meet face-to-face, but students are expected to use the web-based course materials extensively. Essential course material made available on-line requires that the students take a more proactive approach to insuring their own learning.

Level 4: Communal Web Use

The communal level of Web-based instruction is only just beginning to receive a widespread use. At this level classes meet both face-to-face and on-line. Course content may be provided in an on-line environment or in a traditional classroom environment. Ideally, students generate much of the course content themselves. This level goes beyond basic HTML used and requires the use of other on-line tools such as internet chat, bulletin boards, and one and two-way desktop video. This level requires both the instructor and the students to have good HTML skills as well as good technology skills in general. At this writing, on-line group collaboration tools are generally not as user-friendly and bug free as one might hope. Novice technology users might not be able to get past the frustrations of imperfect tools to get to meaningful interaction about the course content.

Level 5: Immersive Web Use

The immersive level is still quite uncommon today. While several excellent examples of it do exist, most organizations do not have the infrastructure needed to support it, nor do most instructors have the skills needed to implement it. At this level classes do not meet face-to-face. All of the course content and course interactions occur on-line. Note that we're not referring to the more traditional idea of distance learning. Instead, this level should be seen as a sophisticated, constructivistic virtual learning community. While it may include some degree of the traditional content presentation, student practice, feedback, and assessment practices found in traditional distance instruction, it is more generally comprised of learner-centered constructivistic pedagogies such as cognitive

apprenticeship (Brown, Collins et al., 1989), and anchored instruction (Bransford, Sherwood et al., 1990). At this level both instructor and students need a high level of technological expertise and sophisticated learning strategies.

In addition to a continuum of levels of web use, we've currently identified 11 factors that influence the desirability of WBI. While other factors exist, this set seems to play the largest role in determining whether and which level of WBI to use. Table 1 below identifies the factors. The remainder of this paper discusses each factor.

Table 1: Eleven Factors Influencing Decisions to Use WBI

1.	Distance
2.	Stability Of Material
3.	Need For Multimedia
4.	Need For Student Tracking
5.	Number Of Students
6.	Amount Of Interaction Needed
7.	Social Pressure
8.	Need For Offline Reference
9.	Infrastructure
10.	Comfort Levels
11.	Access

Factor 1: Distance

Distance refers to the geographical proximity of the instructor and students. We represent distance as a continuum ranging from a group of people close proximity to a population that is disbursed over great geographical distances. Obviously if the instructor and students are scattered over a wide geographical area, and it is difficult if not impossible for them to meet face-to-face, then on-line instruction is likely a good way to connect the instructors and students. If the students and the instructor can easily meet face-to-face then the Web will be of less value. This is primarily because of the amount of information that can be exchanged, and the interactions that can occur in face-to-face settings, dwarfs that which is possible over the Web. However, distance should not be the overriding factor. There are situations and circumstances in which even those instructors and students in close proximity can benefit from on-line learning.

Factor 2: Stability Of Material

Stability of material ranges from highly stable content to completely variable. For example, course content on anatomy is fairly stable: a patella is always going to be a patella. However, course information on web programming is incredibly dynamic, and can change literally overnight. If the course material is highly stable, then the Web is probably not the best candidate for the delivery mechanism. Most students would still rather have the portability and readability of a textbook over network-dependent, low-resolution screen text. In addition, highly variable material requires frequent and consistent updates by the instructor or students in the learning community. An advantage of using the web is that distribution of content, or updates to content, is the responsibility of the user. This can save both time in distribution, and money in printing, binding, and shipping.

Factor 3: Need for Multimedia

Need for multimedia ranges from low to high. Granted at this point the ability to provide multi-media at acceptable speeds depends on bandwidth, and the type of media being used, the Web can be an excellent tool for presenting multimedia content. It combines pictures, text, graphics, sound, and motion video seamlessly. In addition, it allows students to access this material whenever and as often as they need. Therefore, if the course requires or can benefit from multimedia, then the Web is a good solution.

Factor 4: Need For Student Tracking

The need for student tracking refers to the desirability and degree of accounting for student interaction with, and progress through the course. WBI like all computer-based training is well-suited for collecting data about students as they interact with a course. In addition to such features as on-line testing, it is also possible to track things such as amount of time spent, content examined, content created, and student paths through the content. Depending on how student tracking is done, one can examine paths through not only your web materials, but to external web materials as well. Examining this type of data, together with an analysis of students' mental states (i.e. using verbal reports as data, (Ericsson and Simon, 1984)) allows instructors to create a rich model of the learners.

Factor 5: Number Of Students

Though it may seem counter intuitive, the more students a course has, the lower the level of WBI that is appropriate. A fully immersive WBI environment as described in level 5 requires significantly more preparation time and classroom management time for the instructor than a traditional course. In our experience, a large part of this time comes from interacting with individual students. We believe that a single instructor cannot manage more than 10 to 20 students in this type of environment. For every additional 10 to 20 students the instructor should have some sort of teaching assistance. On the other hand, for courses with hundreds of students it makes more sense to distribute as much information as possible on-line. Therefore, for large numbers of students levels 1,2, and 3 are indicated. But levels four and five, in which more interaction is required, should be reserved for smaller classes. This is often times a struggle as you begin to think about implementing web-based instruction. Administrators who are pressed for classroom space and the need to generate more tuition related dollars often encourage faculty to take more students in on-line environments.

Factor 6: Amount Of Interaction Needed

By the same token, traditional didactic courses can benefit from levels 1,2, and 3 of WBI. But courses in which a more Socratic method is employed require the interactivity found in levels four and five. Email, chat rooms, bulletin board systems, and desktop video can be great facilitators of interaction. Interestingly, the skills which allow some students to participate more in face-to-face discussions may not be as valuable in on-line discussions. For the type of synchronous interaction available in chat rooms, we found that typing ability and speed has a monumental influence on participation. The faster a participant can type the more likely that person is to make contributions to the chat. The more accurately a person can type influences the perceived credibility of the chat contributions.

Factor 7: Social Pressure

Although we feel it is the least pedagogically valid of the factors influencing the desirability of WBI, social pressure is the one that drives most decisions about using WBI currently. While social pressure has little impact on the educational outcomes of WBI, its role in the operation of larger educational systems is too significant to be ignored. Institutions and organizations that offer no opportunity for Web based instruction may find themselves viewed as old-fashioned and out of date. This finding could lead to a lack of credibility and loss of resources however undeserved it might be. It is important to balance the pressure to use Web based instruction with economically and pedagogically sound reasons for doing so. But it must be a balance of sound reasons, and social pressure should not be ignored merely because it is educationally insignificant.

Many argue that instructors should put their classes on-line regardless. It is an interesting problem, that we think can be explained in the form of an analogy. Imagine that you are a professor of molecular biology, and your department chair comes to you and says, "I want you to write a self paced textbook to take the place of your introduction to molecular biology. Now, I will pay you for a summer course to do this, but here is what you will need to do. You will need to research and write all of the text. You will need to proof read it, typeset it, print it, bind it, and take care of distributing it to your students. Oh, and by the way, it is possible that none of your students would have ever seen a book before." Most of us would politely pass on this opportunity to someone else, but more and more this is what is being asked of faculty members. The social pressure of putting classes on-line needs to be tempered with the reality of the resources available to put the course on-line.

Factor 8: Need For On-line Reference

More and more content is available on the web with each passing day. From real estate listings to meteorological information, good, sound, and reliable content is available on the web. In certain disciplines, it may be impossible to not use web based resources. For example in the study meteorology, one can imagine that instructors would want their students to access weather related sites on a daily basis. In an environment such as this, much of the content exists without the instructor creating it. This is a compelling reason for students to be on-line. For other types of content where on-line resources may not exist, it may not be the wisest idea to put the course on-line.

Factor 9: Infrastructure

The infrastructure of any organization cannot be overlooked when making a decision to use WBI. Consider for a moment that in levels 4 and 5 nearly all of the course is delivered via the web. If your web server is not robust enough to handle heavy traffic, or if your Information Systems department finds it difficult to resolve server problems quickly, WBI may not be a viable option.

There also needs to be a support infrastructure for faculty to help them get materials on-line in the first place. While HTML at its most basic level is mastered fairly easily, more complicated interactions and media presentations may require external support. Students and faculty both may enjoy working from home rather than on campus. The organization needs to provide appropriate technical support to make sure that technology failures play as little role as possible in the success of the class. Faculty need appropriate hardware and software support to work with the on-line environment.

Factor 10: Comfort Levels

Obviously faculty who have never seen the web have no business trying to conduct web-based classes without significant training before they begin. Students who do not understand either how the web works, or how to manage information on the web will become frustrated in web-based environments. The level of comfort one has in the environment will dictate how much one can get out of the environment. Students struggling to understand the nature of menus and submenus on a web page will likely spend more time learning how to be a student in the environment than the content contained in the environment. It is a matter of time, and time cuts both ways here. We need to move quickly to respond to pressure to have a web presence, and we need to give ourselves time to make sure it is done well, and that we are comfortable in doing it.

Factor 11: Access

Related closely to infrastructure and comfort levels, access refers to whether or not we can get to the materials. Instructors need to be able to work from the office and at home. If they travel a lot, they need to be able to work from the road as well. There needs to be access to both hardware to run the environment and software to develop and work within the environment. Access refers not only to internet access, but to equipment access as well. Every time we offer an on-line class, there will be students who enroll in the class with some type of access problems. Usually it is a problem with a web-browser version, or in modem speed. In some cases it is as dramatic as the student needing to invest in a new computer. Students need to be prepared to accept responsibility for access, surely. But additionally, instructors need to be prepared to address access problems, and the institution needs to be prepared to help resolve them.

Conclusions

We aren't sure if there are any real conclusions yet: what we have to say is based on experience, research, and analysis. It is also based on the state of web technology as of the writing of this paper. At this juncture in history, we can foresee the five levels remaining fairly consistent. While level 0 may cease to exist, institutions take on the responsibility of reaching level 1, and faculty for reaching level 2, the higher levels require more of a conceptual shift among faculty and student. This requirement may make widespread use of these levels of WBI a longer time coming.. The factors, however, are quite malleable. As technology changes, so will the factors. Keeping up with the factors will be difficult in traditional outlets. While this report was prepared in February of 1999, it may not make it to print until July of 1999. Four months in web-time may be an eternity. We need to be prepared to not only reap the rewards of web-based learning, but to manage the responsibilities as well.

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SCREEN MINIATURES AS ICONS FOR BACKWARD NAVIGATION IN CONTENT-BASED SOFTWARE

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Abstract

The users of content-based software programs, including hypertexts and instructional multimedia, rely on the navigation functions provided by the designers of those programs. Typical navigation schemes use abstract symbols (arrows) to label basic navigational functions like moving forward or backward through screen displays. In a previous study conducted by Boling, King, Avers, Hsu, Lee & Frick (1996) the use of concrete representations (screen miniatures) to indicate backward navigation functions was found to reduce the number of errors users made in backward navigation significantly. The current study tested this claim using a more diverse sample of subjects and an electronic instrument instead of the original paper instrument. A hypercard™ stack was developed in two versions, one with screen miniatures and one with arrows to represent certain backward navigation functions, and used to test subjects' ability to choose the correct button for a particular backward navigation event. Subjects using the screen miniatures made significantly fewer errors than did subjects using arrows.

Icons for backward navigation in content-based software

Graphical user interfaces as they are used in most interactive content-based software rely on representations within that software to supply the users with its basic functions. Representations, or signs, are fundamental elements of communication. Signs communicate by virtue of "... a three-way relation between the representamen (that which represents), the sign's object (that which is represented), and its mental interpretant (the situated intelligence that performs the necessary substitution of signifier for signified)" (Mullet & Sano, 1995; p.171). In human computer interface design, the critical process of representation depends on establishing a clear relationship between a representamen and its object for the users. To interact with an information system, users need to draw a connection between each representamen and its corresponding system function.

A common functional element in content-based programs is the hyperlink, or electronic connection between one screen representation and another. Hyperlinks are often represented as text, and for navigation they are often represented as icons or buttons with pictorial symbols on them. Users have to decode these signs (or representamens) correctly or else they risk error in navigating the program, which frequently results in frustration with the programs. The degree to which the visual signs in a program are easily decoded by users of the programs (or interpretants) can therefore be a critical factor in the successful use of such programs (Norman, 1988).

The navigation metaphor

Hyperlinks allow users to retrieve information or pursue a content-related experience (taking a quiz, for example) by invoking various content nodes of the system as unique screen displays. This control by users over the sequence of screen displays is often described as *navigation* through an information space (Nielsen, 1990).

The navigation metaphor has been criticized as inappropriate because considerable differences exist between information space and physical space (Landow, 1990; Mayes, Kibby & Anderson, 1990). Stanton and Baber (1994) point out that physical space is static so the landscape, or physical space, metaphor can not capture the flexibility of hypertext. Maps that have been adapted from physical navigation to provide the hypertext users with navigational aids have also been criticized because in complex programs they can only provide an incomplete picture of the hyperspace (Stanton, Taylor & Tweedie, 1992). Consequently, the users might employ sub-optimal search strategies while depending on a map (Kim & Hirtle, 1995) or might even get lost in the program (Stanton & Baber, 1994).

In contrast, Canter, River and Storrs (1985) assert that there are fruitful and direct parallels between navigating concrete environments and navigating data. Kim and Hirtle (1995) even propose that a spatial metaphor can be used as a framework for explaining and designing tools analogous to navigational aids in physical environments that alleviate disorientation problems in hypertext systems. Their view is supported by the results of

Edwards and Hardman's (1993) experiment to determine how individuals cognitively represent a database in the form of a hypertext document. Edwards and Hardman conclude that individuals appear to be attempting to create cognitive representations of hypertext structures in the form of a survey-type map. McKnight, Dillon and Richardson (1993) have also documented people's use of easily recognizable screen displays as "landmarks" in a process similar to physical wayfinding while they are using hypertext documents.

The navigation metaphor is intuitively compelling. Many readers of this study will recognize themselves in the user of a content-based program who says or thinks, "I just saw it a couple screens ago -- now how do I *get back there?*" Lakoff and Johnson's (1980) discussion of orientation metaphors as a fundamental construct in the human conceptual system suggests that we could have predicted McKnight, Dillon and Richardson's (1993) observations. People's metaphorical speech concerning printed texts reveals a form of ontological metaphor at work; specifically, "A text is a terrain." Consider the statement, "I found that article *pretty slow going*, but I managed to *work my way up* to the discussion section where I *got bogged down* and had to *backtrack* several times in *order to make my way through* the author's explanation." Previously cited observations of users interacting with hypertexts further suggests that, whether or not such a view ignores some of the unique properties of hypertext, users are employing the conceptual "text as a terrain" metaphor to them. The authors of this study will therefore use navigation as a way to describe and reason about the design of pictorial hyperlinks in content-based software.

The trouble with navigating backward

It is clear that backtracking is important in navigating in hypertext environments. Stanton & Baber (1994) found that the most common form of user action in hypertext systems is backtracking to previous nodes; such backtracking serves as an error management activity. Schroeder and Grabowski (1995) found that users had considerable orientation problems in a hypertext system where no explicit backtracking function was provided. Boling et al. (1996) found that users made more navigational errors when they were "going backward," or returning to a previously-visited node, than they made in "going forward," or choosing a destination they had not visited before.

Seeking to explain the higher error rate for backward navigation, Boling et al. (1996) examined over 400 navigation buttons drawn from 130 instructional hypercard stacks. They discovered that designers of the hypertext products reviewed were highly consistent in their choice of button representation for forward and backward navigation involving only one "step," or the difference between linearly adjacent screen displays. However, there was a high degree of inconsistency in the designers' choice of button representation for navigating backward to a specific departure point or screen. What accounts for the observed consistency in designers' choice of representation for single-step backtracking as well as single-step forward navigation? What accounts for the high degree of inconsistency in designers' choice of representation for navigating backward to a specific departure point/screen?

General vs. specific destinations in navigation

Boling et al. postulate that designers' consistency *and* inconsistency lie in the nature of the two types of navigation tasks. They argue that the above two types of navigation, single-step navigation and specific-destination-backward navigation tasks can be viewed as representative of two types of knowledge -- general knowledge (knowing that) and specific knowledge (knowing that one) (Maccia, 1987; Maccia, 1988). General knowledge (knowing that) is knowledge or knowing that is "not bound to particular persons, places, events, things or their interrelationships" (Frick, 1997b). In contrast, specific knowledge (knowing that one) is knowledge or knowing used to "discern the specific features that make some entity unique - what sets it apart from all else" (Frick, 1997a, p. 113).

In the context of navigation, general knowledge suffices for tasks that involve moving by certain rules from the specific location or screen display one is seeing now to a different location/screen display that is unknown in advance. In the physical wayfinding analogy, "knowing that" would be equivalent to arriving at a place after following a navigational instruction like "Go one block down and turn right." In hypertext, an example of "knowing that" would be to "go from this logical screen display to the next one or the previous one." In both cases, the fact that they have arrived at a certain location or screen display is more important than whether or not they recognize the particular location or screen display.

In the context of navigation, specific knowledge is involved in such tasks of moving from where one is now to another specific location or screen display that one has visited previously. In the physical wayfinding analogy, "knowing that one" would be equivalent to arriving at "my house" after following the navigational instruction, "Go to your house." In the hypertext context, an example of "knowing that one" would be to arrive at the menu screen after following the instruction, "Go to the menu screen for this section." In both examples, what is important to users is that they have arrived at the specific place/screen display that was intended and that they have *not* arrived at any other one.

Concrete representations of screens as landmarks

Darken and Sibert (1996) define landmark knowledge as "static information about the visual details of a specific location." As such, landmark knowledge is indeed a form of specific knowledge in which the wayfinder remembers or recognizes a distinct element in the environment and relies on that element as a central location or departure point to further explore the rest of the environment. We argue that users of hypertext programs could rely on the distinctive visual features of specific screen, in the form of concrete pictorial representations on hyperlink buttons, as a form of landmark wayfinding for backward navigation.

Landmark knowledge may be useful in hypertext navigation if, and only if, people can recognize that they have seen distinctive visual features of the specific screen displays involved. Past research in visual recognition has provided ample and encouraging evidence in this regard. Empirical studies show that humans have remarkable recognition memory for visual images they have previously seen (Standing, 1973; Paivio, 1971). More impressively, people are capable of recognizing visual images even when these images have undergone substantial transformation (of size, not orientation) subsequent to the first viewing (Winn, 1993).

Since people do seem to use landmarks in hypertext, and they are capable of recognizing a seemingly limitless number of images as ones they have seen before, the authors speculate (as did Boling, et al., 1996) that miniature representations of screens might function more effectively as representations of backward navigation to specific locations than do abstract representations, like variations of left-facing arrows or text-based buttons of the "Return to submenu" type. The use of miniatures for backtracking is not unprecedented in hypertext applications, although the examples known to the authors have been "history list" type implementations (Ayers & Stasko, 1996; Nielsen, 1990; van Dam, 1987).

Such representations would preserve the context and much of the distinctive detail in the previously-viewed screen, which would not happen if only a portion of the screen were represented on the button. Screen miniatures would also obviate the necessity for designers to struggle with the difficult task of representing "low imagery" verbs like "to return" (Rogers & Osborne, 1987) and allow them to use images that stand for nouns ("that screen/location") instead of verbs ("go back") (Krull, 1988).

Concrete representation for navigation backward to specific destinations

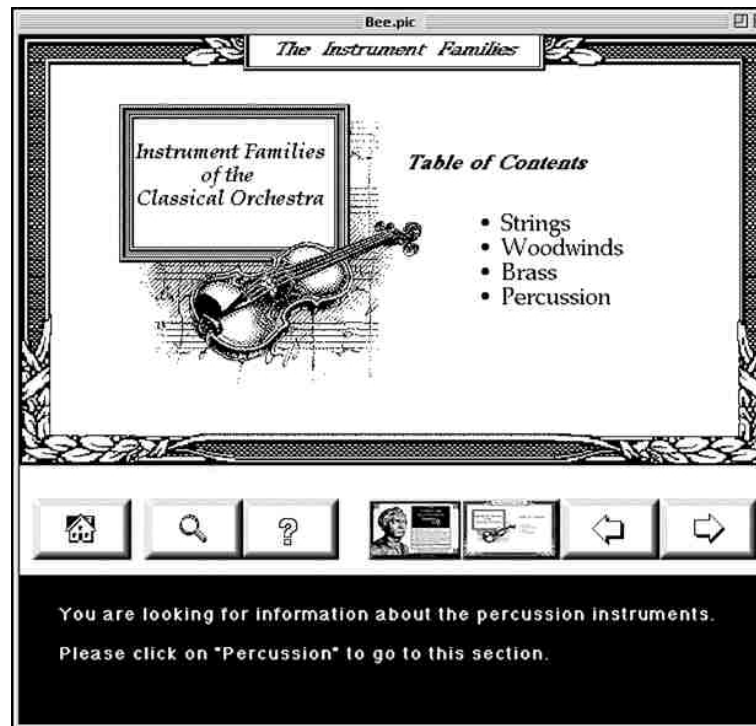
In light of the above evidence, the authors argue that the use of specific imagery (a picture of the specific location or screen display where the user wants to go) should be more helpful to the user than the use of abstract or general imagery (arrows) in representing specific navigational functions. We expected that users would make more errors in choosing navigation buttons for specific backward navigation when the buttons contained abstract symbols (arrows) than when they contained concrete representations of destinations (screen miniatures).

Method

Instrument

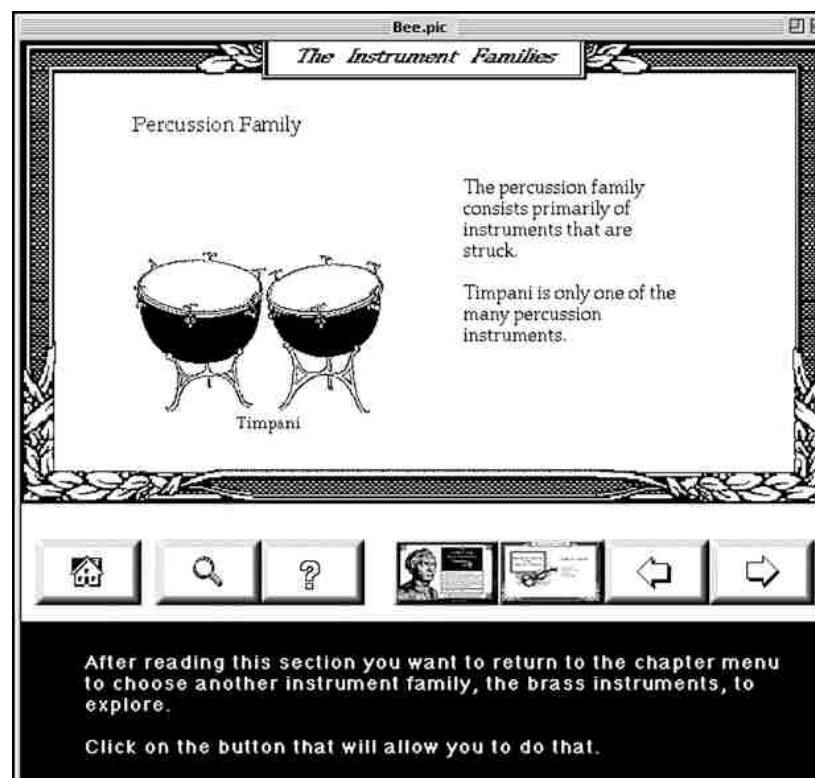
To test the hypothesis, a mocked-up hypertext program was developed by adapting a commercial product, BeethovenTM. The screen of the instrument was divided into an upper part that showed the actual screen from the hypertext program and a lower part where the subjects were presented a navigation task (see Figure 1).

Figure 1. Screen from study instrument showing part of the linear navigation path preceding an actual navigation



Subjects were given the same set of 28 navigational tasks. To ensure that subjects had previously visited the screens to which they would later be asked to navigate “backward,” subjects pursued a simulated navigation path through a series of two to four related screens before they were presented with a real navigational task (see Figure 2).

Figure 2. Screen from study instrument showing a backward navigation task.



The tasks provided the context for a navigational action, sometimes backward navigation, and then requested the user to click the button that s/he would choose in order to perform this action (see Figure 2). For example, a typical task would read:





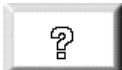
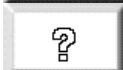








After reading this section you want to return to the chapter menu to choose another instrument family, the brass instruments, to explore. Click on the button that will allow you to do that.

A separator screen was built in between the tasks. Subjects could click a button on this screen to go to the next task whenever they were ready.

Although this study concentrated on the errors made in backward navigation, the tasks involved buttons of all major navigation functions to prevent the subjects from focussing only on the backward navigation buttons. The start and end time of the experiment, the time spent on each screen, and the names of the buttons clicked by the subject were recorded in a log file as subjects completed the instrument.

Two versions of the program were developed to measure the effectiveness of concrete and abstract representation in the use of buttons for backward navigation. Both versions provided seven typical hypertext functions represented by a set of buttons. These functions were “quit”, “more information”, “help”, “go back to main menu”, “go back to chapter menu”, “previous”, and “next.” The only difference between the two versions of the instrument was that “the go back to main menu” and “go back to chapter menu” buttons were represented differently. In one version these functions were represented by abstract pictorial representations (arrows). In the second version they were represented by miniaturized images of the screens to which they were linked (see Figure 3).

Figure 3. Comparison of all buttons appearing in two versions of the study instrument with their respective functions.

Function	Abstract representation	Concrete representation
Quit		
More information		
Help		
Go back to Main Menu		
Go back to Chapter Menu		
Previous		
Next		

Subjects and Procedure

Thirty-five subjects representing different ethnicity, nationality, and educational background participated in this experiment. The gender ratio of the 35 subjects was 63% female to 37% male. The majority of the participants were between 20 and 29 years old (77%). Twenty percent were between 30 and 39 years old. One participant (3%) was between 50 and 59 years old. Nearly a quarter of the participants (22%) were enrolled in undergraduate programs, 75% were enrolled in graduate programs. Three percent (one participant) were not students. Half of the participants were majoring in varying fields in education (51%) while the remaining half were distributed among several other subject areas (see Table 1).

Table 1. Proportions of participants with different majors in the sample

Major	Participants (Number/Percent)	
Business	3	8.6 %
Computer Science/Telecommunications	3	8.6 %
Education	18	51.3 %
Library and Information Science	3	8.6 %
Natural Sciences	2	5.7 %
Other	6	17.2 %

All participants in the study reported that they had used graphic browsers before. Likewise, all participants except one had experiences with application programs that utilized navigational tools similar to those presented in a short demographic survey that they filled out after completing the instrument. Almost three fourths (74.3%) of the participants had no prior experience with hypercard. The remaining 25.7% who had used hypercard before reported to be either relatively inexperienced (14.3%) or moderately experienced (11.4%). No participant considered himself as very experienced in using hypercard. Thus, the participants could be considered as having some experiences with iconic representations for navigation. However, their familiarity with the default hypercard icons used in this study was fairly low for most of the subjects.

Subjects were randomly assigned to one of the two treatment conditions. Subjects were not aware of the differences between the two versions of the program. They only knew there were different versions and they were assigned to one of them. A test session took about 20-25 minutes including the time required for introducing the instrument.

Subjects were introduced to the instrument through an opening screen on the instrument that described the tasks they would encounter in the instrument. They then worked at the computers individually. The researchers did not sit next to the subjects so as not to influence the subjects inadvertently with body gestures or verbal signals.

Results

To ensure that the random assignment to the two treatment groups (see the methodology section) yielded no major differences between the groups, Pearson's chi square was calculated for gender, age, and prior experience with graphical browsers and hypercard. No significant differences between the groups were found for any one of the variables.

Mean number of errors and response time

According to our hypothesis, we expected the participants in the concrete pictorial representations group (miniatures -- Group B) to make fewer errors in backward navigation than the participants in the abstract pictorial representations group (arrows -- Group A). This expectation was confirmed. The mean number of errors in identifying navigation buttons for each of the treatment groups is reported in Table 2.

Table 2. Mean number of errors in identifying navigation buttons for each of the treatment groups

Group	Mean overall	Standard Deviation Overall
Group A - abstract pictorial representations (arrows) N = 18	10.39	4.865
Group B - concrete pictorial representations (miniatures) N = 17	4.59	3.743

A one-tailed t-test revealed a highly significant difference between Group A and Group B for the number of backward navigation errors ($t = -3.937$, $p < .000$). For all navigation tasks, Group B who used concrete pictorial representations made fewer errors than Group A who saw abstract pictorial representations.

No differences between the two groups were found in the mean response time to the backward navigation tasks.

Discussion

The results of this study suggest that concrete pictorial representations may provide a less ambiguous means for backward navigation than do abstract representations. Providing screen miniatures on navigation buttons helped the users select the appropriate button for backward navigation, possibly by supporting their use of landmark navigation. In contrast, the group who saw the abstract pictorial representations made more mistakes relating navigational functions to the different symbols represented on the buttons.

Considerations for designing screen miniatures

Special consideration needs to be given to the design of screen miniatures for navigation buttons. In this study, some participants commented that it was difficult for them to distinguish between the miniatures representing the main menu and the chapter menu since they looked similar at the first glance. Nielsen (1990) made a similar observation. He criticized HyperCard's graphical history list that showed miniature pictures of the last 42 screens visited, pointing out the screen miniatures could easily be confused since they looked too similar. Thus, screens functioning as landmarks (that is, destined to appear as miniatures on buttons) would need to have some unique visual features that retain their distinctiveness even after undergoing considerable reduction in size.

Miniaturization of an entire screen display results in the loss of detail and, most probably, recognizability. One solution to this design problem might be to reproduce only a small portion of the original screen display on the navigation button. This design approach was used in Mosaic G, a derivative of NCSA's Mosaic 2.5, the popular browser for the World Wide Web (Ayers & Stasko, 1996). It may also be observed in any number of Web site designs where a portion of a logo or image map is repeated on subordinate site pages as a hot link back to the main page of the site. No empirical data has been reported on this form of navigation so far as we are aware at the time of writing. From a gestalt-psychology perspective, however, one could anticipate that showing parts of the screen without their surrounding context might not be very helpful providing concrete "landmark" signs (Easterby, 1970). Consequently, in the current study the authors created miniatures of entire screens, relying on distinctive elements of the full size screens to retain enough detail that they were functionally recognizable. Further study on the possibilities and limitation of partial screen landmarks is warranted.

Limitations of the study

The scenario of the study was not authentic. In an authentic hypertext environment, users get feedback on their navigation immediately and generally have the chance to correct their errors right away. The subjects in this study were directed to go through the hypertext stack in a predetermined sequence and did not receive feedback for the errors they made. The advantages of this approach were that error rates for respective navigation buttons could be recorded consistently, and the structured paths reduced the potential confounding effects from subjects getting lost in the hypertext program or learning the program's structure.

Future Research.

Research should be conducted to study subjects' performance with screen miniatures in authentic tasks and authentic contexts. Such studies might also examine the speed and ease of learning of the meanings of abstract versus concrete navigation buttons.

Comparison of screen miniatures versus detailed textual links may also be warranted. While one might expect faster recognition of individual concrete images (screen miniatures) over recognition of textual links, the time difference might be offset by the fact that the screen miniatures require users both to recognize them and to remember whether the information they seek exists at that previously-visited location. Textual links might carry more helpful semantic content that ultimately reduces either the time required to make a choice, or errors in navigation, or both.

Summary

Backward navigation to a screen/location visited previously is a frequently used navigation function within content-based software. The use of screen miniatures may be a fruitful design strategy for reducing error in this type of navigation, and might be considered as an option for backward navigation even though other navigational functions within a single program are represented differently.

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PSYCHOLOGICAL FACTORS INFLUENCING WORLD-WIDE WEB NAVIGATION

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Abstract

This experimental study investigated psychological characteristics and external web-site features influencing learning and disorientation in web navigation. The research design is a 2X2 ANOVA with mode of navigation (linear, nonlinear) and distracters (i.e., the presence of “seductive” links) as the two factors. The paper reports findings of the following dependent measures as they relate to the two-factor research design: friendliness of the web site, attribution of disorientation, overall level of disorientation, confidence in navigating the web site passage, interest in web site passage topic, accuracy at stating main point of the passage, and number of ideas recalled from content of passage. It was found that preference for sensation-seeking behavior and/or spatial-holistic ability did not influence the participants’ perceptions of disorientation. Other results indicated that recalling examples from the text was facilitated when the site had no distracters. But an interaction indicated that participants’ conception of the main point of the passage was negatively influenced if the site had no distracters when in the nonlinear navigation mode.

Introduction

Given the rapid growth of the Internet and the commensurate need to design improved systems for participant access and learning, this study investigates psychological issues related to navigation in the World Wide Web. In this paper, I am going to focus on results from an experiment that relate to *psychological characteristics* (e.g., sensation-seeking behavior, spatial-holistic ability, disorientation, attribution, confidence, perceived friendliness of web-site and interest in content), *learning* (e.g., accuracy at stating main point of the passage, number of ideas recalled from content of passage), and *external web-site features* (e.g., mode of navigation, the presence of distracters), of World-Wide Web navigation.

These three areas can be conceptualized in terms of a user’s perception of disorientation, defined as uncertainty in one’s location. A common phenomenon on the World Wide Web is for a participant to become sidetracked by other links and become disoriented when seeking a particular location. From the participant’s perspective, did s/he make the right choice or will s/he have to back-track? Did she temporarily ignore her original intent because she has a high need for novelty and stimulation? Additionally, much of the inconvenience of disorientation may be perceptual. Like waiting in line at the grocery store, where some people become livid while others use it as a chance to start up a conversation, disorientation on the web may be considered as exciting or as an annoying distraction that prevents the participant from staying on-task.

Purpose

The purpose of this experimental study is to evaluate the role of internal (psychological characteristics) and external (web-site features) factors in influencing Internet navigation and disorientation. This research also facilitates the development of web-site features that better accommodate navigation preferences and learning. For example, a person low in sensation-seeking tendency may prefer a more streamlined approach to navigation with limited links whereas a person high in sensation-seeking tendency may prefer more varied navigational features with a greater number of available links or distracters. In terms of learning, the participants are tested for content learned from the participant’s navigation of the web site passage. This has direct implications for design and development of web-based learning environments. By assessing perceived factors relating to web navigation, the research provides information regarding the web site features that participants believe are important for a web-site’s participant-friendliness.

Participants

Volunteer participants were recruited from Internet listings that advertised the study, drawing from a diverse nationwide population. All participants had prior experience navigating the Web as a requirement of participation in the study. They were compensated for participation. The seventy-five participants represented a diverse population, with 79% white and 21% non-white (including primarily Asian and Hispanic). The mean age was 30.47 with a standard deviation of 1.26. Of the 74 participants reporting gender, 34 (46%) were female and 40 (54%) were male.

Experimental Design

The study was originally designed as a two-way ANCOVA design with system knowledge as the covariate because systems knowledge has been shown to directly affect participants' competencies at navigation (Hill & Hannafin, 1996). However, systems knowledge scores were very high ($X=4.08$ on five point scale) and positively skewed, precluding the value of using them as a covariate.

Consequently, the experimental design is comprised of a two-factor (2×2) ANOVA design with the two factors of navigation mode (linear, nonlinear) and distracters (presence or absence). These two factors relate to the external features of the web-site. There were four web sites that reflect different instantiations of the two factors (e.g., linear + distracters; linear + no distracters; nonlinear + distracters; nonlinear + no distracters). The four web sites all contain nine web pages of identical text that comprise a passage on *Internet use for education*, adapted from Andy Carvin's web site at <http://edweb.gsn.org/web.intro.html>. The software developed for the experiment randomly selected one of four web sites for each participant to navigate.

In the linear navigation condition, the participant is forced to proceed through the web-site similar to reading a textbook, only able to move forward and backwards. While this is a somewhat artificial treatment, it was designed to maximally contrast with the nonlinear mode of navigation. In the nonlinear navigation mode, the participant has immediate access to all pages at any given time through a navigation bar on the left-hand column.

The distracter condition contained six distracting links placed throughout the nine pages of the web site. The six distracting links were designed to figuratively "seduce" the participant to click on the link (e.g., David Letterman's Top Ten, jokes, Dilbert cartoons) and encourage off-task behavior. Each distracter was comprised of a small picture with a link indicating to "Click here to ...". The no-distracter condition did not contain any distracters.

The task for all participants was to successfully find the headings under which five statements were located within the nine-page online passage. Participants could access the statements from any page on the web site. In determining the appropriate heading location, the participant did not have open-ended access to the Internet; rather, s/he was limited to the pre-defined web pages for each web configuration. The toolbars were de-activated so that s/he could only access web pages included in the experimental web site. Software was developed in Perl to track the participant's path through the web site in terms of total time spent, time spent on distracting links, and the number of distracting links selected. The whole procedure took approximately an hour.

Research Procedures

Following completion of the initial task, the participant was profiled online according to the following two psychological dimensions: preference for sensation-seeking behavior and spatial-holistic ability. In terms of sensation-seeking preference, participants answered a battery of questions pertaining to preference for sensation-seeking tasks (from Zuckerman, 1979). See Appendix A for example items. These 34 questions consisted of paired statements from which the participant would select the one statement best describing him/her. For example: A) I would prefer living in an ideal society where everyone is safe, secure, and happy; or, B) I would have preferred living in the unsettled days of our history. The mean score of the participants was 18.50 ($sd=5.83$) with a possible range of 0-34. In terms of spatial-holistic ability, participants completed the Street Test (Street, 1931), a thirteen-item gestalt completion test. This instrument assessed spatial-synthetic ability by requiring the participant to mentally construct the whole picture from a partially-represented figure, such as a figure of a bearded man, a cat, or a locomotive. See Appendix B for two example figures. The mean score of the participants was 7.36 ($sd=2.52$) with a possible range of 0-13.

Additionally, information regarding the participants' prior knowledge was collected in terms of content knowledge of the passage's topic, and systems knowledge. Participants' mean prior content knowledge of the use of the Internet for education was 3.65 (on a 1-5 Likert scale where 5 is extremely knowledgeable) with a standard deviation of 1.05. As mentioned previously, systems knowledge scores were very high ($X=4.08$ on five point scale) and positively skewed, thus not lending much information to differentiate participants.

The following dependent measures were assessed through an online questionnaire:

Psychological factors

- Friendliness of the system
- Attribution of disorientation
- Overall disorientation
- Confidence in navigating the site
- Interest in passage topic

Learning

- Accuracy at stating main point of the passage
- Number of ideas recalled from content of passage

Predictions

First, in terms of psychological factors, it was predicted that individuals differing in sensation-seeking preference and spatial-holistic ability would prefer different web-site features. For example, a person low in sensation-seeking tendency may prefer a streamlined site with limited links and options whereas a person with high sensation-seeking tendency may prefer more varied navigational features with more links and/or distracters. Furthermore, it was predicted that these two factors would influence other psychologically-related dependent measures, such as perceived disorientation and confidence with navigation on the web-site.

Second, it was predicted that different web configurations (as defined by level of distracters and navigation mode) would differently affect performance on learning and psychological measures (as listed 1-7 above).

Results

Dependent measures were collected for the seven areas listed above, including both psychological factors and learning. Results will be presented in each of these seven areas.

First, in terms of *friendliness of the web-site*, participants were asked to assess the friendliness of the site on a Likert scale of 1-5. There were no statistically significant results in the two-way (navigation mode, distracters) ANOVA with site friendliness as the dependent measure. As would be expected in considering all of the participants (who represent all four web site combinations), participants' confidence in navigating the site was positively correlated to their reported friendliness of the site ($r=.411, p<.0001$).

Second, in terms of *attribution of disorientation*, participants were asked to "Consider the times when you felt disoriented during the task. Overall, do you attribute your feelings of disorientation to your self or to the web site? (with 1 representing to the self and 5 representing to the web site.)" This question served to assess to what extent participants attributed (i.e., blamed) navigation problems on the web site as opposed to themselves. However, there were no statistically significant results in the two-way (navigation mode, distracters) ANOVA with attribution of disorientation as the dependent measure.

Third, *level of disorientation* was determined from ten Likert-scale questions from Beasley & Waugh's Non-Linear Media Disorientation Assessment instrument (Beasley & Waugh, 1995). As expected, participants' disorientation scores correlated negatively to systems knowledge ($r=-.253, p<.05$), interest in content ($r=-.351, p<.005$), and confidence in navigating ($r=-.605, p<.0001$). From a two-factor ANOVA (navigation mode, distracters), there was a marginally significant main effect for navigation type ($F=3.318, p=.07$), where those in linear condition were more disoriented ($X=13.58$) than those in nonlinear condition ($X=10.63$). This indicates that participants feel more oriented with a nonlinear web-site format as compared to a linear format.

Fourth, there were no statistically significant results in a two-way ANOVA where *confidence in navigating* the experimental web site was the dependent variable. As expected, there was a strong negative correlation of perceived disorientation with confidence in navigating the site ($r=-.605, p<.0001$). Interestingly, females reported more confidence navigating the site than males ($X=4.68$ vs. $X=4.26, p=.001$), yet they also reported more overall disorientation with the site ($X=10.52$ vs. $13.24; p=.07$).

Fifth, there were no statistically significant results in a two-way ANOVA where *interest in passage content* was the dependent variable.

Sixth, participants were asked to *explain the main point of the passage*. Items were scored on a 1-5 scale, with a representative answer receiving a "1" as "It provides a general discussion about the web." and a representative answer receiving a "5" as "It analyzes the possibilities the web offers to educators and its importance as a learning tool." From a two-factor ANOVA (navigation type, distracters), there was a statistically significant interaction of navigation type and distracters ($F=4.70, p<.05$) for the main point score. This interaction indicates that participants performed better in the linear condition with *no* distracters ($X=3.63$ vs. 2.62), and in the nonlinear condition *with* distracters ($X=3.56$ vs. 3.42). Perhaps the distracters in the nonlinear condition forced subjects to expend more effort in discerning the meaning of the passage and were thus beneficial. In contrast, in the linear condition, the presence of distracters negatively affected performance by not fitting in with the linearity of the passage navigation.

Seventh, participants were asked to *list as many benefits* of using the Internet for education as possible, according to the web-site. They were awarded one point for each benefit listed that was stated in the passage. The range of scores was 0-9, with the mean as $3.34 (sd=1.97)$. A two-factor ANOVA (navigation type, distracters) indicated that there was a significant main effect for distracters ($F=6.68, p=.01$), where those in web sites with *no* distracters ($X=3.90$) performed better (listing more relevant benefits) than those *with* distracters ($X=2.76$). This indicates that the presence of distracters negatively affects idea production (in the form of listing benefits) following the learning experience. Perhaps the distracting links distracted the participant from focusing on and then later recalling passage content.

Discussion and implications

The first prediction, that preference for sensation-seeking behavior and spatial-holistic ability factors would influence perceived disorientation and preferred navigation mode, was not supported based on analysis of the data. However, there was a marginally significant difference in main point scores between those ($N=36$) with high spatial-holistic scores ($X=3.51$) and low spatial-holistic scores ($X=3.06$, $p<.1$), thereby indicating that spatial-holistic ability facilitated discerning the main point although did not interact with other navigational factors.

In terms of the second prediction, three findings regarding motivation, orientation, and learning will be briefly discussed. First, in terms of motivational factors regarding navigation, there is a clear connection between perceived web site friendliness and perceived orientation within the site. Second, in terms of web site and interface construction, this study indicates that participants feel more oriented with a nonlinear web site format as compared to a linear format. As would be expected, it was found that perceived disorientation was highly negatively correlated to both site friendliness and confidence in navigation. Third, when factoring in learning from the web-site it was found that recalling examples from the text (e.g., benefits of Internet use for education) was facilitated when the site had no distracters. But an interaction indicated that participants' conception of the main point of the passage was negatively influenced if the site had no distracters when in the nonlinear navigation mode. An important caveat is that the participants' task was not to learn the passage; consequently, the two learning measures (stating the main point of the passage, and listing educational benefits of using the Internet) actually assess incidental learning. Overall, this evidence begins to suggest that participants may indeed learn more from a nonlinear than a linear navigation mode. It is not clear whether or not the role of distracters, or "seductive" links, negatively affects learning. Future research should include more comprehensive learning measures.

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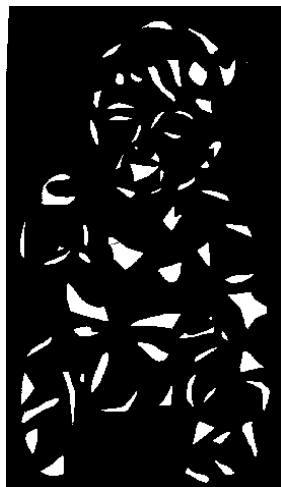
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Appendix A: Sample items from sensation-seeking instrument (from Zuckerman, 1979).

Instructions: Each of the items below contains two choices. Indicate which of the choices most describes your likes or the way you feel. In some cases you may find that both choices describe your likes or the way you feel. **Please choose the one that better describes your likes or feelings.** In some cases, you may not like either choice. In these cases mark the choice you dislike least. This scale should measure only your likes and feelings, not how others feel about these things or how one is supposed to feel. There are no right or wrong answers. Be frank and give your honest appraisal of yourself.

1	•I would like a job which would require a lot of traveling.
	•I would prefer a job in one location
2	•I am invigorated by a brisk, cold day.
	•I can't wait to get indoors on a cold day.
3	•I find a certain pleasure in routine kinds of work.
	•Although it is sometimes necessary, I usually dislike routine kinds of work.
4	•I often wish I could be a mountain climber.
	•I can't understand people who risk their necks climbing mountains.

Appendix B: Sample figures from instrument assessing spatial-holistic ability (from Street, 1931).



A baby



A bearded man

THE EFFECTS OF GOAL INTENTIONS ON PROBLEM SOLVING AND READING COMPREHENSION IN GENERATIVE HYPERTEXT PROCESSING

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Introduction

The study employed a 2 x 2 (Generative Activities by Navigational Activities) post-test only research design in examining learning while using a hypertext system in a linear, navigational, linear generative or navigational generative format. In Experiment One, participants were assigned one of the four conditions and expected to learn the information to solve a posed problem, while students in Experiment Two learned the information to pass a reading comprehension test. Results from Experiment One revealed that students in navigational condition outperformed those in linear condition with respect to their problem solving score. While there was no significant difference between generative and non-generative conditions, the study found that there was an interaction term indicating that generative activity may inhibit navigational hypertext system in problem solving. In contrary to Experiment One results from Experiment Two revealed significant difference between generative and non-generative conditions. While no significant difference between linear and navigational conditions with respect to their reading comprehension scores was found, a closer look at the learners' reading comprehension raw score and their dwell time revealed that learners assigned linear conditions outperformed those assigned navigational conditions but this effect was wiped out by their dwell time in the final analysis. In both experiments the computerized text used was identical.

Generative Learning

In Wittrock's (1974, 1978) generative model, he examined how learners used background knowledge to construct meaning from stimuli. Learners are not passively but are actively engaged in the construction of meaning as it relates to their beliefs, experiences, current goals, and the context in which learning occurs. Linden and Wittrock (1981) found that students who were instructed to generate associations for text showed greater comprehension and fact retention than those who were taught using conventional reading instruction. Doctorow, Wittrock and Marks (1978) showed that students who generated paragraph summaries significantly increased their retention and comprehension of the text compared to control groups who did not generate summaries. Studies in traditional text processing also found that encouraging students to generate elaborated explanatory answers about new content increases learning (Pressley et al., 1992). Generative and elaboration strategies have been shown to be effective while learning from text in general (Pressley & Ghatala, 1990; Pressley et al., 1992; Wittrock, 1974, 1978, 1989). Their application to hypertext systems, where learners already have many task requirements (i.e., navigational choices and different goals), has not been evaluated. The results of the study by Barab, Young & Wang (in press) indicated that there was a positive correlation between generative activities produced and the reading comprehension scores. The design of their study (Barab et al, in press) did not separate the navigational capabilities from generative activities, because both conditions afforded navigational control; therefore it is still unclear if the generative system would differentially benefit readers with problem solving and reading comprehension goals for reading.

In working with generative hypertext, the text is being altered as is the reader's understanding of the information contained in the text. This has much in common with research in ecological psychology, defining cognition as a process of a dynamic interaction in which neither the environment nor the organism is the only primary cause. The literature on situated cognition contends that meaning is constructed as an ongoing interaction between a perceiving/acting agent and an information-rich environment (Clancey & Roschelle, 1993; Dent, 1990; Gibson, 1986; Greeno, 1989; Young, 1993; Young & McNeese, 1995). Organisms and their environments define and shape each other in the process of interaction. Thus the learners' goals and intentions define and are defined by the situation in which the information is learned. As such, the interaction of individual's goals for reading and the situational constraints contribute to how the information is perceived and learned (Greeno, Smith & Moore, 1993; Young, 1993). One cannot exist without the other. Taking this view leads to an emphasis of understanding as an unfolding process in which information is "picked up" (Gibson, 1986) from the text as a result of the interaction between each reader's current intentions and the affordances provided by the current text. Learning is viewed as an

active process in which students modify and reorganize knowledge while they are learning, rather than as a passive process where learners are viewed as receptacles of knowledge (Greeno, 1989). Hypertext in generative format affords students more opportunities to become actively involved with information than do non-interactive environments. These interactive environments also encourage the concept of "mindful engagement". Salomon et al. (1987, 1991) discussed that although computer tools offer a partnership with the potential of extending the user's intellectual performance, the degree to which this potential is realized greatly depends on the user's mindful engagement. The introduction of contrived problems can help focus or anchor learning in environments requiring large amounts of learner control, by constraining navigation toward those aspects of the hypermedia that are consistent with the posed problem. The potential benefits are mediated by learner goals for using the hypertext (Barab, Bowdish, Young & Owen, 1996; Barab, 1997).

Learner Control and Program Control

In spite of the theoretical appeal of hypertext learning environments, empirical findings yield mixed results with respect to the learning benefits of learner navigational control over programmed linear control of instruction (Goforth, 1994; Kinzie & Sullivan, 1989; Niemiec et al., 1996; Steinberg, 1989). Although some studies have found increased benefits of navigationally controlled instruction (Gray, 1987; Hannafin & Sullivan, 1996; Kinzie, Sullivan, & Berdel, 1988), others have found that students with high degrees of learner control performed less effectively than those receiving program control (Pollock & Sullivan, 1990; Ross & Rakow, 1981). When one examines these isolated studies, there appear to be results showing both advantages (Gray, 1987; Hannafin & Sullivan, 1996; Kinzie et al., 1988) and disadvantages (Pollock & Sullivan, 1990; Ross & Rakow, 1981) of learner navigational control opposed to programmed linear control. Lawless and Kulikowich (1996), examining hypermedia navigation as well as achievement and attitudinal measures, found that some students benefited from increased learner control while others appeared lost, confused, or even apathetic. Still others have credited differences to prior knowledge finding that increased learner control appears to be useful for more knowledgeable learners (Shyu & Brown, 1995).

With the development of multimedia technology and World Wide Web, computer-based non-linear text has been made multi-dimensional by including not only text-based information but also images, audio and video clips. Reading hypertext allows readers to interact with the text, to make decisions about both what information to access and sequencing of this information (Landow, 1992; Carver, Lehrer, Connell & Erickson, 1992). These features of hypertext have drawn much attention from both researchers and educators (Barab, Bowdish, & Lawless, 1997; Gall & Hannafin, 1994; Heller, 1990; Landow, 1992; Nielson, 1990; Spiro & Jehng, 1990) but little attention has been given to the other type of hypertext which is referred to as generative hypertext (Barab et al, in press; Young, Barab, & Wang, 1997) based on the works of Wittrock (1989). Unlike reading traditional hypertext, reading generative hypertext requires readers to adopt a more active role in reading and become readers/authors (Barab et al, in press & Young et al, 1997). This type of hypertext format not only allows learners to make decisions about what information to access, sequencing of information, and control the pace, but also to change the actual document by engaging in generative activities while reading, thereby creating their own unique text. This type of open-ended activity afforded by the generative hypertext can encourage readers to be more mindfully engaged. (Salomon & Globerson, 1987; Salomon, Perkins & Globerson 1991). Although the benefits of mindful engagement in learning are appealing, little empirical evidence is available for its effect in the context of computer-based generative hypertext.

Predicted on the research related to the advantages of providing students with a problem focus (Anderson et al., 1994, Barab, et al., 1996, CTGV, 1990) and advantages of instructing students to generate associations for text (Linden & Wittrock, 1981) we sought to test this in two separate experiments: First, when readers had a specific problem-solving goal in mind for reading and second when their goal was simply to comprehend the text in the context of preparing for a traditional test of reading comprehension. We designed a generative form of the Nigeria hypertext which provides two Navigational activities (Linear vs. Navigational) and two Generative activities (Generative vs. Non-generative) in this study. We were specifically interested in comparing students' problem solving and reading comprehension abilities when information about Nigeria was presented as: 1) Nigeria Hypertext in linear format; 2) Nigeria Hypertext in linear and generative format; 3) Nigeria Hypertext in navigational format; 4) Nigeria Hypertext in navigational and generative format. We hypothesized that generative activity would benefit reading comprehension due to their active processing while reading and navigational activity would benefit problem solving. We also hypothesized that linear condition would benefit reading comprehension while generative activity would benefit linear hypertext system.

In Experiment One, students were assigned one of the four conditions and expected to learn the information to solve a posed problem. In Experiment Two, students were assigned one of the four conditions with the expectation of learning the information to pass a reading comprehension test. Dependent measures included a questionnaire assessing students' problem-solving success (Experiment One) and reading comprehension (Experiment Two). Efficiency measure was calculated for both reading comprehension and problem solving scores to control time spent with the hypertext (dwell time) given previous findings demonstrating significant correlation's between dwell time on hypertext learning and outcome scores. Items of dependent measures were developed to address the issue of

achievement. Therefore, items were not measuring one particular construct. Specific research questions of this study are:

1. Were there any significant differences among the students assigned the Navigational conditions (linear vs. non-linear), Generative conditions (generative vs. non-generative) with respect to their problem solving scores? (Experiment One); and
2. Were there any significant differences among students assigned Navigational conditions (linear vs. navigational) and Generative conditions (generative vs. non-generative) with respect to their reading comprehension scores? (Experiment Two).

Experiment One

Methods

Participants

43 undergraduate students were recruited from a Northeast University. Before the experiment, each participant completed a consent form. All participants received two extra course points toward their course grade for their participation. Participants include 6 males and 37 females. They were randomly assigned to one of the four conditions.

Computerized Lesson

The instructional lesson used in this study was a social studies lesson about Nigeria which was modified from its previous version (Barab et al, in press) programmed using Hypercard™. The lesson was run under four conditions (linear vs. navigational, generative vs. non-generative) on Macintosh personal computers. This computerized lesson contains approximately 70 megabytes of information, including 25 single-spaced pages of textual information, 22 digitized images, and 5 digitized video clips. All the content is adapted from four high school textbooks, two articles from the Nigerian consulate, one articles from the journal *Face* (1998) and current information retrieved from the World Wide Web. All information has been reviewed for accuracy and completeness by two native Nigerians: a Nigerian graduate student majoring in African history and a Nigerian undergraduate majoring in Education. The content of the treatment material remained the same in all four conditions in both experiments. However, to establish a problem solving goal in experiment One participants viewed a short digitized video clip suggesting that there was an untreatable virus currently plaguing Nigeria. Although the area of Nigeria where the virus began was unknown, there was patient data available on six patients that could be used to determine the origin of the virus in hopes of locating the host and developing an antibody. However, these files only provide general descriptions of each patient's background that, when matched with the correct ethnic group, could be used to predict the area of Nigeria where the virus most likely originated. Some of the information was related to the patient profiles and can be used to predict the source of the virus, while other information was related to other aspects of Nigeria.

Problem Solving Score

A problem solving score was calculated from learners' determination of the ethnic group of all six patients and their inference that since four of the six patients were Hausa, the virus most likely began in the north of Nigeria where most Hausa people live. Students were given one point for each patient correctly identified and 2 points for the overall choice of North, where four of the six patients came from, with a total score of 8 points.

Procedure

All recruited participants were screened for students with high prior knowledge of Nigeria. Virtually nothing was known about Nigeria by all participants of this study. The control of prior knowledge was dropped out of the analysis. Treatment conditions were randomly assigned to participants in both experiments and they were told that the lesson was designed to help instructional designers to develop effective educational software and would take about 30 minutes. All participants were given a brief computer-based tutorial concerning the skills necessary to use the software. Participants were instructed to click on a particular button depending on which condition they were assigned. To pose a problem solving context, participants at this point watched digitized video clips in which the problem was introduced. While participants made navigational choices, the computer program generated a log file to maintain a continuous record of time they spent on each node, their navigational path, their personal journal notes, card headings generated, naming of geographical and ethnic maps. After completing the computer-based section of the experiment, students completed their problem-solving responses or a reading comprehension questionnaire depending on which experiment they were assigned. The log file data were examined to determine the total time each participant spent studying the lesson and was used to calculate efficiency measure to control for dwell time on the computerized lesson. The efficiency measures of reading comprehension and problem solving was calculated by summing up the number of correct answers divided by the total time and then multiplied by 1000 to give whole-number values.

Results

One participant was identified as a Native Nigerian and was dropped out of the analysis. The total number of participants in the study was 43. Randomized assignment was ensured by the design of the study, so the preliminary analyses focused on screening data to ensure the accuracy of data entry and evaluation of sample distribution, linearity and normality of the scales used in this study. No univariate outlier (standardized score > 2.5) was found after the evaluation of the statistical assumptions but the evaluation revealed non-normality of the outcome variable (problem solving efficiency score). Statistical transformation suggested by Tabachnick & Fidell (1996) was performed to stabilize the variance of the outcome variable.

The results of the Analysis of Variance disclosed that there was a significant difference between the two navigational activities (Linear vs. Navigational) with the navigational activity demonstrating superior problem solving efficiency score ($F=20.459$, $p < .001$). Although there was no significant difference between generative and non-generative conditions, there was a significant interaction among the navigational activities and the generative activities ($F=4.124$, $p < .05$), which indicates that generative activities interfered learners when they were given more freedom to navigate to solve a problem.

Experiment Two

Methods

Participants

44 undergraduate students were recruited from a Northeast Land Granted University in this study. Before the experiment, each participant completed a consent form. All participants received two extra course points toward their course grade for their participation. Participants include 12 females and 32 females. They were randomly assigned to one of the four conditions.

Computerized Lesson

The same instructional lesson used in this experiment as in Experiment One. However, instead of watching the video clip which was used to introduce the problem in Experiment One, participants were instructed to learn the information in preparation for a set of reading comprehension questions. All other information in the four conditions was identical.

Reading Comprehension Measure

The reading comprehension measure focused on factual information derived explicitly from the computerized lesson. The scale was designed to measure retention and recall of the factual information directly related to the social studies lesson. The Scale was composed of blank fill-in items with a total of 30 blanks. They were created from content that spans all the cards in the computerized social studies lesson and have been reviewed by a content expert (a high-school history teacher), two educational psychologists and one doctoral graduate student. Data collected from the previous study (Barab et al, in press) have been used to perform item analysis of the reading comprehension scale. Items that had a correct response rate above 95% or below 5% were removed, so the final pool of items is reduced to 22 items. The overall score for the reading comprehension measures were calculated by adding up the number of correct responses (29), with a maximum score of 29 points.

Procedure

Procedures were identical to Experiment One, except that after they completed the program they filled out a reading comprehension questionnaire. The log file data were examined to determine the total time each participant spent studying the lesson and was used to calculate efficiency measure to control for dwell time on the computerized lesson as discussed in Experiment One.

Results

One case was dropped out of the analysis because of incomplete data set due to computer program crash in the experiment. The total number of participants in the study was 44. Randomized assignment was ensured by the design of the study, so the preliminary analyses focused on screening data to ensure the accuracy of data entry and evaluation of sample distribution, linearity, and normality of the scales used in this study. The evaluation of the statistical assumptions found 1 univariate outlier (standardized score > 2.5). It was removed from the analysis. The evaluation also revealed non-normality of the outcome variable (reading comprehension efficiency score) statistical transformation suggested by Tabachnick & Fidell (1996) was performed to stabilize the variance of the outcome variable. The total cases included in the final analysis were 43.

The results of the Analysis of Variance revealed that there was a significant difference between the two Generative activities (Generative vs. Non-generative) with generative activities help improving reading comprehension significantly ($F=5.029$, $p < .05$). There was no significant difference between Navigational activities

(Navigational vs. Linear) while reading and no interaction term among the two navigation activities and two generative activities was found.

Discussion

The results of this study suggest that increased levels of learner control are beneficial when individuals are using a hypertext program to solve a specific problem. In this study, individuals who were free to navigate directly to those cards of information they deemed appropriate did significantly better at the problem-solving task than those who proceeded through the document in a linear manner. This finding is consistent with the findings in Barab et al's study (in press). While there was no significant difference between students assigned the Linear Non-generative Condition and Linear Generative Condition, students assigned Navigational Generative condition did not do well on problem solving comparing with those assigned Navigational Non-generative condition. This finding indicates that generative activities in general may benefit learning (reading comprehension) but may inhibit navigational hypertext when learners are engaged in problem solving. Generative activities may produce interference with respect to their navigational choice and sequencing of text. When navigating through the hypertext to solve a problem has already posed considerable difficulties, the addition of generative activities proves to be a distraction and an overwhelming burden in problem solving.

In contrast to the results of Experiment One on problem-solving scores, we found that students assigned the Generative condition outperformed those assigned the Non-generative condition. We had expected that individuals assigned the Linear condition would do better than those assigned the Navigational condition. While it was true, the analysis failed to reach a statistical significance level. A close look at the raw reading comprehension score (reading comprehension score before being converted into efficient score) revealed that learners assigned linear condition outperformed those assigned navigational condition ($F = 4.745$, $P < .05$). This finding indicates that when students' raw reading comprehension scores were converted into efficient score (raw score/dwell time), their dwell time wiped out most of the effect (see table 1 below). They had high reading comprehension score but were not efficient because they spend more time and therefore they reviewed significant number of facts.

Table 1. Means and Standard Deviations of Dwell Time and Raw Reading Comprehension Score by Students in the Two Conditions Using Hypertext for Reading Comprehension Test

CONDITIONS	Dwell Time (minutes)		Raw Score	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Linear Condition	36.89	12.52	20.02	4.91
Navigational Condition	28.18	11.87	16.44	5.04

Conclusion and Implications

In this study we examined students' problem solving and reading comprehension when using text in linear, navigational, linear generative or navigational generative hypertext system to solve a problem or to prepare for a reading comprehension test. The results support the driving force of learners' goals, whether implicit in the educational setting (e.g., studying for a test) or adopted from a contrived context (e.g., anchored instruction or problem-based learning), in co-determining the learning context. Understanding students' goals in turn explains the outcomes of instruction, the effects of instructional designs (e.g., learner control/program control). Further the study also provides empirical evidence regarding which formats may best be used to teach students problem solving and/or comprehension skills. For example, students with problem solving goals who used the Navigational hypertext system outperformed those students assigned the Linear conditions. However, when students had reading comprehension goals, students using Generative hypertext system outperformed those using Non-generative hypertext system. We did not find significant difference between linear and navigational activities with respect to reading comprehension, being a finding that could be attributed to the effect of dwell time. Although we are still not sure why generative activities did not benefit learning overall we did find that generative activities hurt learners when they were given more freedom to navigate to solve a posed problem.

Given the size and complexity of many hypertext environments that students are expected to use (e.g., the World Wide Web, CD-ROMs), it is imperative that educators consider the goals that students have for engaging in these environments. Educators exercise some control over the goals that students adopt by creating a context in which students read for a test or read to complete some performance-based assignment such as problem solving. In so doing, they must recognize that materials optimized for some goals (e.g., information search and retrieval) may be distracting and clumsy for others (e.g., reading comprehension). This is consistent with the theories of situated cognition and ecological psychology in which it is posited that different learner goals establish different learning contexts, which may or may not couple the learner and environment. While the literature on both generative activity and learner control does not lead to a clear conclusion regarding the usefulness of learner control as an instructional

strategy and generative activity as a format of hypertext, the explanation may lie in the goals that users adopt for learning. This study provided some empirical evidence that learner's goals must be understood to fully explain the interaction of student with instruction. This study found that learners in the Generative condition who had reading comprehension goal outperformed those assigned the Non-generative condition. Learners with problem-solving goals scored higher on a problem-solving measure than did learners with less control. Such a difference was true but was not significant when learners had reading comprehension goals. This finding is of interest; especially when their reading efficiency score is taken into consideration. Future research needs to continue to explore the interaction of goals and instructional context, especially with respect to the instructional activities that require more mindful engagement, such as reading comprehension test focus on inferential information rather than factual information.

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PROJECT-BASED LEARNING WITH THE WORLD WIDE WEB: A QUALITATIVE STUDY OF RESOURCE INTEGRATION

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Abstract

The purpose of this study was to investigate the process used by learners to direct, locate, and integrate information resources for use in a project-based environment. Four cases (N=9) were analyzed from an introductory educational technology course during a unit on telecommunications. Participants were asked to generate projects for integrating the Internet into the curriculum. Within this project-based context, learners searched for information resources that would accompany their project ideas. Three major findings related to use of hypermedia systems during project-based learning were discussed: (a) progressing from data-driven to goal-driven approaches were critical to developing a coherent project idea; (b) consolidating multiple information resources with proposed project methods and rationales was challenging for learners; and (c) metacognitive, domain, and system knowledge appear critical to achieving coherence in project development. Implications related to the role of instructional scaffolding in encouraging goal-driven and metacognitive processing during open-ended learning are considered.

Introduction

In the information age, it has become increasingly important for students to learn how to identify information needs, locate corresponding information resources, and integrate information from a variety of sources into cogent, productive uses (Moore, 1995). Such requirements represent radically different cognitive goals than are typically fostered in traditional classrooms – goals exemplified by teacher-centered or instruction-centered interactions that prescribe responses from learners. Externally-centered instructional methods, according to critics, fail to support meaningful generation of understanding (Jonassen, 1991) and fail to address the knowledge requirements of a rapidly expanding technological society (Hannafin & Land, 1997).

Yet, recently, much attention has been dedicated to diverse applications of technology that support active, student-centered learning. Contemporary theoretical perspectives have emerged that emphasize the centrality of the learner in exploring, manipulating, and generating understanding (Cognition and Technology Group at Vanderbilt, 1990; Spiro, Feltovich, Jacobson, & Coulson, 1991). Open-ended learning environments (OELEs) are learner-centered environments that facilitate the unique efforts of learners to generate and refine meaning (Hannafin, Hall, Land, & Hill, 1994). They represent a variety of approaches and technologies that enable learners to engage cognitively complex tasks that require critical thinking, self-direction, problem-solving, or meaningful integration of knowledge (Land & Hannafin, 1996).

Project-based learning is an approach to open-ended learning that encourages meaningful learning through student-directed investigation (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991). Students pursue solutions to open-ended problems by formulating questions for investigation, designing plans or proposals, collecting and analyzing information, and creating “artifacts” or products of their understanding (Blumenfeld et al., 1991). Project-based approaches satisfy two primary components: (a) learners generate a question or problem that serves to organize and drive learning needs; and (b) learners produce a final product or series of products to address the driving question/problem derived (Blumenfeld et al., 1991). Through extended investigation and experience with the problems under study, learners are presumed to identify knowledge needs, locate required resources to help them meet these needs, and integrate diverse information into coherent explanations or projects.

With project-based approaches, information resources, such as the World Wide Web, can play a critical role in the learning environment. In the process of working on projects, students require access to information. As students generate learning goals or problems, they seek new information when they find themselves unable to proceed without deepening understanding of what is already known (cf., Moore, 1995). Identifying and generating a “need to know” is assumed critical for meaningful integration of information. Organizing frameworks, such as student-generated problems or questions, are required for learners to focus, verify, and generate cohesion to the information retrieved (Hill & Hannafin, 1997; Moore, 1995).

Simply providing access to information does not guarantee if will be useful to students in generating and refining projects. That is, students might search vast databases of information, but fail to *use* this information to solve problems or deepen understanding. The process would be similar to searching for information with no purpose, intent, or reason. Without generating driving questions or learning goals, it is unlikely that retrieved information

would be meaningful to learners, since it would be isolated from a meaningful context (cf., Brown, Collins, & Duguid, 1988).

Yet, the process whereby learners generate information needs, search information resources, and integrate varied resources into a cohesive project is little understood. What is known, suggests that learners' level of processing is often poorly matched to the processing needs of information-rich OELEs. For example, previous research on student learning with OELEs indicates that learners often have difficulty generating unique learning goals and, instead, rely heavily upon external guidance to direct their activity (Land & Hannafin, 1997; Oliver, 1999). Furthermore, studies of learner use of the World Wide Web have indicated that students frequently fail to establish or alter task-relevant goals, and they show little evidence of engaging meaningful, reflective activity (Hill and Hannafin, 1997). Individual knowledge variables, such as metacognition, system knowledge, and prior domain knowledge have been shown to influence the extent to which learners productively seek, locate, and integrate information resources (Hill & Hannafin, 1997). Qualitative studies of children's use of information retrieval systems during project-based learning show that students often (a) fail to generate questions that extend from what is known; (b) are ineffective in using search terms; and (c) process accessed information as "answers," rather than as data for reflection and evaluation (Moore, 1995; Wallace & Kupperman, 1997).

Accordingly, the purpose of this research was to investigate the process used by learners to guide, locate, and integrate information resources for use in a project-based environment. Addressing this purpose requires insight into the unique intentions, actions, and sense-making processes of learners through out the learning process. The goals of this research were primarily descriptive in nature and were aimed at gaining a deeper understanding of the problems and processes experienced by learners in this endeavor.

The study examined the following questions:

1. What general strategies do participants use to guide their information seeking?
2. What is the role of system, domain, and metacognitive knowledge in locating web resources?
To what extent do students integrate web resources into a coherent project?

Method

Nine undergraduate pre-service teachers participated in the study. The participants were primarily attaining certification in early childhood and elementary education, although three were pursuing secondary English certification. They were enrolled in a required course, "Learning with Educational Technologies," and were awarded extra credit for participating in the study. Students were asked to generate project ideas for an instructional planning activity to integrate the Internet into the classroom. Within this project-based context, learners searched for information resources that would accompany their project ideas. The participants elected whether to work as groups or by themselves for the project. The groups and/or individuals were studied as separate cases and analyzed for similarities and differences by referencing an existing theory-based pattern (Yin, 1994).

Three primary techniques were used for data collection: Think-aloud protocols, videotaped observations of system use, and student-generated documentation (i.e., final project documentation and history lists of web usage). Data collection lasted four consecutive days. Each class period lasted approximately 2.5 hours. All interactions were videotaped, with the camera recording activities on the screen and audio recording student conversations. The instructor and another co-investigator were present during all class periods and continually circulated among the students to facilitate their learning.

Think-aloud protocols and observations of videotaped system events yielded foundation data for the analysis. Think-aloud protocols were transcribed and matched to videotaped observations of learner actions with the web. Data were collated according to each of three pre-defined research questions: Strategy use, information location, and coherence of project ideas (see for example, Merriam, 1988). Criteria were developed for each question, which were used to assign data (see Lincoln & Guba, 1985). For instance, isolated responses such as "maybe I should try another search engine," or "I need to find something on public schools on the web" were labeled as individual units (Ericsson & Simon, 1992). Both authors coded the data in order to achieve 100% agreement on the codes.

Findings and Implications

Question 1: General Strategies Associated with Information Seeking

This question examined the strategies used by participants to identify knowledge deficiencies, set learning goals, and seek information using the World Wide Web to generate and refine project ideas. Each protocol was coded for evidence of two categories of strategies:

1. data-driven strategies;
2. goal-driven strategies (adapted from Hmelo, in press).

Category 1: Data-driven strategies. Data-driven strategies involved inferring from the data (i.e., web resources) to possible project ideas or explanations for use of that data. Using this approach, participants identified broad subject areas, conducted a search, read information on the topic, and formulated ideas and questions *from* the web resources. During initial stages of project planning, all participants used data-driven strategies to explore possibilities for ideas. These strategies were most readily apparent in instances where participants conducted a search on a general topic (e.g., the state of California) and accessed a number of possible links from a given page (e.g., tourism in California) or list of search results. They would then “browse” the sites that appeared interesting in order to evaluate their usefulness. Janie, for instance, conducted a search to find sites affiliated with grocery stores for her project idea. She stated, “Let’s see if something about grocery stores is listed...[finds Groceries On-line link]. Let’s find out about this website.” She read the information, returned to the retrieved search list, and began exploring other grocery store links such as Food Lion and Shaw Supermarkets. The function of these searches was to focus ideas and to “see what is out there” before committing to a specific project idea.

Data-driven approaches were marked by interpretations of the significance of isolated data (e.g., a specific site accessed) independent of pre-defined and specific contexts for using them. Such approaches did not require deliberate search strategies as a means for finding information. Rather, participants identified broad topics, used general search terms (e.g., “travel”, “groceries”, “Shakespeare”) viewed “hit lists” of retrieved sites, and browsed through the sites in an effort to find ones that could be used for the project idea. Janie, for instance, would often browse through long lists of links, without specifying what she was trying to accomplish: “OK, I’m getting to the end of the list of 366 sites. And it’s always the last page ... that has the information you’re looking for...”

Participants who relied heavily on this approach characteristically sorted through many irrelevant sources that ultimately had little to no bearing on developing project ideas; instead, they engaged in tangential inquiry of web resources without a clear “anchor” or context for directing the search task. While data-driven reasoning was common among all cases during initial stages of project formulation, two cases relied heavily upon data-driven strategies throughout the entire project (Case 3: Janie, and Case 4: [Desi, Nell, and Opal]). Their reliance on external data as the driving force for ideas often led to problems in locating information and in discerning how information could be useful. In turn, this often led to frustration, inefficiency in information retrieval, and the use of frequent statements such as “We’re just not finding anything.”

Yet, use of data-driven strategies sometimes resulted in serendipitous findings that led the participants in new directions for their project ideas. For instance, when browsing the EduStock site, Kara and Tammy found a stock market simulator that enabled real-time, simulated buying and selling of stocks. They incorporated this feature into their project idea, which prior to finding this site, was more vague and disconnected (“We’re going to do something with the stock market”). Similarly, Tammy noted that the stock market is in the process of converting from decimals to fractions. She noted, “We can integrate more math skills, since the kids will need to convert.” Their project ideas were formulated and expanded based upon the identification of resources and tools that they did not intentionally access for use in the project.

Similarly, when Janie was browsing grocery store sites for cost comparison data, she found a link to a supermarket chain in Hong Kong. She said, “a Web site from Hong Kong I can go grocery shopping on. So, we get to expand our project to include different countries. . . it has its prices in their currency. Boy my kids are going to have to do some big time conversions.” In both of these examples, the participants had not previously considered these ideas, and they were able to identify resources and consider alternatives for using them. Use of data-driven strategies led to expansion of possibilities for the web project, in that the search space was not constrained by requirements for specific forms, or purposes, of data.

Category 2: Goal-driven strategies. With goal-driven approaches, participants sought information in the context of a goal, hypothesis, or question. Such strategies required a judgment regarding what information was desired, prior to knowing what information was available. When searching, participants considered the kinds of web resources that were needed, bearing in mind both the project focus and resource needs, rather than collecting isolated sets of web resources. Goals for information-seeking were inextricably tied to learner hypotheses and/or “needs to know” for the project idea. A major function was validating or testing the viability of project ideas.

Goal-driven approaches represented strategic, directed intentions to access specific sites or information. The purpose of these goals was to confirm that specific information was accessible in order to apply it to the project idea. These strategies were most obvious in cases where the learner(s) were looking for a specific site or piece of information. To illustrate, Case 1 participants proposed a project for elementary students to learn geography by planning a virtual vacation. They identified the State of California as a possible place to visit. Accordingly, Jill suggested, “Let’s see if we can get a Disneyland [site] to come up. Because if we can’t find it, the kids won’t be able to access it.” They continued these types of directed searches for airline and rental car prices, gasoline prices, maps of the areas, and so on. The purpose of these searches was to determine whether or not the idea was viable using web resources. If they were unable to access the information and/or find it useful, it was unlikely that their students would benefit from the activity. Finding and validating the usefulness of specific sites or ideas assisted participants in expanding or filling in the details of their project ideas.

Use of goal-driven strategies required a focus that helped participants to limit the search space and to filter relevant from irrelevant information. When participants approached the search task from the perspective of confirming a hypothesis, they were able to apply the retrieved information to solve a problem that was relevant to their project idea. For instance, Case 1 (Jack, Jane, & Jill) were looking for sites that their students could use to plan and budget a virtual family vacation. Jane commented, "We also have to figure out gas prices. It's got to be more expensive at different [geographic] locations." Formulating this hypothesis led the group to investigate gasoline prices in different states across the United States. The information retrieved was then useful for helping them to evaluate their project focus and consider the problem stipulations that would be relevant to their future students.

Similarly, Case 2 (Tammy and Kara) considered a project idea for their students to use on-line, simulated investment portfolios as a means to pay for college. When looking for information on tuition costs at the University of Oklahoma website, Tammy noted: "This tells us all of the fees per/credit hour. So, an Ivy League school would cost a lot more. We could [look up cost information for different schools] and give them a choice between attending a community college, OU, or an [Ivy League] School." Following up on this hypothesis about differential cost structures enabled them to find information that established another dimension of complexity to their project. When search strategies were driven by hypotheses, the accessed information did not remain isolated and discrete; rather, it was situated within an applied context (Brown et al., 1988); in this case, the project context that was generated by the participants.

Question 2: Knowledge Sources for Retrieving Information from the WWW

Question one examined the general strategies used by participants to define the information they wanted to retrieve from the Web for use in the project. Question two extends from this question to examine how successful participants were in actually *retrieving* or locating this information. Three sources of knowledge influence successful retrieval of information: (1) system knowledge (and use of search terms); (2) the role of domain knowledge in locating information; and (3) metacognitive knowledge of how to monitor and revise search techniques (Hill & Hannafin, 1997). It is important to note that all three categories of system, metacognitive, and domain knowledge operate simultaneously to influence successful retrieval of information. Yet, for the purposes of distinguishing their respective influences, they will be treated separately in the reporting of results.

System knowledge. Participants typically retrieved information from the web by using search engines, search engine indexes, and/or known URLs that were typed into the "go to" field. When participants were already aware of sites or features available on the Web, they were successful in locating them and assigning a use for them in the project. For instance, Jack from Case 1 [trip-planning topic], was already aware of many sites on the Web that could be useful for their project. He noted, "There is a deal on Yahoo that can help you make maps. We can have the students use this to make maps of where they will go. [The map tool on Yahoo] will tell them how long it will take to [travel to their destination] and will help keep them realistic." In this instance, awareness of features available on the web and a purpose for how they could be used helped Case 1 successfully locate needed resources for their project.

Whereas system knowledge of how to use these search features was critical for locating information, it was also clear that the way in which questions were asked influenced the search terms defined which influenced subsequent retrieval. For example, Janie, who reported to be an experienced Web user, continued to use vague, broad search terms like "schools" and "web". When she encountered hundreds of retrieved sites, she proceeded to systematically browse through all the abstracts related to those sites, stating that the best one will surely be found on the last page of abstracts. Standard Boolean operators were not typically used by Janie to refine or narrow the scope of a search. Consequently, she frequently reported being frustrated at failing to find useful sites. In one critical instance, Janie neglected to use the bookmark feature to store sites of interest to her. When she wanted to return to these sites on the second day, she spent almost 2 hours searching for them (unsuccessfully).

Case 4 (Desi, Nell, and Opal) experienced similar difficulties with identifying and using focused search terms. In one interaction, Desi remarked: "We're trying to find information on history. I'm trying to think of how we could...word it. Because we're not wanting what happened to Shakespeare, we're wanting what happened in general history, right? Just try searching for "16th century."

The vague nature of the search terms used by Case 4 was common throughout their web searching. Consequently, they found little information of use to them and frequently remarked they nothing was available on the web on "history." Throughout the entire period in which they worked on the project, Case 4 failed to delineate the aspects of Shakespeare's life or works that would be the focus of the project. Nor did they define a specific historical event or artistic influence that was considered relevant to his writing. Consequently, they used equally ambiguous search terms such as "17th century" or "Shakespeare history" in an effort to retrieve poorly specified information.

Domain knowledge of the topic under investigation. Learner domain knowledge has been found to be a critical factor for both developing instructional contexts and for locating information in hypermedia information systems (Hill & Hannafin, 1997). Making meaning from new knowledge is largely influenced by the extent to which it is connected to existing knowledge (Brown, Bransford, Ferrara, & Campione, 1983). In this study, we

found that limitations in domain knowledge were difficult to overcome in an ill-structured information system where inquiry-based searches were required. To illustrate, many of the problems experienced by Case 4 in finding information seemed to be driven by a lack of domain knowledge about the time period and historical events associated with Shakespeare's writing. In some instances, their questions were based on misunderstandings or inaccurate subject knowledge, and they were often unaware of such misunderstandings. This led to a snowball effect of frustrations, since they then had difficulty finding information and failed to consider that their initial assumptions were inaccurate.

In other instances, however, Case 4 occasionally found (and learned about) information that triggered awareness of their misunderstandings. For instance, after two days of unsuccessful browsing about history and Shakespeare, they stumbled upon a site that provided information regarding the reign of Elizabeth I. Nell noted, "If we look up Elizabeth I, that would tell us the history there, and what was going on when he was [in England] because it says that his writing got gloomier during that time."

Similarly, Case 4 had misunderstandings regarding the time period in which Shakespeare was writing, and consequently used inaccurate search terms. During day 2, the group searched for historical information on the Middle Ages. Later, they saw a title on a search index entitled "The Renaissance and the Globe Theater". Nell noted, "Renaissance! That is why all of this Middle Ages stuff was not coming up. So let's look up Renaissance now." These instances illustrate how lack of domain knowledge seriously hindered the extent to which participants could productively find relevant information on the Web. However, it also appears that participants *can* use an information system such as the Web to recognize limitations in knowledge and to use what is learned as the basis for further investigation.

In contrast, Case 1 experienced few problems with locating relevant information. We believe that this was due, in part, to the fact that all members of this group had well-established schemata for trip planning and were thus able to draw upon this knowledge to ask questions and use search terms effectively. For instance, Jack commented, "We haven't looked at [websites] for airline tickets and car rentals. Go to Hertz.com." Later, they used the Yahoo Travelocity site for students to investigate prices for airline reservations. In this instance, prior knowledge and experience with trip planning (as well as system knowledge of what was available at Yahoo and the Hertz car rental home page) made locating relevant information productive for this group. Prior domain knowledge, then, was critical for identifying a "need to know" and for then using search terms and indexes to retrieve the needed information.

Metacognitive Knowledge. Metacognitive knowledge is often characterized as consisting of three interrelated components: (a) awareness of one's own cognition and the degree to which one's cognitive efforts are successful; (b) knowledge about the different cognitive demands of different learning tasks, and (c) procedural knowledge of strategies to employ when the status quo is not successful (Garner and Alexander, 1987; Moore, 1995). In the context of our study, metacognitive knowledge refers to the process of reflecting on, or monitoring the effectiveness of the search process and then refining the process when necessary. Previous research on use of the World Wide Web found that metacognitive knowledge was critical for participants "to reflect on their search processes, refine their actions, and make better use of the system" (Hill & Hannafin, 1997, p. 56). Participants with low metacognitive knowledge often used unproductive search strategies and failed to monitor and alter those strategies when necessary (Hill & Hannafin, 1997).

All four of our cases demonstrated some reflection and monitoring. At some point, the participants in each case reflected on the effectiveness of their search strategies; in three of the cases, the participants acknowledged that their search efforts were not fruitful. However, as we discuss below, our data demonstrate that awareness alone does not constitute a sufficient condition for metacognitive knowledge. The role of learner metacognitive knowledge in locating desired resources was apparent in instances where participants refined search terms and strategies when needed. Case 1, for instance, often evaluated the limitations of the accessed information and re-focused their search efforts to narrow the type of information retrieved. Using the WWW to effectively locate information requires key components of metacognition -- continual monitoring of learning activities and goals, and an awareness of instances when plans are inconsistent with outcomes.

Case 2 (Tammy and Kara) also relied on metacognition to re-direct the search process. While searching for performance data on the company Kimberly Clark from the EduStock site, they found a website that they initially hoped would provide this information. Instead, the website was irrelevant for their project. Tammy noted, "This website gives me a ton of stuff. But, I want [a web page about] the company Kimberly Clark. I'm sure they have their own web page." She then revised her search, using a Yahoo index and found the home page for the company.

Effective location of information from the WWW seems to require the following: (a) awareness of the form and purpose of information desired; (b) awareness of whether the accessed information matches the desired information (i.e., filter relevant from irrelevant information); and (c) awareness of how to refine search terms and strategies in order to produce effective results. Not all participants used these processes, however, and those who did not experienced difficulties in accessing desired information. For instance, Case 4 was searching for poorly specified information for their Shakespeare project (i.e., world events associated with the time of his writing). When

they recognized that the information accessed did not match what they wanted, they failed to refine either their search goals or their search strategies. Their main problem seemed to be that they never identified what information they actually wanted. Without clear criteria for relevancy, they were unable to effectively sort through what they found. They repeatedly entered the same search terms, often switching search engines, with equally unproductive results. In most instances, changing search engines appeared to be an ineffective strategy for refining a search. The failure of some participants to recognize the ineffective outcomes of this strategy seemed often to be related to inadequate system knowledge. They did not know what else they could do when their known and preferred strategies were limited.

For Case 4, the failure to demonstrate metacognitive knowledge concerning search results seemed explained by inadequate domain knowledge, in addition to insufficient system knowledge. In fact, based on three of our cases, we might infer that effective metacognition depends on adequate knowledge in the other two areas. For example, the two cases that seemed to demonstrate low metacognitive knowledge, Case 3 (Janie) and 4 (Opal, Nell and Desi), were also cases in which other knowledge was low and the goal for searching remained ill defined. Case 1 demonstrated high metacognitive knowledge and also demonstrated high system and domain knowledge. By contrast, however, Case 2 (Tammy and Kara) also demonstrated high metacognitive knowledge but had only novice level system knowledge and low domain knowledge (their domain was the stock market). What seemed to separate Case 2 from both Case 3 and 4 was their continual monitoring of the search process in light of their evolving goal. The following exchange captures how they engaged in this process.

Tammy: This is forecasting college costs. They can come to this site.

Kara: So are we still doing the stock thing? Incorporating both or changing?

Tammy: This is why they are doing the stock market. You need to go to college and figure out how much it costs you, you need to go out and figure how to invest to make this much money so you can plan for college

Kara: That's a good idea; point for making money. That makes sense.

For Case 2, metacognition was seemingly able to compensate for low domain and moderate system knowledge. For Cases 3 and 4, the benefits of their metacognitive processing seemed to be limited by the absence of well-defined project ideas or even search goals. Although they engaged in some reflection and monitoring, they lacked clear criteria for relevancy through out the project. Therefore, their monitoring attempts resulted in frustration rather than progress.

Question 3: Evidence for Developing Coherence

The third question provides a means for summarizing the efforts of the four groups in terms of the integration of their project ideas and search results into a coherent project. We defined coherence as the extent to which project methods and resources were consistent with stated purposes. We approached this question in two ways. First, we examined the protocol data for instances of cohesion or processing that suggested the projects were headed toward cohesion. Then, we examined the project write-ups for evidence of coherence.

The examination of the protocol data revealed two broad categories: fragmentation and consolidation. Fragmentation occurred when participants failed to evaluate the usefulness of web resources in light of their project idea. So, when participants were engaged in data-driven searches, fragmentation was common. As the project developed, and searching became more goal driven, most participants consolidated their ideas *and* web resources into a functionally bound instructional activity. This process involved a discarding and evolving of ideas that could be actualized using identified web resources. Participants went through several iterations of integrating ideas and accessed web sites in an attempt to stabilize the overall project idea. The process required them to step back and integrate the activity that will be posed to their students, clarify the reasons for their decisions, evaluate them in light of project requirements, and determine how use of the web fits into the process. This was a difficult process for all cases and, as a result, they all occasionally experienced frustration and confusion. Although all cases achieved some level of consolidation, both cases 3 and 4 were less successful than 1 and 2, and showed more evidence of fragmentation than coherency.

Persistent Fragmentation. Janie (Case 3) began with an idea about having students (grades 2 or 3) research local prices of groceries and compare them with prices in different areas of the country (later she expanded to other countries, but went back to just the US in her final project). As she began exploring the web, she realized she could structure the activity in several ways: (1) by asking students to use on-line advertisements for grocery prices for different areas of the country; (2) by having students communicate via e-mail with other students in different parts of the country regarding grocery prices; and (3) by using tools such as cost of living comparisons to help explain the reasons for the differences. While using the Web, she focused almost exclusively on one alternative at a time: finding sites for collaboration with schools *or* finding sites for cost of living comparisons *or* finding on-line grocery sites. Fitting the pieces together was challenging for Janie, and she seldom stepped back to grapple with the whole picture.

Janie's write-up of her project reflected her fragmentation. She first stated that the objective of her project was for students to find out the cost of foods around the country and why the costs are so different. However, she later stated, "I really don't know how to give them an answer to "why?" but only to allow them to understand and realize that not all things are the same as where they live." In other words, she never quite integrated her project ideas. Her Web resources included: (a) e-mail contacts with classes around the country; (b) sites for looking up prices for favorite foods around the country; and (c) several sites for cost of living comparisons. The relationships between these three resources were never made clear.

Case 4 also demonstrated many instances of fragmentation. Desi et al. spent most of their time inefficiently searching for sites on the art and history associated with the time period when Shakespeare was writing. When they found a site on Renaissance Fair Garb, Nell noted, "Perfect. So each group is going to specialize in an area. They will each have to come up with a costume. Everyone will dress up and bring food..." Desi replied, "Now I'm confused. I thought it was going to be about what would make Shakespeare more understandable to them." Nell, "well, they will have to study a passage anyway, so have them perform it. They will already be dressed up."

After two days of searching for world events and art associated with Shakespeare's time, Nell noted, "Why don't we just [change] our project. They don't necessarily need to know the art. Art had no influence on history. Art didn't really influence Shakespeare." Desi interrupted, and requested that they change the focus, "[our students] will have to read Beowulf. So, let's go for it." Opal asked, "So what is our point with Beowulf?" Desi replied, "we want them to understand the culture. It's a hunter and gatherer kind of society." Nell said, "We can just change everything we have for Shakespeare and apply it to Beowulf. To understand it, you also have to have an overall comprehension of the culture." After further discussion, Opal finally suggested a move toward consolidation, "let's just scrap all of that and focus on the comprehension of the play itself. We found all of those sites that break down the language and they can go into those chatrooms and discuss with those other people the questions they have about the play, and see if they can find out through those rooms and e-mails, the perspectives of other people and their interpretations of the play."

Unfortunately, Case 4 had only rare moments when they moved toward consolidation. Their project write-up demonstrated considerable fragmentation. They stated that their objective was to make learning of Shakespeare more meaningful than the traditional teacher-directed approach. In examining their project, it became evident that their main struggle throughout this study was not knowing how to operationalize that goal using Web resources. They ended up including three categories of Web resources: (a) numerous sites about Shakespeare's life and times; (b) sites for criticism; (c) sites for chat rooms about his works. The main requirement for their students would be to develop a Web page that included excerpts from an (unspecified) play translated into modern language along and other information of their choice about Shakespeare. The purpose of each of the tasks implied by the resources was not clear, nor were the relationships among the resources and the tasks made clear. Additionally, two of the three resource categories were for information on Shakespeare that could be found in one or two books.

Successful Consolidation and Integration of Project ideas, Project Requirements, and Information Sources.

Unlike Cases 3 and 4, Case 1 (Jack, Jane, & Jill) demonstrated considerable consolidation early on in the work on their project. They chose a travel-related topic that would require students to use the Web primarily to gather extensive information to plan a vacation itinerary. Once they identified a specific sub-topic (e.g., car rental rates), they searched for Web sites consistent with the topic, then noted the URL. When consolidating ideas and available resources, they often discounted options or simplified the structure and scope of their project to keep it manageable. For instance, when grappling with the question of student autonomy in choosing vacation destinations, Jill said "so do we want to leave it completely up to them, or give them a scenario such as you're going to California?" Jack replied, "It might be easier to say you're going to California." Jill went on to explain, "it would be easier on them, but also on us, because we would know what were are looking for in grading this." She explained to one of the instructors that "verifying" students' work would require such structure. Although the group failed to consider varied notions of teaching that would entail alternative evaluation techniques in this instance, they did move toward further consolidation.

Their project write-up also showed evidence of consolidation. They wrote that the purpose of their project was to involve students in an authentic learning task that would require them to integrate their knowledge of geography, math, language arts, etc. to plan a vacation using the Internet. Students would choose from three vacation planning scenarios that stipulated the state, the total budget, time frame, and number of family members. Students would have to use those constraints to plan: how they will get there; where they will stay; what/where they will eat; how they will get around; and what they will do for entertainment. They identified three categories of web sites for their students to use: (a) mapping; (b) travel agencies; and (c) state tourist information. They clearly articulated how these categories would be needed. The plan was to help their students get started with a few good sites, then turn it over to them.

The extent to which participants were successful consolidating the web resources into a coherent project was largely dependent on whether or not their metacognitive processing involved articulation of a project goal and monitoring of search progress in light of that goal. Although Tammy and Kara (Case 2) took longer than Jack et al.

(Case 1) to articulate their final project goal, they were just as successful in developing a coherent project. Case 2 needed to engage in more negotiation of what the project would entail since Kara was inclined toward direct teaching methods while Tammy was in favor of creating a more student-directed, open learning environment. This negotiation process seemed to encourage their consolidation processing.

The written report developed by Case 2 provided strong evidence for a coherent project. Interestingly, Tammy and Kara included the fewest number of web resources. In addition to the EduStock site, they anticipated their students would want to access the financial profiles of favorite companies and might want to explore an on-line Investment Club to get a feel for the language used by investors. Much of the information their students would need was available within the EduStock site. It provided some general information on the stock market, allowed for monitoring the performance of companies on the stock market, and included a program for simulating investment in companies one chooses. Although Case 2's project would require the least amount of web searching for future students, relative to the projects of the other three cases, it clearly would require the highest level of cognitive effort and complex problem solving on the part of their future students.

Conclusions

The study uncovered several prominent findings with implications for understanding how learners generate and evolve project ideas while using the Web. All students were able to generate a project in an open-ended, problem-based environment using an information technology. Although they experienced some difficulty and frustration during the process, they nonetheless all achieved adequate success to meet their course requirements and they all developed in their sophistication of using the Web. Yet, three findings are particularly noteworthy.

First, learners needed to move beyond data-driven processes and become more goal driven in order to efficiently progress toward a coherent project idea. All groups experienced difficulty in the process of consolidating their web project ideas with class project requirements and with the vast number of accessed web resources and tools. However, learners who identified specific goals and project ideas up front, and then used the web to find resources consistent with the identified activity, achieved more coherence. Participants whose final projects did not reflect substantial coherence tended to rely on data driven strategies and rarely evaluated how web resources fit into their project idea. The protocols from the two more successful cases showed constant monitoring of the fit between resources located and the intent of the project. Even while the intent of the project was still evolving, Case 1 and 2 participants were simultaneously evaluating the web resources and the current project idea.

Second, all learners went through several iterations of integrating ideas and accessed web sites in an attempt to stabilize the overall project idea. The process required learners to step back and integrate the activity that will be posed to their students, clarify the reasons for their decisions, evaluate them in light of project requirements, and determine how use of the web fits into the process. This was a difficult process for learners, and they occasionally experienced frustration and confusion as a result. This is at least in part due to the fact that most students had difficulty recognizing limitations in their thinking about how to use and conceptualize the Web as a tool for learning. In addition, many students seemed motivated to protect their initial conceptions of both learning and the Web, despite ongoing evidence that their searching was not leading toward clarification of their projects.

Third, all three sources of knowledge were essential for project development that was both efficient and free of frustration. Metacognitive knowledge was especially important for consolidation processing and often seemed dependent on the system and domain knowledge. Only one case seemed to be able to compensate for a lack of system and domain knowledge through their use of metacognitive knowledge. This implies that increased instructional scaffolding will be necessary for students using the Web in situations where they are novices in regard to the system and the domain being studied. Future research should examine how instructional scaffolding might encourage more goal driven and metacognitive processing in open learning environments that involve the Web. Our results suggest that such scaffolding may enable students to achieve greater coherency and experience less frustration.

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MAXIMIZING BANDWIDTH: GUIDANCE FOR THE DESIGN OF NETWORKED INSTRUCTION

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Abstract

To fully exploit the power and potential of web-based instruction, on-line course developers must confront and creatively deal with the limits imposed by bandwidth capacity. Increasing the rate of data delivery will most certainly become a technological possibility, however, the media-rich software environments offered via the Internet can force end-users to consume bandwidth at rates that surpass its availability. To deal with this challenge, a series of design strategies are presented that allow instructional developers to maximize the effectiveness of online materials while efficiently utilizing available network resources.

The movement of distance education to the desktop computer reflects the growing demand for instruction that is time and place independent. The convergence of audio, video, text and graphics in a networked, readily accessible virtual space has prompted a variety of instructional packaging solutions, from asynchronous text-based interactions to real-time desktop videoconferencing, enhanced by a never-ending array of peripherals such as electronic whiteboards and application sharing capabilities. While room-based videoconferencing also continues to grow in popularity, web-based instruction extends the reach of traditional distance education to locations and hours beyond such systems. Learners with an Internet connection can participate in coursework at their convenience without having to go to a given location at a designated time, the constraints imposed by two-way large group conferencing (Moore & Lockee, 1999b).

While networked instruction to the desktop offers a variety of possibilities for course delivery, it is not without flaw. Slow download time, delayed audio and jerky video images are the result of such a system's primary limitation--bandwidth. As distance educators seek to leverage the power of desktop computing for distributed learning; bandwidth places constraints on potentialities by placing a limit on the information transfer capabilities of various teaching technologies. Providers encounter challenges maximizing the instructional potential of this confined resource. Unfortunately, the task is not always easy; as distance educators often inherit a media infrastructure, and typically are not in a position to increase the physical capability of their systems. Instead they must choose appropriate instructional and media attributes that are effective and yet use bandwidth wisely. Different instructional strategies require different levels of bandwidth. The physical infrastructure of available bandwidth places constraints on the possibilities, but a course designer has complete flexibility working under that ceiling (Lockee, Moore, & Moore, in press; Moore & Lockee, 1999a; Moore & Lockee, 1999b).

While networked instruction to the desktop offers a variety of possibilities for training delivery, it is not without flaw. Slow download time, delayed audio and jerky video images are the result of such a system's primary limitation—bandwidth. To put it simply, bandwidth places a limit on what can occur at any particular time throughout the instructional event. As the demands on local and global networks soar, so will the quest for solutions to bandwidth constraints.

The Interaction of Bandwidth and Instruction

Bandwidth is a volume measure of information flow. On a digital network it is the number of bits that can be transported in a given period of time. Digital networks are composed of a number of components that may include a sender's computer, a connection from the sender's computer to a router(s), a connection from the router(s) to the receiver's computer, and finally, the receiver's computer. The slowest link in that path will define the system's available bandwidth. When planning network use, one should keep in mind that effective bandwidth is determined by the weakest link in a system (Moore & Lockee, 1999b).

Instructional design theories recommend that instruction be designed before media is chosen (Smith & Ragan, 1999). Unfortunately, in the practice of computer-based training programs such procedures are rarely possible. In many organizations, the pervasiveness of the Internet has made the web a default delivery media. Currently, distance education course developers must have knowledge of the network over which instruction will be delivered and its capabilities and limitations in order to make important instructional development decisions. Whether creating instruction for delivery over a privately owned intranet or via the globally accessible Internet, the

instructional designer must have knowledge of strategies, trends, and trade-offs in bandwidth consumption is essential to produce courseware that is both technically and instructionally effective (Moore & Lockee, 1999a).

Bandwidth Management Strategies

Bandwidth brings logistics into instructional design simply because successful instruction may be compromised if instructional materials are delivered at a rate at which learners are incapable of consuming them. Learner attention, motivation, and comprehension may suffer when participants are forced to continually wait for an instructional event to occur. Fortunately, instructional developers have a number of strategies for eliminating or reducing these delays. These strategies can be organized into the following categories. *Pre-distribution* strategies attempt to overcome delays by delivering instructional materials and images in advance of the instructional event. *Parsing* strategies emphasize designing materials according to their instructional essence in order to remove extraneous information and data. *Choreographic* strategies attempt to present instructional materials at a rate equal to the rate at which they are consumed (Lockee et al., in press).

Pre-distribution strategies

Pre-distribution strategies are techniques that assist in the avoidance of bandwidth bottlenecks by distributing data through other means. Strategic use of alternative media such as print materials, CD-ROMs and videotapes can dramatically increase the volume of instructional materials to which learners have access while reducing demands on the delivery network. This technique has been called a “hybrid approach” (Douglas, 1993) to distance education because it incorporates the instructional strengths of a variety of teaching technologies. However, traditional distribution routes are required for this strategy to have a successful impact. Also, these tools have the disadvantage of having to be developed or purchased well in advance of the instructional event. To produce these materials a number of skills and equipment may be required. Perhaps most important in using these tools is the ability to evaluate commercial or previously created instructional materials.

Pre-distribution strategies have the disadvantage of increasing the planning time of an online course in order to carry out the logistics of traditional materials delivery (library checkout, postal service, etc.). However, pre-distribution has the advantage of encouraging pre-planning and creating contingency plans.

Parsing strategies

A brief look at many web-based training sites reveals that a large percentage of the web site components are extraneous to instructional goals, such as the inclusion of images for aesthetic purposes. By eliminating web site content that is aesthetic but not instructional, relevant data throughput can be maximized.

The next step is to reduce unnecessary data within instructional content. Training developers must ask themselves what media attributes are essential to the facilitation of learning. For example, is animation needed to convey a process or will a series of still photographs serve the same purpose? The advantages of doing so are functional as well as monetary. Providing information through text instead of a video clip of a talking head is equally effective and consumes only a small portion of bandwidth compared to digital video.

Choreography strategies

The final web-based delivery strategy is called choreographic because it deals with the order in which training is delivered. Images and other media that are data intensive can be strategically interspersed with text. A large volume of text can be transmitted relative to images. In terms of data, text delivers more content than an equivalent amount of data in an image. While students are reading textual material images can be downloaded and be ready to be examined once the text has been consumed. This strategy may make the educational experience seamless and the delays imposed by bandwidth may not be noticed. A similar strategy is often used at amusement parks. Many rides require a long wait. Many parks are now using this wait time to prepare the audience for the experience by showing background videos and other contextual information. The same can be done in an online environment. Secondary presentation forms that augment the instructional message can be included when a data heavy image is required.

Conclusion

In a distributed learning environment, the delivery network infrastructure must be considered so that instructional developers can avoid creating instruction that diverts a learner’s attention because of unnecessary delays (Moore & Lockee, 1999a). While the above strategies can be implemented to utilize bandwidth more efficiently, it is important to remember a point well-made by (Cohen & Rustad, 1998), that “technology should function as a tool for learning, not as the blueprint that drives the learning agenda” (1998, p. 32). The wise use of these bandwidth strategies increases control over the learning event while reducing the influence the delivery media has on instructional goals and objectives.

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Abstract

Recent exponential growth in the field of distance education has unfortunately not been matched with equal growth in a quality research base in terms of informing effective practice. In their 1996 analysis of the distance education literature, McIsaac & Gunawardena state that "much research has taken the form of program evaluation, descriptions of individual programs, brief case studies, institutional surveys and speculative reports" (1996, p. 421). In the past few years, a particular form of study regarding the effectiveness of distance learning has enjoyed increased publication. Instructional technology professionals will recognize the methodology behind these reports as the media comparison study, newly revived for use in a distance education setting. Media comparison studies have historically formed the basis of much research in distance education (McIsaac & Gunawardena, 1996; Schlosser & Anderson, 1994), but are lately becoming even more common. These studies are predictably plagued with the same design issues as their predecessors, however their "no difference" outcomes are being reported for politically different reasons. This paper details the origins of the media comparison study, its current use as an evaluation instrument in distance education, and recommendations for more stringent discrimination between research and evaluation in the field of distance learning.

History of research in instructional technology

Since the adoption of modern media for instructional purposes, innumerable attempts have been made to measure the effect that a given technology has on student achievement. Early in the history of electronic technologies like film and radio, educational researchers were driven to demonstrate that these revolutionary devices had a positive impact on learning (Saettler, 1968). The most common approach to attempt this investigation was the “media comparison” study, so named because of its strategy of comparing the learning outcomes of an experimental group receiving instructional content via one medium against the outcomes of a control group receiving the same content through a different medium. The most popular control group was the “traditional”, or lecture format class, with the instructor serving as the delivery medium. Even though comparison studies were fairly simple in design, variations of the research strategy exist. Most maintained the “media” as the independent variable, but some used the same instructional method (e.g., presentation via live lecture vs. presentation via videotape of the same lecture) while others utilized different instructional methods and different media (presentation via lecture vs. problem solving via computer-based instruction) (Ross & Morrison, 1996).

The use of media comparison studies dates back to the origins of mediated instruction. Early researchers in audiovisual education worked diligently to control all aspects of such experiments so that results would maintain validity and comparisons would be fair. For example, McClusky & McClusky produced a “Comparison of six modes of presentation of subject matter”. Two trial experiments were conducted comparing six methods of presentation for the content depicted in two separate lessons: film only, slides with subtitles only, photographic pictures with subtitles only, and each medium with a supplemental question and answer session. Experiments were carefully controlled so participants viewed slide and print images for exactly the same time as such images appeared in the film. Recall of content was measured for each group using multiple-choice tests. The outcomes reflect some of the earliest evidence of what Russell (1997) calls the non-significant difference (NSD) phenomenon: “These comparisons show such inconsistent results that the film, slide, and print appear to possess no distinct advantage one over the other as far as these particular experiments are concerned” (Russell, 1997, p. 257). And, as history repeats itself, the tendency was to try this research design with the advent of any newer technological innovation, with consistent production of the same non-significant results.

In 1983, Richard Clark, one of the most renowned critics of instructional technology research, detailed the problems inherent in media comparison studies and the improper assumptions about their outcomes. He stated that “these findings were incorrectly offered as evidence that different media were ‘equally effective’ as conventional means in promoting learning. No significant difference results simply suggest that changes in outcome scores did not result from any systematic differences in the treatments compared” (Clark, 1983, p. 447). Clark emphasized that media are merely the delivery mechanisms for instructional content and do not impact the learning process. This perspective spurred great debate within the field of instructional technology (Clark, 1994a; 1994b; Kozma, 1991; 1994a; 1994b; Jonassen, Campbell, & Davidson, 1994; Morrison, 1994; Reiser, 1994; Shrock, 1994; Tennyson,

1994). While some contend that certain attributes of media can and do effect learning outcomes (Kozma, 1991; 1994a, 1994b), Clark maintains that it is instructional method that influences learning, not the delivery medium (Clark, 1983; 1994a; 1994b). While this debate will undoubtedly continue, the futility of comparison studies to measure the impact of media on learning is consistently recognized in the field of instructional technology (Ross & Morrison, 1996). A chronological collection of hundreds of such experiments can be found at <http://www2.ncsu.edu/oit/nsdsplit.htm> (Russell, 1997). The database serves as a reminder to researchers that comparative designs will continue to provide predictable, non-significant outcomes.

While the tendency is to compare learning outcomes via different media is to demonstrate the greater effectiveness of the newer medium, distance education comparison studies have given the argument a new twist. As evidenced in the following examples, the outcomes are now used to demonstrate that the distance-delivered instructional event is at least equal to the campus-based, face-to-face version. Kanner, Runyon, & Desiderato (1958) espoused this approach in less optimistic terms when summarizing their televised instruction research by stating that televised sessions were no more detrimental to classroom learning than face-to-face instruction.

Recent research in distance learning

As anyone involved in the support of distance education programming is aware, the resources required to deliver such programming to geographically and temporally dispersed learners are not inconsequential. Though cost-saving goals are often highlighted in plans for reaching new and different student markets, the front-end investments needed in course development, delivery infrastructures, teaching technologies, and support staff can be formidable (Keegan, 1996; Musial & Kampmueller, 1996). In analyzing the use of distance program evaluation data, Thorpe (1988) explains that administrators venturing into this new educational arena are expectedly anxious to use positive evaluation results to promote the desirable aspects of providing opportunities for remote student clientele. Increased access to such programming does not seem to serve as a satisfactory benefit for the implementation of distance education efforts. Stakeholders desire to demonstrate that participants in distance-delivered courses receive the same quality of instruction off-campus as those involved in the “traditional” classroom setting. What better way to determine the equality of experiences than to compare student achievement between the two groups? For example, according to Newlands & McLean (1996) “The calming of fears about the quality of distance learning has been assisted by evidence that, in terms of assessment, distance students perform as well as internal students...” (p. 289). One of the most prominent early works in teleconferencing training, *Bridging the Distance* (Monson, 1978), employs a collection of comparison studies for this very reason—to ensure soon-to-be distance educators that off-campus students will be just as academically successful as their campus-bound counterparts.

The guaranteed validation of equality of learner achievement has led to use of comparison studies about distance education in almost every imaginable discipline. The research design remains exactly the same as previously compared mediated experiences, the on-campus students serve as the control group, since their experience is unmediated, while the distant students provide the treatment group. For example, “The 38 South Carolina campus students, considered the control group in this report, completed either all or the majority of their degree programs in traditional classroom settings on the Columbia campus” (Douglas, 1996, p. 878). Repeatedly, outcomes are embodied in statements like “there was no real difference between grades of in-class and ITV students” (Fox, 1996, p. 362). Some authors offer additional analysis such as, “There were no differences between pre-and post-tests (which measure increases in knowledge) across sites. This demonstrates that the program was effective in increasing knowledge...” (Reiss, Cameon, Matthews, & Shenkman, 1996, p. 350). Behind conclusions such as these is the conviction that distance learners are engaged in an equally rigorous instructional experience even though they are not participating in campus-based education. General unawareness of the history of instructional technology research, especially the out-dated notion of the effectiveness of comparison studies, is exemplified in a recent sociology journal through the following excerpt:

Of greatest concern to us is the absence of well-crafted comparison studies, that examine not simply student attitudes towards distance learning, but the actual knowledge and skills that students acquire from televised teaching. Ideally, this demonstration could involve the same instructor teaching two sections of the same course during the same school term, one exclusively by live instruction and the other only by distance learning (Thyer, Polk, & Gaudin, 1997, p. 367).

Instructional technology research journals are not exempt from the publication of such studies. In a 1996 issue of *Educational Technology Research & Development*, Whetzel, Felker, and Williams began their article “A Real World Comparison of the Effectiveness of Satellite Training and Classroom Training” with an analysis of research regarding the effectiveness of televised instruction, summing up the mixed results by re-stating Clark’s (1994) view that “...any necessary teaching method can be delivered by many media with similar learning results (Whetzel, Felker, & Williams, 1996, p. 6). However, their study used a research design that compared the achievement of the on-site versus distant students:

For the two courses in which satellite and classroom training were compared, an analysis of covariance (ANCOVA) was used to compare delivery modes for nonequivalent groups (satellite and classroom participants), using pretest score as the covariate and posttest score as the dependent variable (Whetzel et al., 1996, p. 10).

The use of media comparison studies in distance learning is not limited to higher education settings. Barry & Runyan (1995) assembled a "Review of Distance Education Studies in the U.S. Military" in which they cited eight "empirical studies that compared student achievement in distance learning courses to achievement in comparable resident courses" (p. 43). Their closing statement embraced the reliable non-significant difference results as proof that the U.S. military could safely continue to invest in the expansion of distance learning initiatives. Due to the expanded publication of studies like these, a distinction must be made between valid research in distance education and evaluation efforts for distance program confirmation.

Methodology analysis

Although we often use the terms interchangeably, as we have noted earlier, evaluation and research are not the same although they may share many methods.

Evaluation is practical and concerned with how to improve a product or whether to buy and use a product. Studies that compare one program or media against another are primarily evaluation. Evaluations seek to find the programs that "work" more cheaply, efficiently, quickly, effectively, etc.

Research, on the other hand tends to be more concerned with testing theoretical concepts and constructs or with attempting to isolate variables to observe their contributions to a process or outcome (Moore, Myers, & Burton, 1994, p. 35)

Research studies generate hypotheses from theory. In the case of so called "hard" sciences such as physics, these predictions are usually a quantitative point value, magnitude, or form function which become point predictions (Meehl, 1967). Point predictions become easier to refute as measurement improves, that is, the better the measurement the more the hypothesis is exposed to rejection. (Indeed many replications involve changes in measures rather than "study" conditions). Rejection, in the case of a point prediction, is a *modus tollens* refutation (i.e. T \rightarrow E, not E, therefore not T) (Popper, 1968). Research in the "soft" sciences however, does not, indeed cannot, test point predictions. Rather, the logical complement of the predicted outcome, the point-null hypothesis (there is *no* difference between, for example, two groups of participant's mean scores) is tested. Interestingly, the effect of this manipulation is that the theoretically derived hypothesis is not subjected to true *modus tollens* – it cannot be *logically* refuted (Meehl, 1967). The null hypothesis can be accepted but not embraced as true, yet it's acceptance does not refute the core hypothesis (Orey, Garrison, & Burton, 1989). For this reason (among others such as the "loose" connection between theory and variables), it is often the case that "soft" science researchers commonly speculate about what could have occurred when the null is accepted. Such *post hoc* speculation is permissible because the core hypothesis cannot be truly refuted. Such theories never actually die, researchers just sort of "...lose interest in the thing and pursue other endeavors" (Meehl, 1978, p. 807). Theory-based research studies are not good candidates to be "repurposed" as "negative" evidence that something didn't happen.

A "second level" problem relates to what Reeves (1993, 1995) among others has referred to as pseudoscience. Reeves offers nine characteristics of pseudoscientific studies and estimates that perhaps 60% - 70% of "empirical-quantitative" studies in the major instructional technology research journals suffer from two or more of these flaws. The bulk of these weaknesses such as failing to link the study to a robust theory, poor literature review, weak treatment implementation, measurement flaws, inadequate sample size, and poor analyses (Reeves, 1993; 1995)) bias the research towards *not* finding a statistically significant difference (Burton & Magliaro, 1988). In other words, bad science and bad designs can produce no differences.

The last two comments relate to both theoretical and evaluation comparative studies. The first comment is that when we test a hypothesis, we test not just the variable of interest, we also test the assumption of *ceteris paribus* (all things are assumed to be equal except for those conditions that are actually manipulated) (Orey et al., 1989). It is in fact a "folk" version of *ceteris paribus* which researchers often resort to when they explain the failure to find a predicted statistically significant difference by resorting to differences in the sample or task that were outside of what was being manipulated. To the extent that *ceteris paribus* is not true, the results of the study (in either "direction") are suspect. With test such as ANOVA and ANCOVA, this relates to the assumption of homogeneity of variance. This assumption is often not tested because the tests are assumed to be robust to such violations (Thompson, 1993). Unfortunately, it does not appear to be true with ANCOVA (see, e.g. Keppel & Zedeck, 1989) and may not be true of ANOVA either (e.g. Wilcox, Charlin, & Thompson, 1986).

Second, in research or evaluation, measurement is a problem. Faulty measurement was another of Reeves' (1993, 1995) indicators of pseudoscience but in evaluation, particularly as it relates to "real world" educational contexts such as found in distance or distributed education, the problem is often more insidious. The burden of showing reliability and validity for any test not in general use is always upon the researcher (Burton & Magliaro, 1988). Many studies related to distance learning use "teacher-made achievement tests" which may, or may not have

reliabilities or validities established. Perhaps worse than using a test which produces scores which are largely error or unrelated to the content however, is the fact that such tests are often used a part of a graded exercise. Graded exercises may cause people who tend to make A's and B's simply work harder to overcome any problem in the instruction. The potential lack of adequate tests are measurement problems. The potential difference in effort are violations of *ceteris paribus*.

In terms of statistics, many current researchers have argued that null hypothesis testing should be eliminated altogether (e.g. Carver, 1993) while others such as Thompson (1996) and Robinson & Levin (1997) would like to see such tests supplemented. Although there are differences, both camps tend to agree on two things: effect size and replication. Effect sizes should always be reported according to Thompson (1996) but, as Levin (1993) points out "to talk of effect sizes in the face of results that are not statistically significant does not make sense" (p. 379)

Replication refers to repeating essentially the same experiment multiple times. No finding should ever stand on a single study. It is worth noting however, that while some believe that such experiments can inform social science theory (e.g. Phillips, 1992), others (e.g. Salomon, 1991) believe that no matter how well constructed experimental and similar research approaches are, "they are based on a number of assumptions, none of which fit the study of whole classroom cultures" (p.13). We assume this would include distant classrooms and distributed cultures.

Finally we offer the following caveat related to accepting NSD studies as proof. Establishing a null is very much like the not guilty assumption of the US legal system. In both cases, the burden of proof is on overturning the assumption based on evidence. But failure to reject the null hypothesis means just that and nothing more; just as a legal finding of not guilty does not mean innocent. As Carver (1978) puts it:

What is the probability of obtaining a dead person given that the person was hanged? Obviously, it is very high, perhaps .97 or higher. Now, let us reverse the question. What is the probability that a person has been hanged, given that the person is dead? This time the probability will undoubtedly be very low, perhaps .01 or lower. No one would be likely to make the mistake of substituting the first estimate (.97) for the second (.01); that is to accept (.97) that a person has been hanged given that the person is dead. Even though this seems an unlikely mistake, it is exactly the kind of mistake that is made with interpretations of statistical significance testing (pp. 384 – 385).

Evaluation versus Research in Distance Education

While it may have been the intent of the investigators of comparison studies cited herein to create generalizable findings, the motivation behind the studies were most likely to obtain information about the success of local distance education programs. Appropriate uses of media comparisons for distance program evaluation are detailed as follows, as well as alternative methods and exemplary models.

Evaluation in distance education

Program evaluations in education frequently look to achievement as a measure of success, and sometimes through the use of comparison studies as an evaluation method. Smith & Glass (1987) call such inquiries comparative evaluations, as the studies assess the effectiveness of a product or program by pitting it against an alternative product or program that is designed to meet the same needs. However, such comparisons work best if the treatment group and control group are similar in identity and can be randomly assigned (Fitz-Gibbon & Morris, 1978), which is usually not the case in distance education. Participants in higher education distributed courses are typically non-traditional learners who cannot attend class at the originating institution, hence their enrollment in distance programs. Not only are these students different demographically, but they also possess other characteristics which vary from traditional college attendees, such as prior knowledge and experience and level of motivation (Verduin & Clark, 1991). In any case, if comparative evaluations can be designed to represent comparable groups of learners, the results of such studies must be published as local findings instead of generalizable contributions to the theoretical base of distance education.

Although student achievement is one common measure of distance program success, Keegan (1996), Holmberg (1989), and Thorpe (1988) recommend that program evaluators collect and report a number of other types of data to give the most exhaustive description of a distance education program. Saveyne & Box (1995) suggest the collection of information with regard to instructional design, participant attitudes (student and instructor), and implementation issues, such as technical quality, student support, etc. Keegan (1996) proposes a four-point evaluation scheme for distance programs which assesses 1) the quantity of learning achieved such as the number of new students served, attrition rates, time to program completion, etc.; 2) the quality of learning achieved measured by the effectiveness of the program in facilitating desired learning outcomes; 3) the status of the learning achieved indicated by the transferability of program coursework, recognition of degrees by employers or graduate institutions; and 4) the relative cost of the learning achieved acquired through the analysis of the cost-efficiency of distance programs relative to conventional programs, as well as the cost benefits of the distance program versus traditional programs (1996, pp.186-188). The case studies provided by Keegan (1996) are mindful examples of distance program evaluations, as they provide a thorough portrayal of program efforts through analysis of the aforementioned indicators. Another effective distance evaluation model can be found in the Flashlight Project (Ehrmann, 1994), an

effort by the Annenberg/Center for Public Broadcasting to help institutions of higher education assess their uses of instructional technology for distributed learning. If the intentions of investigators are to determine the effectiveness of distance education programs, these evaluation reports serve as exemplars due to their comprehensive approach.

Research in distance education

Those involved in the design, development, and implementation of distance education programs have access to a wealth of data from which to conduct valid research. For a summary of the existing literature base in distance education, see McIsaac & Gunawardena (1996) and Schlosser & Anderson (1994). Interestingly, both pieces highlight the need to move away from the continued use of media comparison studies toward more productive lines of inquiry. If researchers are driven to investigate the effects of delivery media, perhaps they will heed Reeves' (1995) advice and design instructional technology studies that will indeed improve education. Examples of research that have served to inform the development of effective distance learning experiences can be seen in Garrison (1990) and Gunawardena, Campbell Gibson, Dean, Dillon, & Hessmiller (1994). Garrison (1990) analyzed the ability of audioconferencing to provide necessary levels of interaction for feedback as well as for student satisfaction. Distance delivery media also afford varied levels of social presence, as found by Gunawardena, et al. (1994). Knowing how media convey information and allow individuals to interact are important considerations in the design of distance programming. Indeed, more researchers should leverage their involvement in distance education experiences to contribute to the knowledge base of the field. McIsaac and Gunawardena (1996) indicate that what is needed is "rich qualitative information or programmatic experimental research that would lead to the testing of research hypotheses" (p. 421). While determining the efficacy of distance programs is important to all stakeholders, investigators must ensure that such inquiries begin with valid questions and that the intentions behind the study are well-defined. Concurrently, it is equally important that editors of professional journals also distinguish between research and evaluation in distance education and communicate that distinction to the authors of their manuscripts.

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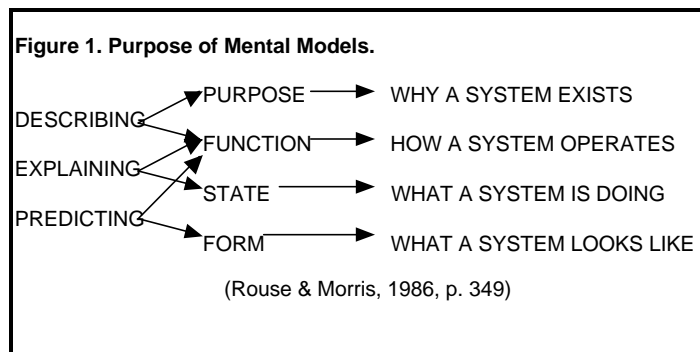
STUDENT MODEL CONSTRUCTION :AN INTERACTIVE STRATEGY FOR MENTAL MODELS LEARNING

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Introduction

A “mental model” is a knowledge structure, composed of concepts and the relations between them (Jonassen, Beissner & Yacci, 1993; Shavelson, 1974). A mental model is a systemic type of learning outcome - it is a system of information, concepts, and relationships between them. When people have a mental model of a system, be it a judicial system or a washing machine, they know its components and how the components affect one another.

A mental model is a learning outcome distinct from declarative and procedural knowledge (Jonassen & Tessmer, 1996), going beyond semantic relationships and skills acquisition to systemic understanding. Building on the theory base that information in memory is encoded in and retrieved from a structure that preserves meaning, theorists posit mental models as powerful engines for higher order cognitive processes. If learners have a mental model of a device or system, the model enables them to solve problems, generate inferences, and make predictions about the system that is modeled (Johnson-Laird, 1983; Wilson & Rutherford, 1989). Figure 1 models some of those functions.



Rouse and Morris’ work with troubleshooting and mental models would suggest another function of mental models learning: predicting what is wrong with a system (diagnosing).

There are at least three important implications of mental model research that should be considered by instructional designers. First, learners form mental models, whether the designer takes that fact into account or not, and inaccurate models can impede learning (Carroll & Thomas, 1982; Rouse & Morris, 1986; Norman, 1983). Second, troubleshooting performance (a type of problem solving) can be facilitated through construction of mental models (Gentner & Gentner, 1983; Rouse & Morris, 1986; Lesgold, 1986; Mayer, 1989; Rodgers, Rutherford, & Bibby, 1992; Downey, 1996). Structured knowledge has been found to be a powerful predictor of the ability to apply content knowledge to solve problems (Gomez, Hadfield, & Housner, 1996; Cormier & Hagman, 1987).

Finally, research on expert knowledge representation indicates that structural knowledge is essential to expert performance (Chi & Glaser, 1984; Larkin, McDermott, Simon, & Simon, 1980). Tardieu, Erlich, & Gyselinck, (1992), for example, found no difference between expert and novices at the propositional level of memory, but significant differences at the mental model level. That is, there was little difference in the amount of domain knowledge that each group possessed, but there were differences in the way that knowledge was organized. Although the expert must have a sufficient knowledge base to draw upon, if it is not expertly structured, it is of little advantage.

Mental Models Instructional Strategies

For years, Richard Mayer (1984,1997) has explored methods for teaching students a mental model of a simple system such as a brake system, pump, or weather system. In general, his research has indicated that graphic-textual representations of mental models are more effective than textual descriptions (Mayer & Sims, 1994), and that animated graphical representations are more effective than static ones (Mayer, 1997). His measures of mental model performance are transfer of learning, inference and problem solving.

Mayer’s instructional methods, as well as that of other researchers such as Kieras and Gentner, focus upon learners as observers of a model, not as constructors of it. At most, learners may manipulate variables in the model to observe the effects of their interaction (e.g., increasing the resistance in a circuit model to observe the effects on the system).

Consequent with the learning theories of constructivism (Savery & Duffy, 1996) and constructionism (Kafai, 1997), we believe that mental models may best be learned when the learner has an opportunity to build the model, not just observe it. Research into computer-based learning indicates that learners understand and retain information better when they interact with it in ways that encourage elaboration, inference, or other forms of meaningful learning (Hannafin & Peck, 1987). In other words, building a model may be more effective than studying a model, whether static or animated.

The theoretical assumption behind this model building strategy is that:

Someone who acquires a mental model of a system acquires an understanding of the components of a system and their relation to one another. This includes an understanding of the function of the component and its effect on other components.

From a constructivist and constructionist perspective, a learner can best acquire this mental model by personally constructing the model - by connecting the concrete components and their abstract relations

The model construction task must be scaffolded by access to cues and information, but must not show the model itself. The most effective learning strategy involves students inferring the place and function of system components. This building task forces students to reflect on the function of the component and its effect (relationship) on neighboring components.

Mental model learning acquisition is best measured by three related measures: troubleshooting diagnosis, troubleshooting solution, and prediction of change of state. All three measures can be used for abstract systems (e.g. judicial system) as well as concrete ones (pump, carburetor).

Prototype of the Instructional Strategy

To explore the thesis that mental model construction can be an effective instructional strategy for mental models learning, we constructed a prototype that embodies this approach. The mental model to be learned is the Internet, meaning the student should learn the components of the Internet, their functions, and their relationships to one another. To do this students must learn to place the components of the Internet in their proper places, and assemble the proper functions of each component. For example, students should learn the function of a modem, how it depends on its preceding component (the computer) for a signal, and how it transmits the modem signal to the next component (the telephone). This model-assembly module was constructed as a CBT module, using Authorware authoring software. Learners must build the model from its disassembled parts, and must assemble the functions of the parts as well (Figure 1). The module contains instructions on how to use the system, the model itself, and test for acquisition of the mental model. We then tested the module with a group of learners.

Prototype Test

Subjects

A group of 43 subjects participated in a pilot test in November 1999. All subjects were students in the first author's undergraduate *Introduction to Computers* evening course in a community college in southeastern Texas. The pilot test was held during week 13 of a 17-week course.

Method

All students were informed at the beginning of class that the instruction for that session would be delivered by a computer animation. They were also advised that the instructor wished to collect anonymous data on their interaction with the computer animation as a pilot test for his dissertation project. They were further advised that their participation in the data collection was strictly voluntary, and that if they did not wish to participate in data collection they could exercise that option by not inserting the data disk into their computer prior to starting the instruction. All students elected to participate in the anonymous data collection.

Materials

Materials for the pilot test consisted of

1. the model-assembly module, which had been copied to the hard drive of each computer prior to the start of class;
2. a diskette containing a folder for the model-assembly module to write data into;
3. a brief paper-and-pencil background survey (age, sex, do you use a computer at home or work, do you use the Internet at home or work) ; and
3. a brief quiz with items requiring the student to infer causes of malfunctions, identify system components, and infer system functions.

Procedure

Students were instructed to double-click the icon for the model-assembly module to open it, and to go no further until the instructor had confirmed that all had been opened successfully. At this point a random number generator in the Authorware module had assigned each subject to either the control group or the treatment group;

thus, assignment to groups was double-blind. When the instructor confirmed that all modules had opened properly, the students were told to proceed in accordance with the instructions they saw on their screens.

Both the control group and the treatment group went through two computer-based activities: an instructional activity and a reassembly activity. In the instructional activity the control group observed the model assemble itself by clicking on a Continue button as each component of the model was explained. Clicking caused the component to go to its assigned place and the next element of instruction to appear. The treatment group saw identical components and instruction, but were required to drag each component to its correct location; if they dragged to the wrong location, the component snapped back to its start position, and the target spot was highlighted to facilitate a second try.

In the reassembly activity both groups saw identical screens. The components were scattered around the edge of the screen, and the students were instructed to drag each component to its correct location; the locations were consecutively numbered to indicate both location and sequence. As each component was “dropped,” the software wrote to the diskette file the component name, the time, and whether the attempt was right or wrong. When all 19 components had been correctly placed, the module moved automatically to the final screen, which advised the student to click on File, Quit to end the program and await further instruction. Data written to the diskette file were: elapsed time in the reassembly event, number of correct tries, number of incorrect tries, and the date and time.

Students were then given the paper-and-pencil instruments and asked to read the file number from their diskettes (the random number generated at the outset), write that number on the first page of the questions, and answer the questions.

Results

The reassembly task was a recall test, requiring the student to remember the basic location of the components. The quiz consisted of 7 items requiring the student to infer causes of malfunctions, identify system components, and infer system functions. The scores on the paper-and-pencil instrument and the number of wrong placements in the reassembly activity were compared using a pooled t-test and an ANOVA in Data Desk. Both tests produced identical results:

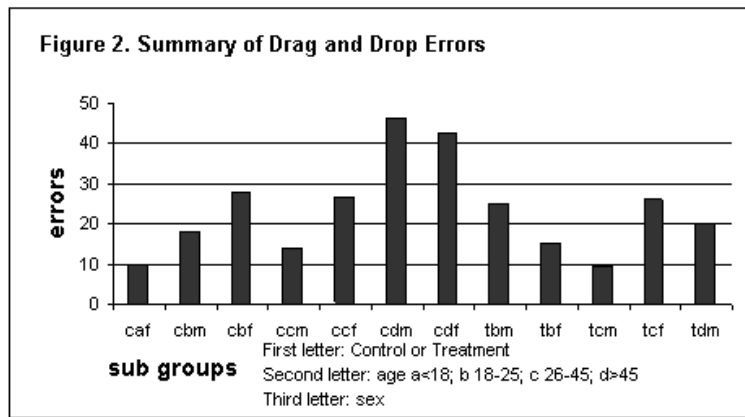
			Control	Treatment
Drag and drop errors p=0.79	n	25		18
	M		23.68	22.17
	SD		17.42	14.87
Quiz correct p=0.59	n	23		16
	M		5.0	5.25
	SD		1.45	1.34

The most significant data from this pilot study was the instructor’s observation of several students during the reassembly activity repeatedly dragging a component to the same wrong spot. The students apparently did not understand that the failure of the component to snap into place indicated it was being dragged to the wrong location. The expressions on their faces clearly showed frustration (as opposed to indifference or vagabonding). Response to this phenomenon is discussed below under Conclusion and Future Plans.

The students self reported the following in the Background Survey:

Age <18: 1, 18-25: 17, 26-45: 15, >45: 6
Sex f:17, m: 23
Use computer at home – yes: 34, no: 5
Use Internet at home or work – yes: 25 no:14
(n from the paper-and-pencil instruments is lower than 43 because of failure to complete portions of the instrument and 1 case of a student misreporting the random number from the diskette.)

The chart below illustrates an interesting result in scores on errors in placement of components. The over 45 age segment of the control group had clearly higher error totals than any other group. This part of the results



was not tested for statistical significance; however, in the Background Survey 5 of 6 responded yes on using a computer at home or office, and 3 of 6 responded yes on using the Internet at home or office.

Conclusions and Future Plans

The data suggest some better grasp of the model within the treatment group, although the observed errors in the drag-and-drop tasks likely account for several high error scores in both groups in the reassembly task. This failure to understand the nature of the drag-and-drop tasks must be addressed as the first priority. To this end an additional activity has been placed between the instruction activity and the reassembly activity to demonstrate how to drag-and-drop and to emphasize that the movement of a component back to its start position means that it was dropped at the wrong location.

The data show apparently significant differences between age groups and between males and females within age groups. These results suggest the desirability of using age and sex as covariates in future studies.

This pilot study did not attempt to assess structural knowledge. Future studies will include structural knowledge comparisons between novices and experts using Pathfinder techniques.

The Background Survey, Comprehension Test, and Pathfinder data collections will all be put into the Authorware module so that data collection will be further streamlined and the data itself will be entirely contained on a single diskette. Having all the data written directly to disk as it is generated will eliminate logistical distractions from the experiment and will facilitate conducting the experiment.

The participants in the pilot study generally indicated satisfaction with the instructional material in post-experiment, informal conversations. They were intrigued by the Authorware product and were eager to learn more about the Internet. Their attitude suggests a positive level of receptivity to both the computer-based method and the reassembly activity within it. This augurs well for further studies.

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PINNING THE CORNERS: USING SCENARIOS IN INSTRUCTIONAL DESIGN

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“Our use of old words to describe new things can often hide the emerging future from our eyes”

Charles Handy.

Introduction

This work came out of the practice of day to day consultative instructional design. Dealing with uncertainty in communicating with clients and within the design team can create management headaches, and lead to unsuccessful projects. Stone and Villachica (1997), discuss the increasing organizational risks of instructional design efforts, as the size and scope of instructional design (ID) efforts increase. Instructional designers are also being asked to develop projects that are increasingly complex, and developed in increasingly short timeframes (Stone & Villachica, 1997).

Mixed into this difficult environment is the increasingly specialized language of both the consultant and the client, and technological complexity. These factors combine to create an environment where miscommunication between client and consultant is more likely and less tolerated.

Fourth generation instructional systems design (ISD) models advocate an iterative prototyping regime in the development of instructional design projects. Scenarios can be used as one level of prototype, and can create possibilities for learning and increased communication. Uncertainty in instructional design efforts is a given. Scenarios are a tool to pin the corners of uncertainty that allow designers to find a robust solution.

What are Scenarios?

In a strategic planning context, scenarios are narratives of structurally different futures to help guide strategic conversation and organizational learning (Van Der Heijden, 1996). In the context of instructional design, however, the use of scenarios is on a tactical level, not a strategic one. Strategic conversations and the wider scope of discussion should take place before and not during the instructional design process begins.

When used on a tactical level, scenarios are narratives that describe structurally and functionally different approaches to solving a given problem. There are several important points in this definition.

Scenarios are narrative to make the abstract concrete. “End users seldom know what they want until they see it” (Stone and Villachica, 1997. P. 6). Most users are not instructional design experts, if they were they wouldn’t need to hire us. They know they have a problem, and believe that an expert in instructional design can help them solve it. By providing clients with stories of how the intervention will be used within their organization, IDs can help all parties define the scope and nature of the problem and proposed solution.

The narratives that compose the different scenarios, however, must be structurally and functionally different from each other to present a range of options to the client. Because clients don’t know what they want until they see it, designers must present a range of possibilities for the client to see. Structural differences stem from differences of theory or approach. Is the intervention constructivist or traditional? Is it performance oriented or learning oriented? Functional differences stem from both media and organizational contexts. Is it paper based, or computer based? Who uses it? How often?

Instructional Models and Scenarios

The use of scenarios in strategic planning represents an important shift from a rational approach to one that is process based (Van Der Heijden, 1996). The rational paradigm of strategic planning is a linear model that results in a probabilistic point forecast. Process models are evolutionary and iterative. Taking their cue from biology, rather than physics, process models adapt the solution to fill an organizational niche.

The rational model of strategic planning has striking parallels to earlier models of instructional design. The rationalist school assumes predictability, clear intentions, separation of thought and action, full understanding and rationality of human behavior (Mintzberg, 1990). Early models of instructional design assume predictability of the learner and the design process, clear learning goals stated in advance, analysis before design and development, clear communication between client and designers, and a certain rationality in the learning process.

Experience with increasingly complex projects, however, shows where these assumptions have failed, creating a crisis of design. People are rarely predictable, the goals of a project are almost never clearly stated in advance, analysis bleeds into design and development, and communication between designers and clients is rife with uncertainty.

Fourth generation models attempt to address these shortcomings (Tennyson & Foshay, 1995). They utilize iteration and overlapping design phases to great effect, creating efficiencies within the design process. They model

an evolutionary learning process that adapts the intervention as new information becomes available. Fourth generation process models assume a changing, uncertain solution space. Scenarios are a tool for rapidly prototyping multiple solution plans in an ISD effort in an environment of uncertainty and change.

Using Scenarios in the ID process

Scenarios fit in any iterative design process when there is uncertainty, either on the design side or the client side. Pinning the corners of uncertainty create a potential solution space. Within that space may lie several near optimal solutions. The challenge of design is to find the highest possible peak.

The scenario development process can basically be broken into three major steps:

1. Define the problem
2. Create a scenario matrix
4. Write scenario narratives

An example

A medium sized school district has contracted with your instructional design group to help them build a district wide information system. The district's technology plan calls for an integrated information system that will facilitate communication between teachers, administrators and parents. Beyond that, the district also needs to integrate standards based education using the state frameworks.

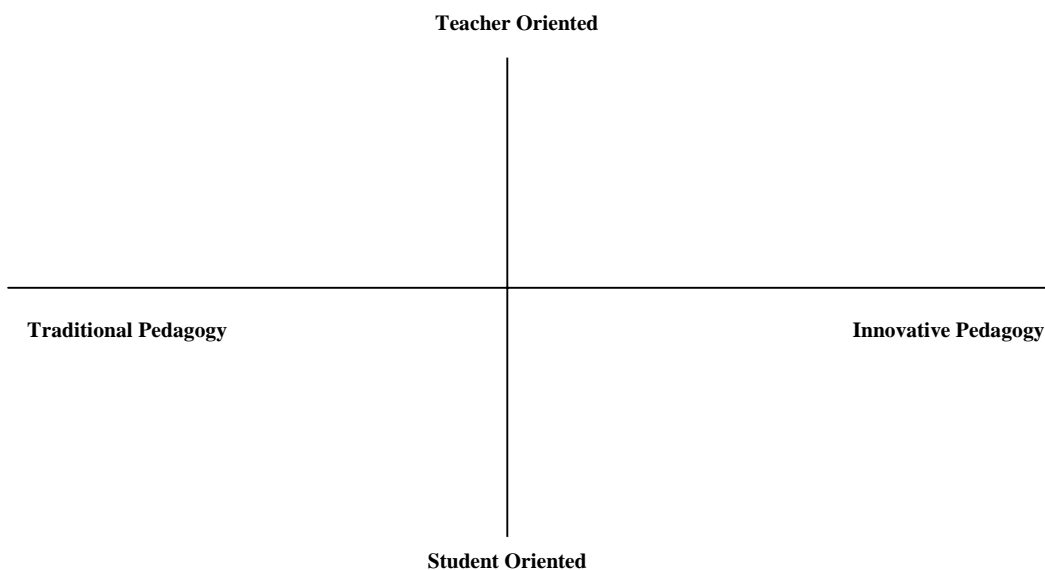
The superintendent and the district technology coordinator both know they want something different from the packaged solutions offered by the vendors. Most of the solutions are inflexible, and don't integrate all of the district's requirements. The trouble is, they don't know exactly what they want.

After meeting with the district's team, you and your group meet in the conference room in your office. There are many possible solutions to the problem. The district is rapidly expanding its physical network infrastructure, so there is a lot of potential.

Your team looks at the possibilities and decides there are several uncertainties that will effect the design of the system. The first question they have is whether the system is intended to be used primarily by students, or by teachers. The second question the design team has relates to the district's plans for innovative pedagogy. Expected change in pedagogy will greatly impact the scope of the system.

These two questions are the critical uncertainties in the design. There are many other questions to be asked and answered, but the design team feels that these two questions are the ones that will drive the system in widely divergent directions depending on the answers. The other questions will derive from these answers. The team decided to create a set of scenarios around these uncertainties, creating the following axis:

Figure 1: Scenario Matrix



Next the team works to fill in the axes of the matrix. What are the key differences between systems that would exist in each of the four quadrants? After some discussion, a consensus about the nature of the different systems begins to emerge. The matrix is filled in even further.

Figure 2: Populated Matrix

Teacher Oriented	
<ul style="list-style-type: none"> • Similar to many products on the market. • Mainly a grade and test tracking system for administration. • Content broken out by specialty and closely tied to existing curriculum. • Capture current best practices. 	<ul style="list-style-type: none"> • Performance support orientation for teachers. • Create systems for knowledge management. • Content in flexible database, easily searched and rearranged.
Traditional Pedagogy	Innovative Pedagogy
<ul style="list-style-type: none"> • Common CBT and IMS system. • Content arranged in order, presented in order. • Automated grading and tracking functions. • Data collection and analysis at higher levels of organization. 	<ul style="list-style-type: none"> • Flexible content organization, easy for students to explore. • Student research and exploration tools. • Opportunities for student creativity and sharing.
Student Oriented	

Once all of the quadrants are filled in, it's time to start writing the narrative. The team decides to delegate the narrative for the upper right quadrant to you. You decide to write it from the perspective of a new teacher, just starting to use the system.

Augmented Teaching

Jeanne breathed a sigh of relief. Her morning was over and now she had a minute to gather her thoughts. She was trying to figure out how to support a few students in her class that she realized didn't have the prerequisite knowledge to do the work in her 9th grade English class. She was also concerned about trying to tie her curriculum into the pod's science and technology focus. There were four pods in the high school, each acting as it's own magnet school. She had recently joined the district and was trying to relate her English curriculum to the larger science focus.

She turned to her screen and opened the Teachers Assistant. The program, or TA as it was affectionately referred to, was a combination communications system and resource base for all of the district's teachers. It also linked to other school districts so teachers from all over the state could share experience and resources. It also held her grade book; the results of all of her students last state standards exam, as well as IEPs, parent contact information and a wealth of other district information.

After logging on, she opened up the query system and typed in "teaching English and science". The results showed an ongoing statewide conference on that subject, several lesson plans and teaching tools tied to state standards. She clicked on one of the lesson plans that looked interesting.

The lesson plan gave recommendations and a scoring guide for a writing exercise on the history of science. Students could choose a specific idea or scientist and write about that subject. She liked the idea and the scoring guide helped her tie it to the state standards. Clicking on the communication toolbar, she quickly composed an email to both the team history teacher and science teachers proposing they discuss the idea further as a team project.

The history teacher immediately emailed her back. He liked the idea and had been thinking about something similar. In fact, he was planning to base the entire semester around the history of ideas. Jeanne immediately thought about the TV series "Connections". It would be a great way to introduce the idea to the kids. She clicked on the district resources window and searched the district's video library. The library had a few episodes on tape! She

mailed the history teacher back with the reference number for the videotapes and made an appointment to meet him in the break room at lunch.

After you have written the scenario, reread it to make sure you have hit the major points in your outline. Has each been properly addressed? Can you picture what each of those abstract points means in terms of concrete interventions?

After the scenarios are written and named, the team presents them to the client. Being a skilled practitioner, you are deliberately present the scenarios as a range of options, not as given solutions. You are especially careful not to present one scenario as favored over the others.

The clients and the design team discuss each scenario and its implications. The team's listens to the clients to discern the points of each scenario that meet their needs, and the parts that don't. From this discussion, the design team and the clients together generate the next list of requirements.

The scenario generation process

1. Define the question: What is it you are trying to answer with the conversations generated by the scenarios.
2. Identify critical uncertainties: These may be obvious in the course of discussion, or they may emerge out of structured group processes like brainstorming.
3. Create scenario matrix: By combining the uncertainties, a matrix of possible outcomes is created.
4. Characterize the quadrants: Create a few bullet points of the defining characteristics of the quadrant. Remember that the scenarios that emerge from each quadrant should be structurally or functionally different to present a range of options. If all of the scenarios look the same, you have created a point solution that may not be optimal.
5. Create the scenario narratives: Using the outlines from step 4, create a narrative of the use of the system within the organization. Be sure to be as specific as possible. It is effective to write the narrative from the point of view of the user. Be sure to make all of your assumptions explicit in the narrative. Who is the user? What are their goals? What resources do they have? What do they see when using the system?
6. Name the scenarios: Give each scenario a unique and memorable name. This will help the clients remember and discuss them. It's easier to refer to the "Flock of seagulls" scenario than it is to remember what "Scenario 1" involved.
7. Present the scenario options to the client: When presenting the scenarios to a client, remember that the matrix represents a solution space. The client's most robust solution probably lies somewhere between the boundaries set by the scenarios. Having a preferred scenario can limit the conversation.

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THE MAJOR THEMES AND TRENDS IN DOCTORAL DISSERTATION RESEARCH IN EDUCATIONAL TECHNOLOGY FROM 1977 THROUGH 1998

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Each year an average of about 120 doctoral students graduate from 55 educational technology programs at universities across the United States. Each of these students completes a dissertation as part of their initial preparation as a researcher in the field. The topics for these dissertations vary widely with no standard dissertation type, topic, nor methodology within the field. This variability is reflection of the educational technology field and indicative of the multiplicity of research concerns for the students and their faculty advisors.

Statement of Purpose

The purpose of this research project was to review the dissertations that have been done in the field from 1977 through 1998. During this period of time more than 2,689 dissertations have been completed at 55 United States institutions. Approximately 87% of these dissertations were completed at the 25 larger programs. This review reveals what has been done in doctoral programs and student interest over the past two decades. The specific research questions addressed were:

What are the major themes over the past 22 years?

1. How have the themes changed over the 22 years?
2. How have the research methodologies changed over the past 22 years?
3. What trends are evident in the field?
4. What are the emerging trends in dissertation research?

The answers to these questions lead to a better understanding of doctoral dissertation research in the field of educational technology but also an understanding of the evolving nature of the field as reflected in the research.

Methodology

The methodology used in this study was a content analysis. The use of content analysis enabled the researcher to identify major constructs within the dissertation research and to classify these constructs. Content analysis, as described by Weber (1990), has been used in a number of studies to show trends within a field or body of literature. The basic premise of content analysis is to classify words of text into content categories. This technique was used by Ely (1996) in his series of reports on trends in the field. Insch, Moore, and Murphy (1997) provide further support that content analysis is an appropriate methodology for analyzing written textual materials. Evans (1996) describes recent advances in computer software for supporting content analysis.

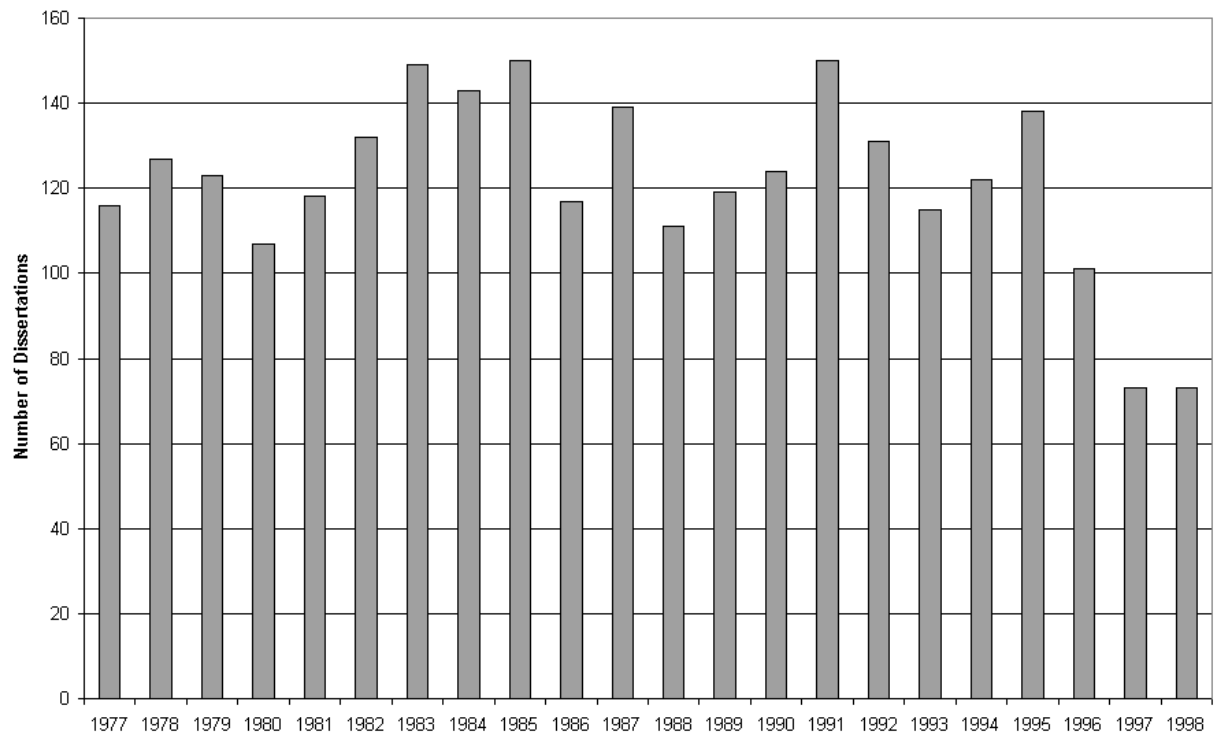
The *Doctoral Research in Instructional Design and Technology: A Directory of Dissertations, 1977-1998* (Caffarella, 1999) database of dissertations was used in this study. This database is available on the Web at <http://www.edtech.unco.edu/disswww/dissdir.htm>. The database directory is divided into five major sections including the student listing, key word in context index, institution listing, chairperson listing, and year listing. The student section lists the student's name, graduation year, dissertation title, institution, and chairperson. The key word in context index makes it possible to look up any of the major words in a title. The institution section lists all of the dissertations completed at a specific institution. The chairperson section lists all of the dissertations directed under the guidance of a particular chairperson. The year index lists all dissertations completed in a particular year. These indexes provide access to the dissertation data in a variety of ways.

The data for the directory is supplied directly by the universities in the United States offering graduate programs in instructional design and technology. These various programs are offered under a wide variety of titles including educational technology, instructional development, educational media, instructional technology, and instructional systems. The basic list of institutions was taken from the list of doctoral programs in the *Educational Media and Technology Yearbook 1996* (Ely & Minor, 1996). This list was checked against the membership list for the Professors of Instructional Design and Technology for the locations of additional programs. The intent was to be as inclusive as possible so that the wide variety of dissertations in the field of instructional design and technology would be included in the directory. The decision to participate and which dissertations to submit was left to the individual institutions.

The directory currently contains entries for dissertations completed by 2,689 students during the period from 1977 through 1998. As shown in figure 1, the dissertations are distributed relatively evenly over the years with an average of approximately 120 dissertations completed each year. The numbers shown for 1997 and 1998 are

probably underestimates of the actual number of dissertations. Due to the way dissertations are reported the institutions tend to be delayed in forwarding the entries and there are always additions to the database that are for dissertations completed two to three years earlier.

Figure 1. Number of Dissertations Completed for Each Year from 1977 through 1998



The dissertations were coded using multiple coding points to identify the major themes and constructs within the field. The QSR NUD*IST software was used for the coding and the analysis. The coding was an evolutionary process of data extraction and reduction to identify both major themes and trends within the dissertation research.

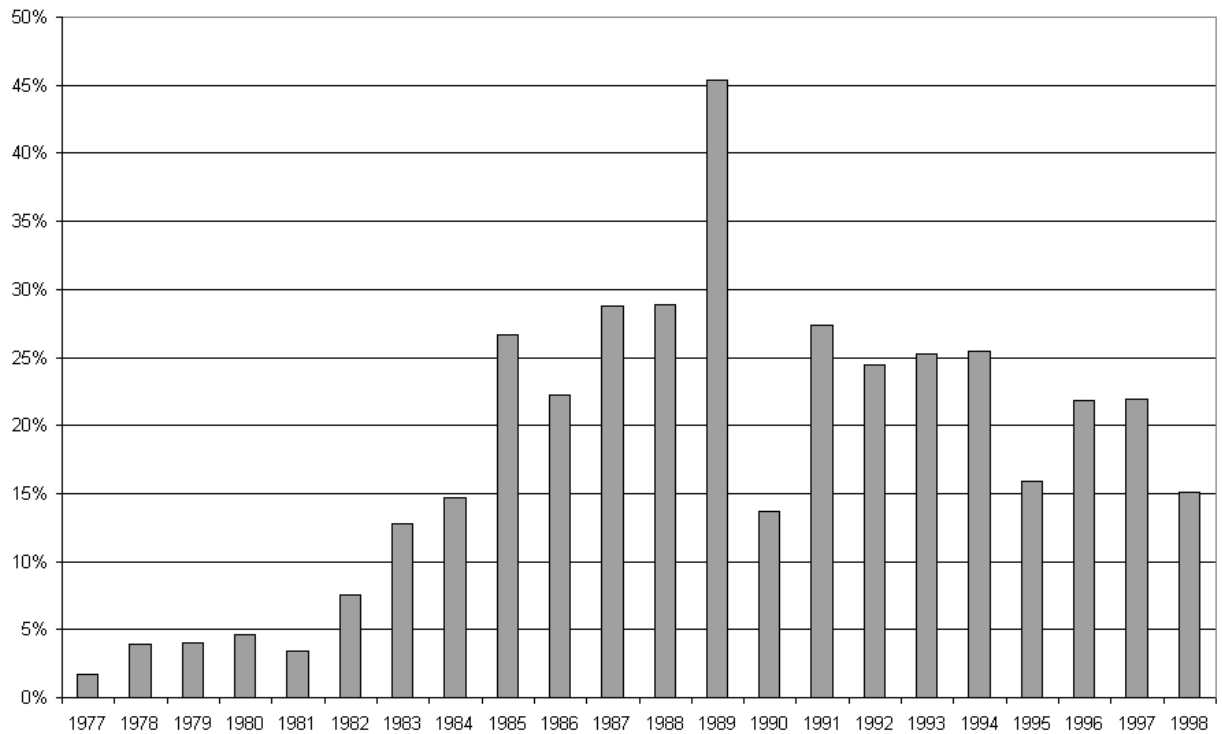
Ely (1996) did a similar, but different, content analysis study of literature sources in the field. His study was limited to one year but included journals, dissertations, conferences, and ERIC documents with the overall purpose of identifying trends for a single year, 1995. Among his documents were 37 dissertations from five large doctoral programs completed during that year. This study builds upon the Ely study but looks at only dissertations for multiple years.

Findings

Initial analysis of the dissertation data showed a wide variety of topics being investigated by students in the educational technology field. This is indicative of the eclectic nature of the field of educational technology and the widely divergent topics that are included in the field. There are no predominate themes or topics for the dissertation research. There were, however, several themes that were prominent in the data that will be discussed in the following section.

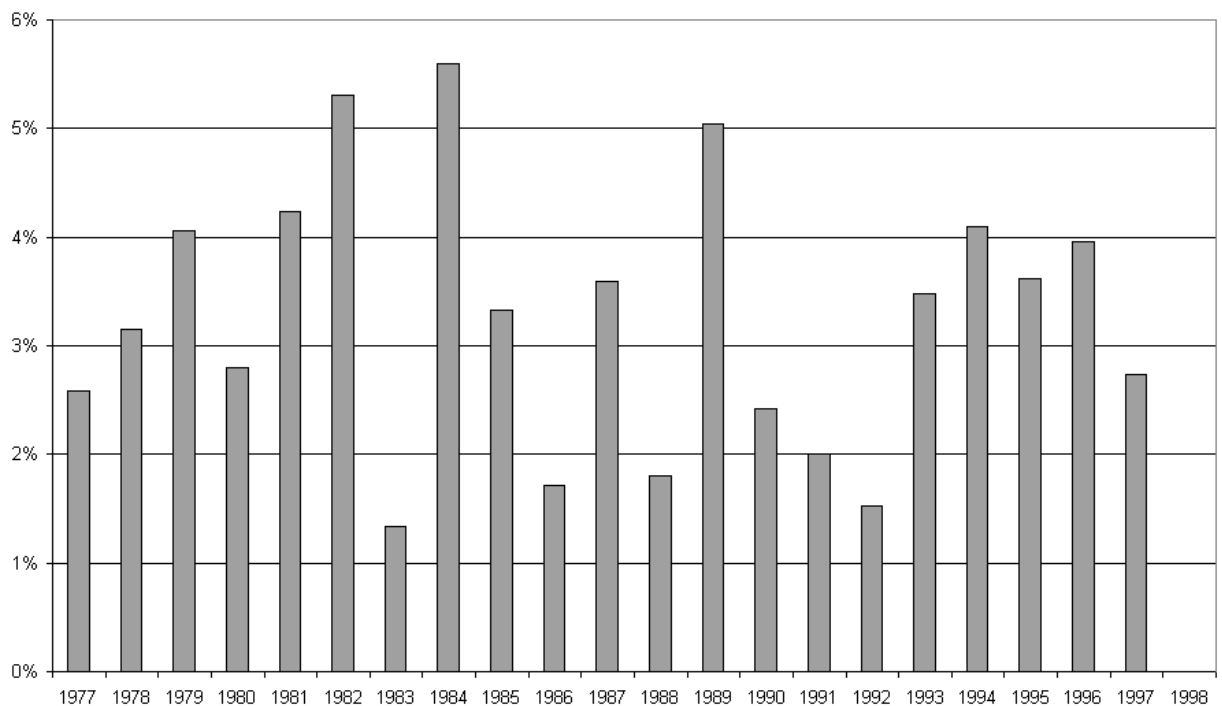
Clearly the most popular topic was research on and about computers. This took many forms including appropriate uses, software design, individual differences, as well as the effectiveness of computers as a teaching tool. As shown in Figure 2, the number of studies dealing with computers grew with the introduction of microcomputers. The Apple II was introduced during the late 70s, the IBM PC arrived in the early 80s, and the Macintosh was released in the mid 80s. With the introduction of each of these technologies there was an increase in the number of studies and for the past 14 years between 15 percent and 25 percent of all dissertations have dealt with computers.

Figure 2. Percentage of Dissertations Dealing with Computers for Each Year



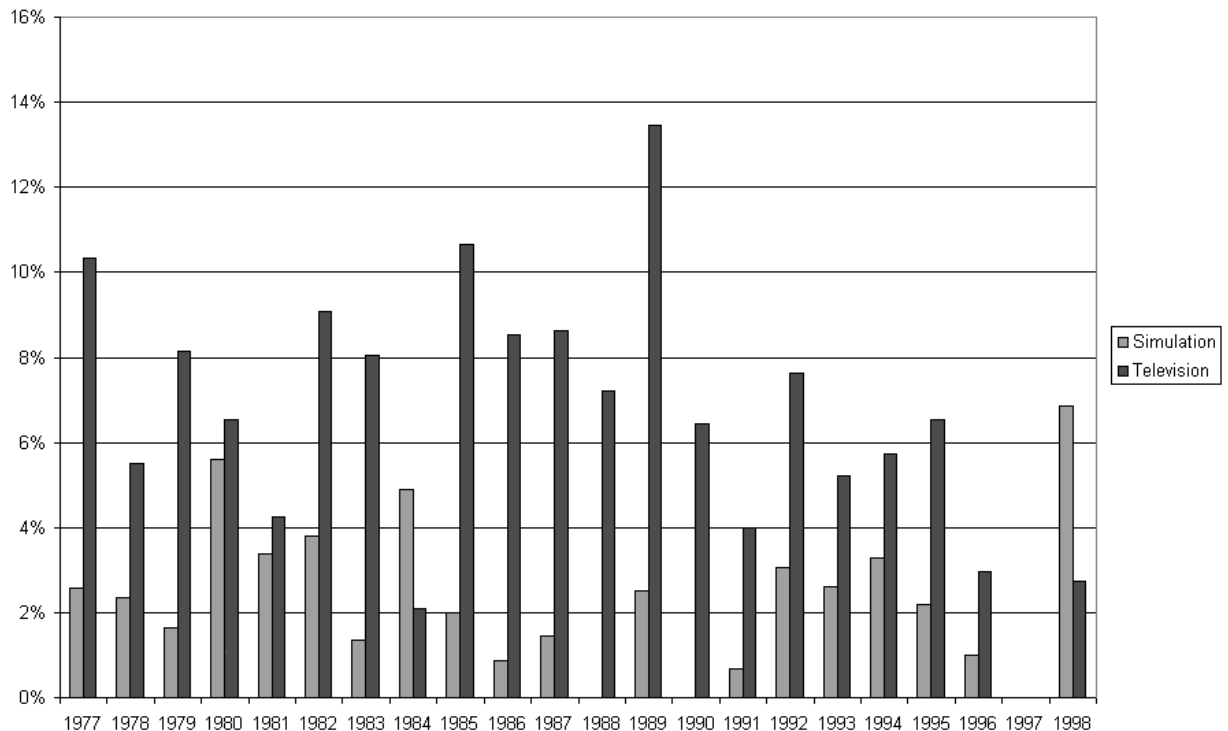
One theme that was constant throughout the 22 year period was research on instructional development, instructional design, and instructional systems development (see Figure 3). This research amounted to approximately two percent to five percent of the dissertations in a given year. This was not an overwhelming number of dissertations but was the most constant theme of interest over the years.

Figure 3. Percentage of Dissertations Dealing with Instructional Development, Instructional Design, or Instructional Systems Development Each Year



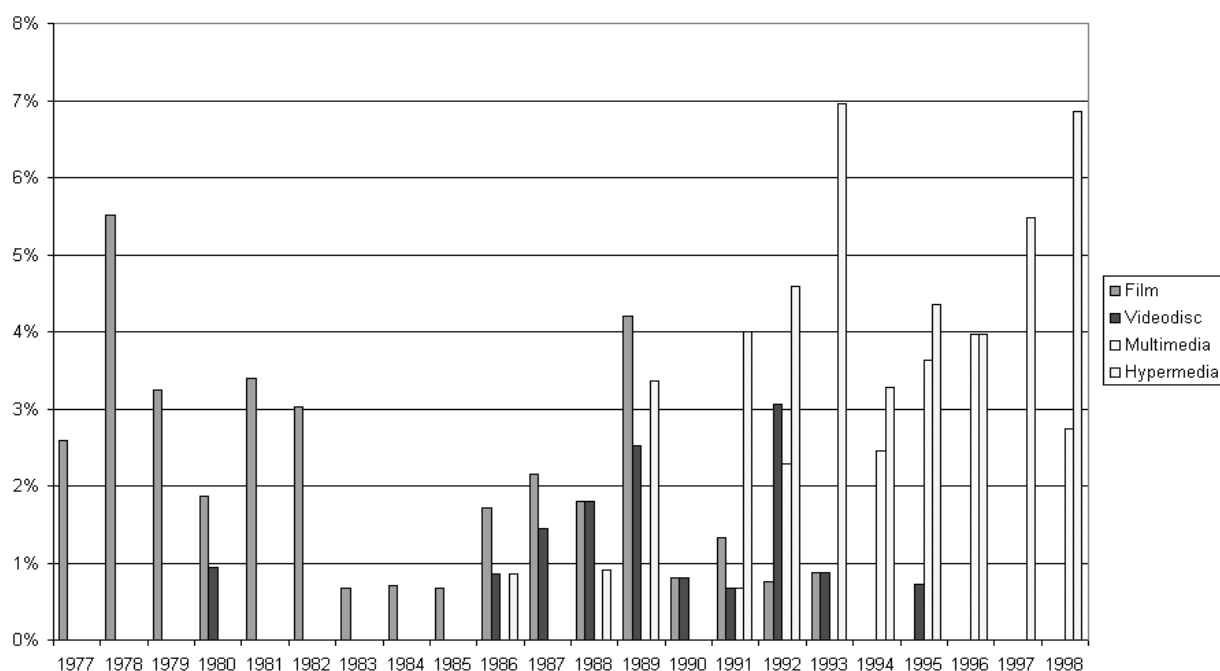
Two other themes seemed to persist throughout the period although both had years of popularity and years with very little research. These themes, shown in figure 4, are (a) simulation and games and (b) television and video. The kinds of research done on these topics varied greatly over the 22 years. The early simulation and game research was largely process and design related while the more recent research has looked at simulations and games within a computer environment. Likewise, the television research followed the evolution and change of this technology.

Figure 4. Percentage of Dissertations Dealing with Simulation and Television for Each Year



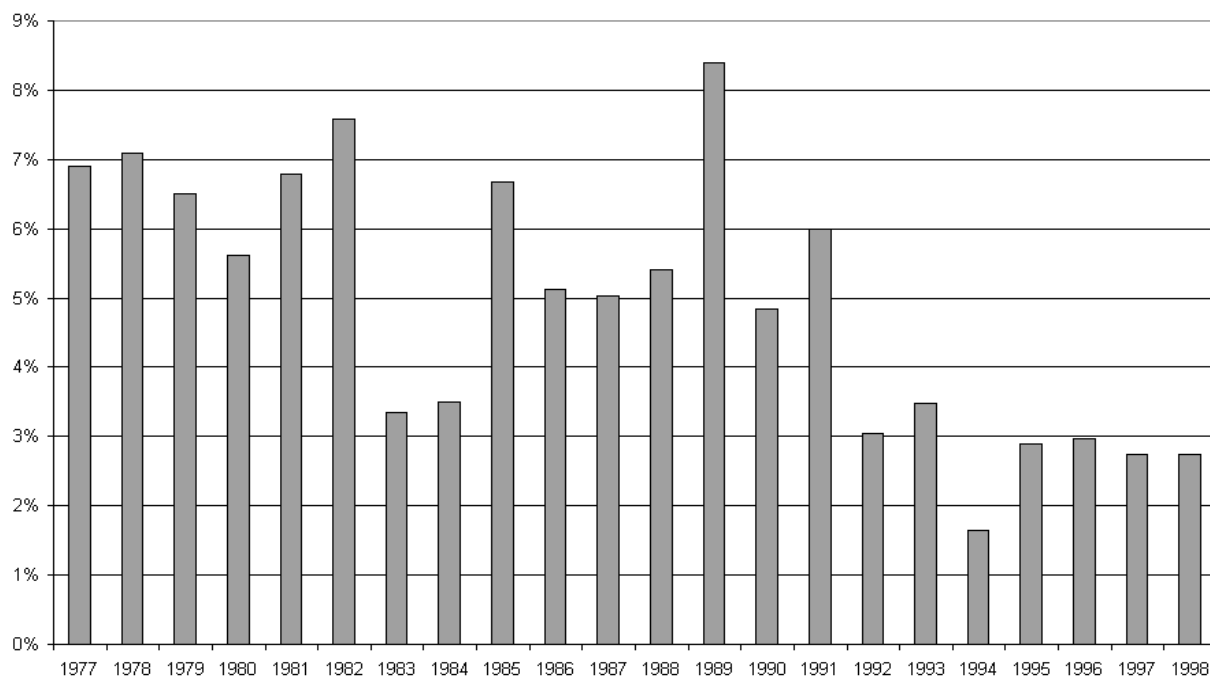
As might be expected, at any given point in time there is research dealing with the newest hardware/software technologies. For example, many studies in the late seventies dealt with the use of film and video but more contemporary studies have dealt with computer applications. The growth of research on computing, shown in figure 1, is one example of this change. The changing nature of the field of educational technology and the tendency of dissertation research to follow the new developments can be seen clearly in Figure 5. During the early years film research was a major segment of dissertation research. During the middle years research utilizing videodiscs was popular amongst doctoral students. In recent years multimedia and hypermedia have been major topics for research.

Figure 5. Percentage of Dissertations Dealing with Film, Videodisc, Multimedia, and Hypermedia for Each Year



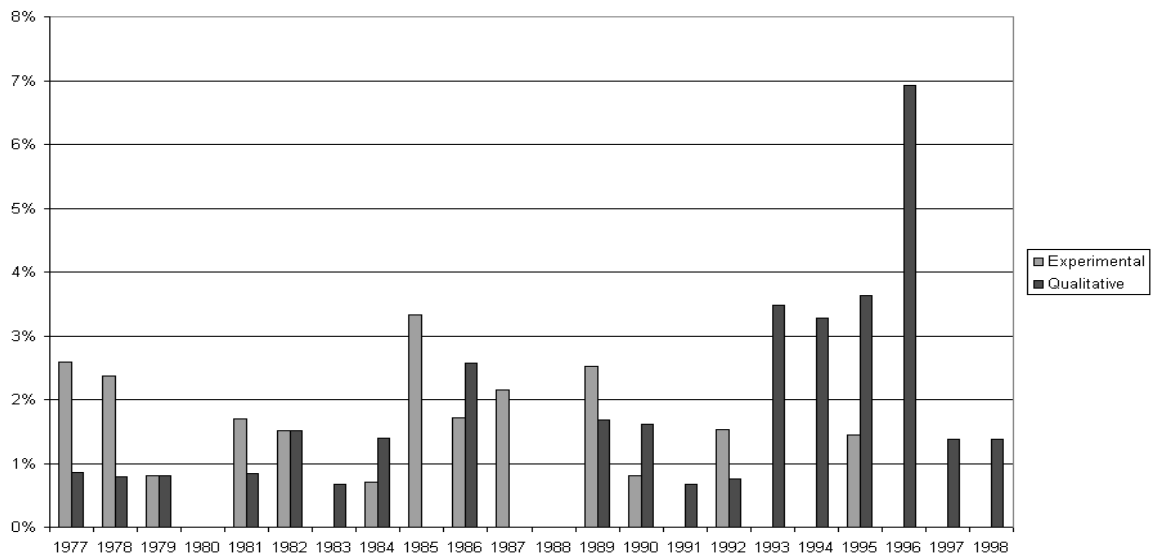
The research methodologies used in the dissertations show some interesting trends. The most startling trend is the reduction in the number of comparison studies from 1977 until 1998 as shown in Figure 6. Many of these studies compared one medium against another medium to determine if one medium was inherently better than the other. In 1983 Clark (1983) wrote about the problems with comparison studies and launched a debate that continued into the early 90s. During the late 70s, comparison studies represented around 7% of all dissertation research. During the late 80s and early 90s the number of comparison studies had dropped to around 5%. For the last five years comparison studies have accounted for less than 3% of dissertation studies.

Figure 6. Percentage of Dissertations Using Comparative Research Methodology for Each Year



Another clear shift in research methodology can be seen in a reduction in the number of experimental studies and an increase in the number of qualitative studies. In the late 70s, very few qualitative studies were done by students (see Figure 7) and these studies were clearly the exceptions to the norm. Now dissertations with qualitative research designs make up a substantial proportion of the studies and exceed the number of experimental studies.

Figure 7. Percentage of Dissertations Using Experimental and Qualitative Research Methodologies for Each Year



Institutions Offering Doctoral Programs

There were 55 institutions who graduated students with doctoral degrees in educational technology during the period 1977-1999. The programs with the most graduates included Indiana University, Boston University, the University of Southern California, Syracuse University, and Florida State University. Figure 8 shows the relative numbers of graduates for the 25 institutions with the largest numbers of graduates. These institutions graduated 2,287 students while the remaining 30 institutions graduated only 402 students. There is a clear variability in the size of the doctoral programs with many extremely small doctoral programs. Interestingly only four of the 25 are private institutions with the vast majority of large educational technology programs offered at public institutions.

Figure 8. Twenty-Five Programs with the Largest Number of Graduates from 1977 through 1998

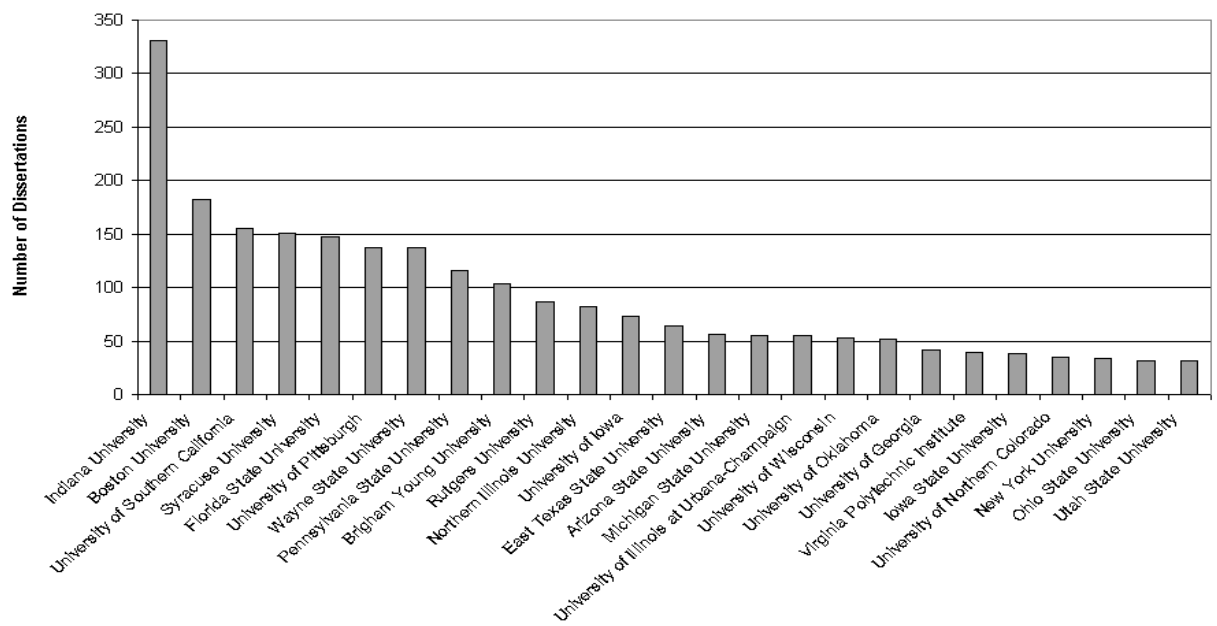
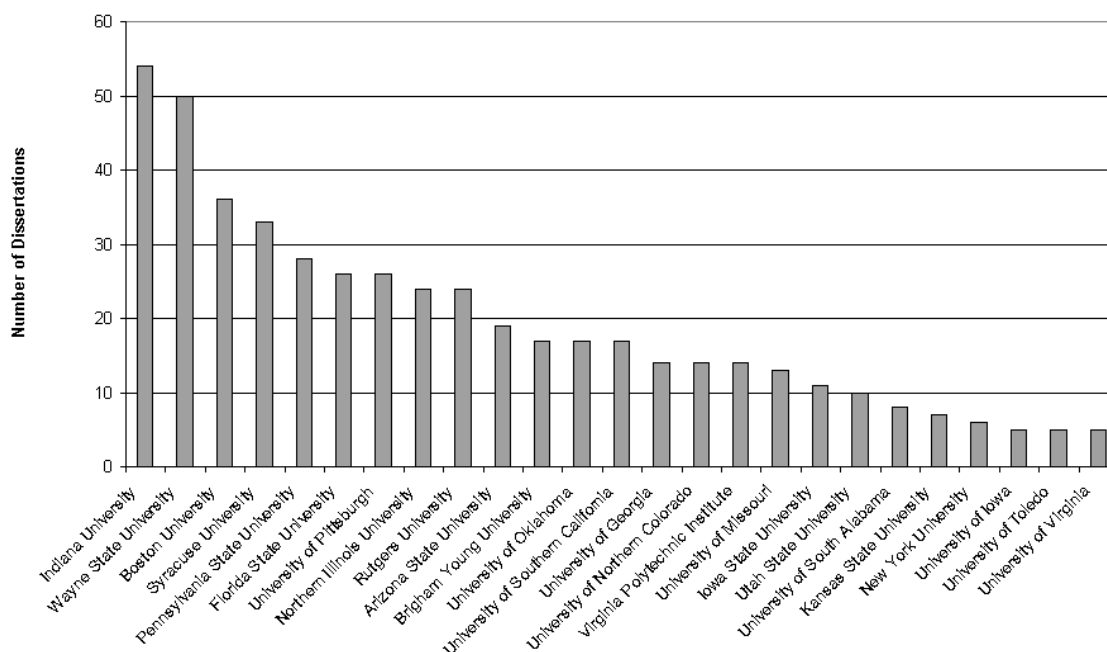


Figure 9 shows the number of graduates over the past five years for the 25 largest programs. The collection of institutions is essentially the same as the list in Figure 8 but the order of the institutions is different with some gaining in the ranking and others moving to the right. For the last five years, these 25 institutions graduated 483 students, which is 95% of the total graduates.

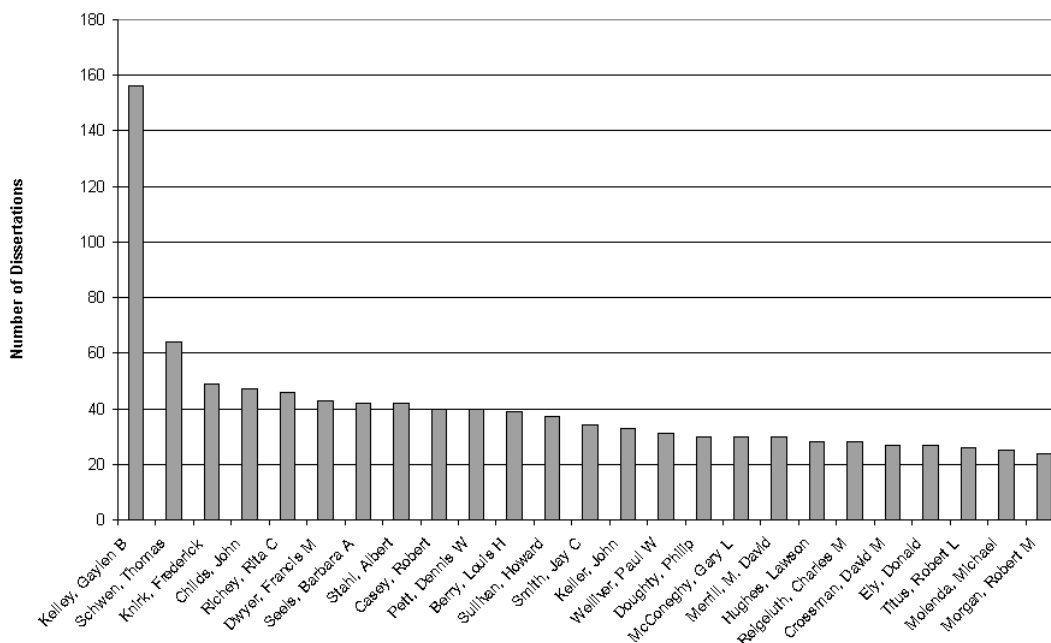
Figure 9. Twenty-Five Programs with the Largest Number of Graduates for the Past Five Years



Chairpersons of Dissertations

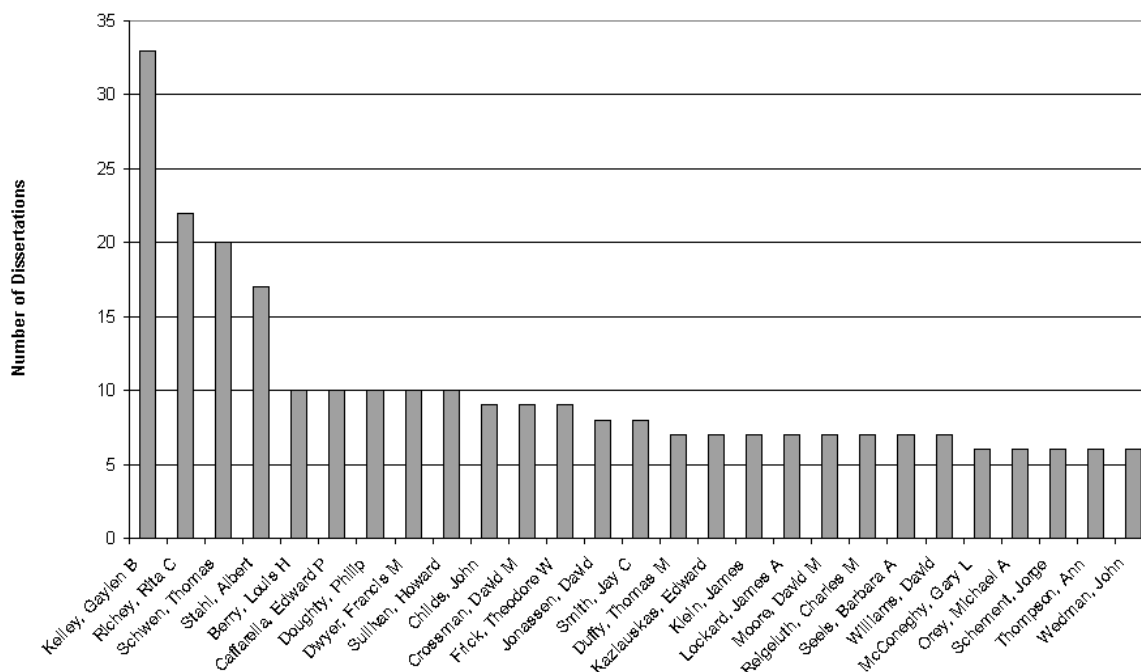
The 25 chairpersons with the largest numbers of doctoral graduates from 1977 through 1998 are shown in Figure 10. The institutions for these chairs are reflected in institutions shown in Figure 8. These 25 chairs worked with 1,018 students during this 22 year period of time which represents 37% of the total students. There were 205 chairs who chaired only one dissertation each. Clearly, the advisement of large numbers of doctoral students is being done by a relatively small number of educational technology professors.

Figure 10. Twenty-Five Chairs with the Largest Number of Graduates from 1977 through 1998



The cohort of chairs with the largest number of graduates over the past five years (see figure 11) includes a few new individuals. The 27 professors in this group chaired 271 out of a total of 518 dissertations representing 52% of the total. Many of these professors have actively chaired dissertations over the entire 22 years but there are several new names who have assumed responsibilities for supervising dissertations.

Figure 11. Twenty-Seven Chairs with the Largest Number of Graduates for the Past Five Years



Summary

The field of educational technology is a very varied field as reflected in the research of doctoral students. The students select a range of topics that have no particular theme not pattern with the research following the development of new technologies. The field utilized a variety of research methodologies with qualitative methodologies having a major role during the past few years. Most of the students graduate from a relatively small number of institutions although there are 55 institutions offering doctoral programs in educational technology. Likewise, a relatively small number of professors chair most of the doctoral dissertations. Thus, although the field is broadly based and draws upon many disciplines, the doctoral study is highly concentrated with a few institutions and professors.

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A CASE STUDY OF USING GROUPWARE TO SUPPORT COLLABORATIVE ACTIVITIES IN A DISTANCE LEARNING COURSE

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Abstract

This case study examined the ways a groupware tool, TWISTER, was used to create a learner-centered distance learning environment. Data were collected using learner participant surveys, observation field notes, interviews, computer transcripts, and course artifacts. Data analysis focused on participant use of TWISTER, characteristics of the participants and learning environment that influenced participation, and the communication and interaction in the different components of the learning environment.

Findings indicated that participants recognized limitations in interactivity frequency and levels in the compressed-video environment. Planned activities successful in this environment included using a wide range of activities and providing several means of access for communication. Although open and collaborative activities encouraged rapport building and enhanced interaction, participants still identified challenges. Use of TWISTER to assist in facilitating the student-centered activities also presented challenges. The tool did not support the activities as intended. There was low overall usage of the tool by all participants. For the participants, the added value of the features afforded by groupware did not outweigh the convenience of email. Existing habits and limitations in functionality and interface were likely contributors to this low use.

Results suggested that distance learning environments continue to need to be improved through devising learner-centered activities and increasing interaction. Recommendations for practice included: 1) assessing and preparing the learners for the learning environment, 2) incorporating ongoing community building and other short activities, 3) planning extra time for management issues, training, and practice, and 4) selecting groupware tools based on functionality in a learning environment and the types of activities to be supported.

Introduction

Post-secondary institutions are rapidly adopting distance modes of educational delivery because of technological innovations, but more than the technology needs to be explored. The teaching and learning also needs to be examined (McIsaac & Gunawardena, 1996). All too often these new technologies are used to present one-way lectures to students in remote locations (Jonassen, Davidson, Collins, Campbell, & Haag, 1995). Contemporary perspectives in teaching and learning theory emphasize student-centered pedagogies where students take part in the development of their own learning experiences (Jonassen, Davidson, Collins, Campbell, & Haag, 1995; Savery & Duffy, 1995; Scardamalia & Bereiter, 1994; Spiro, Feltovich, Jacobson, & Coulson, 1991).

Interactions among students and instructors are a vital piece of student centered learning. Despite innovations in distance learning technologies, student-centered models of learning are difficult to implement in distance learning environments. The communication among participants and levels of interaction are still a concern. Problems lie not only in how the technologies are being used, but also there remains some limitations in the technologies themselves. For example, compressed video delivery systems have been touted as a premier interactive distance learning technology, however, studies show that interaction and communication is still hampered making the use of collaborative learning activities rare (Comeaux, 1995; Harnish, Reeves, & Noah, 1996; Henri & Rigault, 1991; Kolomeychuk & Peltz, 1992; McHenry & Bozik, 1995; Thomerson & Smith, 1996).

Today's technological developments can enhance communication among the participants of a course. Through computer mediated communication tools such as email and conferencing, it may be possible to create environments that do not require face-to-face meetings as the only means for achieving student-centered, collaborative learning models.

Groupware tools may be one such technology. Groupware "help[s] groups structure work through group decision support systems, project management tools, electronic conferencing systems, and shared editors" (Jonassen, Davidson, Collins, Campbell, & Haag, 1995, p. 17). This research sought to identify ways in which groupware tools could be used to support collaborative activities in a distance learning environment.

Groupware systems, in general, differ from other Internet conferencing tools like email/Listservs and newsgroups in several ways. Email/Listservs have little if any structure to the messaging. There may be several topics being discussed simultaneously. Messages of varying topics can be sent sequentially. This requires the user to create their own structure upon receipt. Listservs only exacerbate this problem with many having a heavy message load. Email/Listservs are referred to as "push" technologies because the information is sent to the user. Another type is "pull" technology. Newsgroups are "pull" technology. With this form of conferencing the user goes to an

internet location where the conference is maintained. "Pull" technology solves some of the structuring and load problems. Newsgroups provide some threading of messages and users can select which messages they would like to read. (Dennis, Pootheri, & Natarajan, 1996).

Given the added functionality and support for group work that groupware provides, researchers hoped that student-centered models of learning might be applied to post-secondary learning environments where participants are separated by space and/or time. Based on a review of current perspectives in the areas of distance learning, open-ended learning, and collaborative learning, the following features were identified as important to selecting a groupware product.

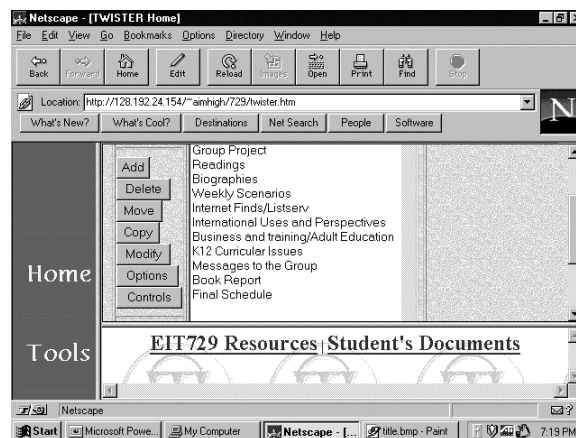
The WWW is a relatively accessible technology to participants affiliated with a higher education institution and was therefore considered exclusively as the delivery medium. The WWW also offers a familiar environment, thereby presenting only a slight learning curve to most participants. Past groupware systems were often proprietary systems run on, LANS or WANS. Recently, many Internet-based systems have been made available.

Other desired features of the groupware included:

1. A space for presenting an anchor or macrocontext can assist learners in an environment that enables open exploration into a set of concepts or set of skills (CGTV, 1992).
2. Participants should be able to engage in both synchronous and asynchronous communication. The added capabilities to thread discussions and link ideas can provide metacognitive support.
3. Databases of information provide resources for accessing content. These could include both pre-developed resources as well as those produced through participant's prior learning such as a case library.
4. By giving learners the ability to add or post group products they contribute to the knowledge base of a larger group and also see that their products have value. (Scardamalia & Bereiter 1994; Lebow, Wager, Marks, & Gilbert 1996).
5. Hypertext links will provide a means for practicing and learning cognitive flexibility. It also enables the idea linking described above (Spiro, Feltovich, Jacobson, & Coulson 1991).
6. Writing/production tools enable groups to produce evidence of their knowledge and expertise.
7. Metacognitive process structures can be built into the environment as a coaching mechanism until learners are comfortable directing their own learning.
8. Shared workspace allows collaboration among individuals as they strive to construct meaning of the concepts or practice skills. For example, this could be in the form of a synchronous whiteboard.

The web-based system used in this study was TCBWorks. This groupware product was designed to support writing, synchronous and asynchronous discussion, idea generation, and decision-making (Dennis, Pootheri, & Natarajan, 1997). Because it did not provide all of the desired features, TCBWorks was incorporated into a class web site that added some functionality. The web site, TWISTER, Talking - Writing - Information access - Solving problems with - Technology for - Education and Research (no longer available online.) integrated a variety of tools including TCBWorks, a groupware product, as well as simultaneous Internet access to information resources, course information, and other related resources. See Figure 1.

Figure 1 TWISTER Tools



Methodology

The aim of this study was to create and examine a student-centered distance learning environment facilitated by using a groupware tool as a supplement. Naturalistic data collection and analysis were used in order to gain an understanding of the participants' experience and to identify considerations for using a groupware tool to support a distance learning course. Given the nature of qualitative research, the questions with which I began this study were open enough to allow for a flexible research design and the possibility of unexpected outcomes. As the study progressed, the following questions guided my data analysis.

Question 1: What factors (i.e. participants' personal characteristics, attitudes, skills, or circumstances) influence participation within the three learning environments (in-class, COMPRESSED VIDEO, and TWISTER)?

Question 2: In what ways do the participants (instructor, teaching assistant, and students) make use of the GROUPWARE tool?

Question 3: What is the communication and interaction among the participants like? Are there patterns of interaction that emerge in the different learning environments?

This study looked at the complex phenomena that occur in a distance learning course supplemented with computer supported collaborative learning activities. The participants' behavior in such a complex, dynamic situation is not as easily controlled as in a laboratory style study. In order to study the uniqueness and complexity of this situation, the whole phenomena was investigated in an authentic environment (Jordan, 1996; Lecompte & Preissle, 1993; Patton, 1990). Through qualitative case study, a deep understanding of the context, the participants, and the interactions among them emerged.

This research study examined a telecommunications in education course offered spring 1997. This course met for a ten-week term at two different sites simultaneously with each classroom connected via compressed video technology. In addition, other class activities took place both synchronously and asynchronously through a groupware tool, TWISTER. This format falls under what Harasim, Hiltz, Teles, and Turoff (1995) call mixed mode, in which the class meetings are extended and supported by computer mediated activities and discussions.

During the first two weeks, data were collected to provide a baseline profile of the students, instructor, and class environment through student pre-surveys, an interview with the instructor, and in-class observations. Throughout the quarter the instructor, teaching assistant and researcher held weekly debriefing sessions. During each class session the research captured written field notes from alternating sites. In the last two weeks of the course, student participants were interviewed individually and in their collaborative work groups. Finally, a post-survey was given to the students. Both the instructor and teaching assistant were interviewed at the conclusion of the course. All of the instruments were developed specifically for the study. The tasks used in the class projects were co-developed by the researcher, the instructor, and teaching assistant.

There was a wide range of activities planned for this class. There were individual and collaborative, technology supported and technology required, in-class, and independent. These activities also included a variety of different kinds of tasks including idea generation, problem solving, construction/production, and hands-on. These varying activities were built-in to meet the needs of different learners with varying skill levels. Also, for research purposes, the wide variety offered an opportunity to examine a breadth of activities both supported and not supported with compressed video and TWISTER.

During a class session it was typical for participants to engage in a discussion of the readings led by fellow students, one from each site. This might be followed by a guest lecturer or a presentation from one member of the instructional team. Time would then be provided for each of three small collaborative groups to meet over the system to work on a web development project. Finally a technology product or skill might be demonstrated with a lab activity to follow.

Outside of class students were expected to interact on TWISTER at least weekly. Weekly TWISTER activities included readings discussions, posting internet finds, and responding to weekly scenarios developed by the instructional team. It was envisioned that TWISTER would also serve to support the collaborative groups developing a topical web-page. Several individual written activities were also required assignments.

Data Analysis

The primary goal of a case study is to look deeply into the complexities of a single phenomenon or instance. The analysis process was formative as were some details of the overall research procedures. Initially, the data were approached openly with only the initial research questions in mind. Following one open coding review, the data were searched categorically in the NUD*IST database. Using the reports generated with these searches, profiles of participants, the learning environment, and the communication and interaction among participants were developed. Finally, assertions from these profiles were categorized and validated and synthesized using relevant literature.

Initially, transcribed data, along with the computer transcripts, were uploaded into NUD*IST software to assist in data management and thematic searching. It also served as a verification for more consistent coding of the participants' own words than what coding by hand might have produced.

Profiles of each participant were developed including both students and the instructional team. Member checking was also done with student participant profiles by emailing each student participant a draft of their own profile and requesting comments.

Using research questions 1 and 2 as guides, data sources were reviewed to develop a profile of the learning environment including utilization of TWISTER. Results comprised of data from across all data sources were sorted

according to one of the following aspects of the learning environment: course structure and design, course activity, physical facilities, technology implementation and technology utilization by both students and the instructional team.

The last review of the data examined the communication and interaction among the participants in the course. Again, reports were generated using keyword searches in the NUD*IST database. These reports were most useful in understanding student and instructional team perceptions of interaction and communication in each of the three learning environments: face-to-face, compressed video, and TWISTER. Additionally, the TWISTER transcripts were examined closely to examine participation, types of communication, and levels of interaction of individual students for both the planned and unplanned online activities. Using data summaries of each small collaborative group project, cross case comparisons were also completed.

Validity

All of the data collected came from the participants. This approach lends itself to an emic data analysis process. As data were analyzed, interpreted, and prepared for presentation, I made a rigorous effort to include the participant's own words (Patton, 1990). Although I am a participant, I am also a researcher; in some instances and for some research questions, I relied on my own typologies or categories in order to interpret the data. In these instances I have used what Patton (1990) calls an "analyst-constructed" or etic approach to data analysis.

Because I was involved in the research as both a researcher and a participant, it was impossible to completely separate my own interpretations from the reality of each of the participants. In order to guard against my own interpretations dominating, planned member checking, triangulation, and reminders to myself of my own worldview and potential biases were integrated into the analysis plan. Finally, all assertions are discussed in comparison to relevant literature.

Reflection on the Methodology

This methodology offered a unique and in-depth understanding of one class' experience using a groupware tool to support course activities. What makes this study unique is that the perspectives of all the participants were studied in-depth. Gaining the learner's perspective not only informed the researcher's understanding of this case, but also offered learners the opportunity for reflection on all aspects of the course. This study attempted to contribute to the body of knowledge in instructional technology by identifying the issues involved in studying distance learning and groupware environments (Koschmann, 1995; McIsaac & Gunawardena, 1996).

Nonetheless, there were clearly limitations that have been illuminated in retrospect. The most dominating limitation was the relationship between the instructor and the researcher. The instructor and researcher were involved in the design of the course and the design of the research. Each having a hand in both presented several problems. These problems emerged during data collection, data analysis, research design, and course implementation. Both learners' experiences and the instructional team members' experiences were affected.

First, the instructor of the course was required to wear "multiple hats." She was continuously asked to be conscious of her roles as research adviser and course instructor. This consciousness of dual roles by the instructional team impacted data collection.

There was hesitancy among instructional team members to discuss particular students, more so in a potentially negative light, and have it captured on tape. For example, members of the instructional team would ask for the tape to be turned off, if the conversation was moving in that direction. Therefore, these discussions were not captured and raw data was sometimes lost. As a result some potential findings could not be substantiated. The findings, primarily regarding the challenges that emerged in the course, surrounded issues of instructional design and technology implementation. This captured only two parts of the picture. A third part was the participants' responsibility for meeting expectations in the course and making use of the available tools. Although the study was designed to capture learner characteristics that might influence participation and communication, this failed for two reasons. First, the data collection instruments gave the learners an opportunity to describe challenges they faced in the class, but did not ask them to reflect on what their role may have been. Second, follow-up data collection opportunities were not planned to gain participants' reflections after this issue was discovered late in the data analysis phase. Moreover, it was the tendency of the instructional team to take responsibility for problems as issues of instructional design and limitations of the technology. This is what was captured in the data and thus presented as findings.

Because of these "multiple hats" learner perceptions were also affected. Data suggested that the instructor also carrying a research adviser role caused some mistrust between learners and the instructor. Moreover, learners perceived the researcher as closely and personally tied to the groupware. There was some concern as to how that might have impacted the data and findings.

Research also had an impact on the selection of a groupware product. In order to collect transcripts of the online discussions, the product had to maintain a record of the communication. TCBWorks offered the opportunity

to customize the usage privileges of participants. For this study users were not able to delete, move, or modify the transcripts. Several users found this lack of capabilities to be frustrating.

Finally, this feeling of mistrust was evident during data collection. The researcher sensed during individual interviews that students were not completely honest regarding their experience in the course. This was confirmed for one participant. In most of the data, she described an overall positive experience in the course, however on her post-survey she revealed somewhat negative attitudes and experiences.

These limitations served as a filter for presenting and validating the conclusions and recommendations asserted in the next sections. Despite the recognized difficulties, important outcomes emerged.

Discussion of the Findings

As Stake (1995) suggests, meaning is added to data after breaking apart the instance and putting it back together. Data were reviewed three times from the frame of each research question. After completing these three in depth reviews, synthesis occurred by examining the findings from the original purpose of the research. Findings were sorted according to the broad categories: the compressed video environment, achieving a student-centered distance learning environment, and integrating the groupware tool. Stepping back to this broader frame enabled a threading of the findings for representation and discussion. Conclusions were validated using relevant literature.

Teaching and Learning in a Compressed Video Environment

Learner participants in this case described being inhibited in interacting over the compressed video system with some feeling as though they were "interrupting" in order to participate. Students also noted difficulties in getting others to interact with them. One participant described her experience leading a discussion as "pulling teeth" to get others to participate. Another equated her experience with receiving the instruction over compressed video when the instructor was not at her site to "watching TV" making it difficult to pay attention for longer than 15 minutes at a time. Several participants observed that the subtleties of face-to-face communication, i.e. body language, facial expressions, no delayed responses, were lost when communicating over the compressed video system. The instructor also observed the student-student interactions as being low level. She considered class readings discussions to be "boring" and in comparing a face-to-face class meeting to one over the compressed video system, she refers to the discussions during the face-to-face "like a real class." Mediated communication through compressed video impacted the interactivity among students as well as the interaction between the students and instructor. Similar accounts of these types of challenges were reported in much of the recent distance learning research on communication in compressed video environments (Comeaux, 1995; Fulford & Zhang, 1994; Kearsley, 1995; McHenry & Bozik, 1995; McHenry & Bozik, 1997; McIsaac & Gunawardena, 1996; Repman & Logan, 1996; Schrum, 1996; Tiene, 1997; Wolcott, 1996).

The interaction between students and the instructor took many forms as suggested by Garrison and Shale (1990). There were the expected challenges for the instructor with presenting information and providing feedback to the learners. Additionally, extra time was needed for redesigning the activities and presentation of information took time to redesign for this environment. Providing feedback to students required coordination to get the right assignments to the right location on the same day. In some instances the feedback was provided via supplemental technologies like fax, phone, or email. The facilitation of these types of responsibilities was distributed between all members of the instructional team. One issue students commented on as being problematic, however, was that the professor was only available every other week for face-to-face communication during class. The attitude and expectations of students as well as their physical location were key here. Students at the local site were less likely to be accommodating to a physically distant instructor than were the remote site students. Since the remote site students were all aware that the course was being delivered over compressed video and because they gained the conveniences afforded through receiving the distance delivery, interacting with the instructor every other week was perceived positively. For students at the local site, however, it was perceived less positively. Prior to the first night of class, many of the local site students did not realize the course was to be delivered at a distance. Several commented that it was enough to "put up" with the videoconference technology, but to have also lost access to the instructor without the added conveniences, was frustrating. Students from both sites agreed that the supplemental technologies did not provide the immediate, two-way interaction sometimes necessary.

"Clarity" in communication also emerged as a major issue in this class with several students. For example, there was a request for clarification of the assignments on almost a weekly basis. This information was provided in the syllabus and discussed during class, yet there was still confusion among some participants. Other instances of a lack of clarity included students not being prepared for class because they "didn't know" or did not remember information disseminated during a class session.

Many of the above challenges have to do with what researchers have referred to as psychological distance (Comeaux, 1995; Wolcott, 1994). Being aware of this from the accounts described in the literature, the instructional team designed the course to incorporate instructional strategies, techniques, and activities that would minimize the psychological distance therefore creating a more student-centered environment.

Designing Student-centered Instructional Strategies for Distance Learning Environments

Using a wide variety of activities in-class and for individual assignments was an attempt to cater to varying knowledge and skill levels, learning styles, and location, and to make the most of the technologies employed. As suggested in the literature most worked well in the environment. Rapport building strategies included icebreakers, being available before and after class, and building in time for questions. Interaction enhancing strategies included using a variety of activities beside lecture, encouraging participation from each site, and making a multitude of ways available to access other participants (Schrum, 1996; Wolcott, 1996). The following two strategies yielded rich findings and were explored in more detail: open learning activities and collaborative activities.

The instructor had always used open learning activities in her course in order to provide learners with an opportunity to make the learning authentic and meaningful for themselves. In reflection, the instructor admitted that there are always some students who become uncomfortable with defining their own learning goals. Often students have no experience defining their goals and negotiating them with an instructor. Similarly, in this case there were some students who were uncomfortable with this process. Eventually all students except one found these open-ended assignments to be personally meaningful. Given these results, this strategy proved successful for this case.

Collaborative activities were used as a means of community building to bridge the psychological distance and increase interaction. Collaborative learning strategies provide opportunities for learners to build knowledge through discourse by solving a problem or completing a task in a group (Blumenfeld, Marx, Soloway, & Grajcik, 1996; Joyce & Weil, 1992). Although collaborative learning activities are known to be difficult to implement in distance learning environments because of the geographic and temporal separation of the learners, if carefully designed they are possible (Henri & Rigault, 1991). In this case there were several opportunities designed for learners to collaborate in small groups and dyads across sites. Findings specifically related to collaborative activities supported by TWISTER are presented in the next section.

Using characterizations of collaborative work from the literature, the small group projects were more successful in providing students the opportunity to work closely with others and learn by completing a task (Barnes & Todd, 1995; Blumenfeld, Marx, Soloway, & Grajcik, 1996; Crook, 1994; McReary, 1990; Sharples, 1993; Webb, 1992). As seen in the Readings Dyads little, if any, collaboration in preparing the readings occurred for most of the dyads.

Two of the three groups experienced problem behaviors as identified by researchers in collaborative learning (Blumenfeld, Marx, Soloway, & Grajcik, 1996; Johnson & Johnson, 1992). One group experienced problems with accountability. A sole member participating in the class from the remote site did not play a significant role in her group's final product. In another group, there was a rich-get-richer-effect. Because one participant had web development experience, she took over the responsibility for this and neither of the other two participants gained skills in this area as a result of the activity, yet she gained more experience. As seen in both these identified collaboration problems there was a link between the participant with the problem behavior and their physical location. The participant with web development expertise did not share her web development skills with the other members of her group because they were not physically accessible during the times she did the development. The participant accused of low participation was a self-described introvert and low level technical skill holder. She claimed she had difficulty contributing to her group especially since she was the only member at the remote site. This physical separation of one learner from the other two impacted the cohesion of these two groups. The small number of participants in the cross-site group was a likely factor as well.

Incorporating a CSCL Tool in a Distance Learning Environment

In order to facilitate many of these student-centered strategies, TWISTER was devised as an extension of the learning environment. Findings regarding its implementation, use, and support for the activities follow.

The instructional team envisioned and designed the learning environment to include use of TWISTER to support a range of instructional strategies. Although referred to as a supplement and never used solely as a means to support an instructional activity, the team planned for TWISTER to be an integral part of the course. Despite this intention, neither the instructor nor the students used it in this way. Difficulties encountered with the features and functionality of TWISTER proved to limit the mode of implementation to a less integral mode, i.e. what Harasim (1996) would refer to as adjunct. Most participants found little value in the added features of having an integrated course support tool. The value did not outweigh the challenges they identified with the features and functionality.

The design of TWISTER was based on findings from the literature and pilot studies with an earlier prototype (Ahern, 1993; CGTV, 1992; Guzdial, Turns, Rappin, & Carlson, 1995; Kaplan & Carol, 1995; Lajoie, 1993; Lebow, Wager, Marks, & Gilbert, 1996; Scardamalia & Bereiter, 1994; Schrum, Fitzgerald, & Luetkehans, 1997; Suthers & Weiner, 1995; Wan & Johnson, 1994). Desired features of the tool included space to post information or orienting scenarios, asynchronous and synchronous capabilities, support for threaded discussions, hypertext capabilities, information searching capabilities, scaffolding for metacognitive process structures, and the capability for participants to produce, share, and display products. In this case, the prototype tool, TWISTER, did

not incorporate scaffolding or production tools. Moreover, as discussed in the following section the synchronous capabilities had limitations in functionality impacting use in this class.

Synchronous/Asynchronous. Considerations Schrum (in press) suggests for when to choose synchronous tools include number of participants, skills of learners, and the type of task. Although, there was only one trial of a synchronous session by the participants, that one instance demonstrated TWISTER's weak synchronous conferencing capabilities. Learners in one of the small work groups were disappointed by time lags and access problems during their attempt.

In this study, several types of tasks were designed to examine how the different capabilities of each learning environment support the varying needs. Types of tasks built in were brainstorming and idea generation (Scenarios), information sharing (Internet Finds), dyadic negotiations (Readings discussions), and small group projects which incorporated a range of tasks including brainstorming, problem solving, and construction/production. Harasim (1993) also recommends task type as an important consideration for choosing synchronous versus asynchronous conferencing tools.

Since there was such little use of TWISTER it would be unfounded for this researcher to make any inferences for best uses of a groupware tool with synchronous and asynchronous conferencing. However, a comparison of observations of the asynchronous use of TWISTER with the synchronous use of compressed video for groups to come to a consensus indicated that decision-making was difficult in asynchronous online environments. Instead of breaking tasks to the level of specificity described above, Harasim (1993) looked at tasks as being convergent and divergent. As seen in the small work groups, compressed video (synchronous) provided a better environment for some types of tasks. When the groups described their group process, all of them stated that compressed video was the better means for decision-making, a convergent activity. Data were also consistent with Harasim's (1993) findings that asynchronous tools are better for divergent activities, e.g. brainstorming, discussion, information sharing.

Hypertext/threaded discussions. Two students recognized the value of being able to structure and organize a conference, i.e. a threaded discussion. Although these two students attempted to do so using the hierarchical structure, other participants made little use of the organizing capabilities. Data showed that there was little interaction reaching the level of a dialogue suggesting that learners did not have a need to impose an organizational structure on their postings.

Space for macrocontext. The hierarchical structure of TCBWorks worked well in serving as a place to present orienting scenarios. The weekly scenarios proved to be the favored use of TWISTER by both the learners and instructional team. With each weekly scenario given a dedicated space, learners could post responses and follow the threaded postings. Although the responses to the weekly scenarios never reached the level of a dialogue, students had no complaints or problems using the tool for scenarios.

Other features not utilized by participants. Two other features available to users of TWISTER were information searching and voting. The information searching feature allowed participants to search the world wide web while communicating in TWISTER. Although this feature was introduced and recommended to learners and identified as a need by at least one small work group, the feature was never employed. Participants claimed they did not realize it was available. The second feature not used by participants was the voting feature built into TCBWorks, the groupware product. This function was not particularly intuitive, and it was likely participants would have needed training. The voting feature was there to assist groups of users in coming to consensus. Although there was an expressed need for support in decision-making by the small groups, the voting feature did not appear to translate well to a learning situation. The instructional team mentioned voting as an available feature when TWISTER was introduced, but they did not encourage its use nor provide specific training.

Learner-interface Interaction

Hillman, Willis and Gunawardena (1994) suggest an additional type of interaction experienced in distance learning environments, learner-interface interaction. This type of interaction refers to the "transparency" of the technology. TWISTER was a prototype groupware tool, and although it was tested, was still laden with design and functionality difficulties. Data suggested that these peculiarities kept the tool from becoming transparent for these learners.

TWISTER's limitations in functionality presented challenges to learners interacting with the tool. Additionally, learners perceived as an inconvenience having to "go to it" in order to interact. Conferencing systems like TWISTER are often referred to as pull technologies (Dennis, Poothari, & Natarajan, 1997). Email can be described as a push technology, the opposite of a pull technology. With push technologies like email and Listservs, conferencing information and messages are sent to participants' email box. If they are regular email users, as many were in this class, checking email was already a familiar and often daily activity. Knowing this, learners and instructors often opted for email when they wanted to be sure the information would be received or if they wanted to initiate a two-way dialogue.

Learner Characteristics

Consistent with studies examining online learning environments, data in this case indicated that participant characteristics proved to be indicators for how and when they used the groupware tool (Eastmond, 1995; Hiltz, 1990; Schrum, 1996). Characteristics emerging as important included: access, experience and skill level, and attitude. The type and means of access a student had to the internet outside of class time affected their use of the groupware tool. Access was a factor deemed important at the outset of the research, however, the full extent of its impact was underestimated. Not only did learners with unreliable or no access, struggle, but learners with limited access also encountered difficulties. Learners with home or work access, only, were sometimes limited in the days or time of day they could interact on the system. Furthermore, those with limited, unreliable or no access also affected the work of others trying to collaborate with them.

Previous experience and technology skill level were important indicators, too. This was seen from both ends of the continuum including low skills to very high skills and previous experiences, both positive and negative. Several studies have identified similar characteristics of readiness for participating in online environments (Eastmond, 1995; Hollingshead, McGrath, & O'Connor, 1993). In order to expect learners to participate, a minimal skill level was required from the outset. Again, in collaborative environments, one learner's struggle can impact a whole group or even class. But still, some students bring with them notions and habits with which they are accustomed. This, too, can affect their participation.

Finally, attitudes toward several aspects of the learning situation were apparent indicators for participation and utilization. Consistent with what O'Malley and Scanlon (1990) found, despite learners' range of attitudes toward group work, most described their experience with the groupwork in this course as positive. Findings from this case differ from O'Malley and Scanlon (1990) however, with the small work groups. Some learners expressed negative opinions about having participated in cross-site collaborative groups and most learners agreed the groupware tool did not support their small group's work well.

This study examined two types of interaction using the groupware tool: learner-learner interaction and learner-instructor interaction. Participants in this class used the tool to share ideas and information and to maintain records. There was little demonstration of interaction reaching beyond the level of individuals posting single messages or pieces of information to the large group. This finding followed a one-to-many pattern of interaction proposed by Romiszowski and Mason (1996) as common to asynchronous tools. Data suggested that utilization of groupware tools is a complex and multifaceted issue. The limited use in this case was the result of problems learners had with system implementation, system access, as well as the features and the functionality of TWISTER.

Recommendations for Practice

These recommendations for practice result from a process of naturalistic generalization. Through careful data analysis, interpretation, and audit trailing, the findings from this case study were examined in light of the related literature. Caution was taken given the number of limitations in this study.

Assess the participants. This case demonstrated the impact that learner knowledge, skills, experience, and attitude can have on the learning environment. Before a new course begins it would be helpful to gain a sense of these characteristics for the particular set of learners in the learning situation. If there are wide ranges in skills and experience, activities can be tailored to meet individual needs.

Learners need to be prepared. Learner "readiness" as Eastmond (1995) suggested is important to successful implementation. First, learners need to understand how the course will be delivered. Additionally, in online or groupware environments they will want to be sure they have sufficient access to equipment.

The instructor should be prepared for the time it takes to manage a DL course. In this instance there were three members on the instructional team, and in every class meeting each member of the team was occupied with responsibilities. It is important that an instructor not underestimate the amount of time required.

Employ short and varied activities during class sessions. As one participant described, her attention span averaged about 15 minutes when viewing instruction over the compressed video system. To expect learners to be able to pay attention for longer periods of time is unreasonable. Not only should activities be short, but also varied. By changing the type of activity, learners may find more opportunities to participate.

Constant clarification may be necessary. Given that the average attention span in compressed video environments may be only 15 minutes long, it can be expected that the learners may miss some information. Plan for this by reviewing often, or providing supplemental handouts.

Interaction does not come easily in DL Environments. Despite the difficulties, low levels of interaction need not be settled for. Interaction can be constantly encouraged by incorporating participatory, discussion-based activities, leaving little room for lecture. High levels of interaction may need to be modeled.

Build community. As the instructor in this case believed, building community is important in DL environments. However, rotating locations every week may not be the solution. Off campus learners registered for the course with the knowledge there would be differences; on campus students did not. These expectations can color learner attitudes and influence the dynamics of the class. Instead the instructor can make themselves readily

accessible in other ways. For off campus students, instructors might consider taking the initiative to check in with them outside of class sessions through supplemental media, e.g. email, telephone, etc.

Open and collaborative activities are important. Open and collaborative activities are important in building student-centered DL environments. Open activities give learners the opportunity to experience authentic and meaningful learning. Cross-site collaboration helps to build community and increase interaction. Consideration, however, should be given to the group size and location of participants. Consider using an equal number of learners at each site. If groups are constructed based on particular characteristics, e.g., expertise, locations of these individuals should be noted. Also consideration should be given to providing supplemental technologies as necessary. A groupware tool may not be the only solution; email, synchronous chat tools, telephone, and fax could also be considered.

Allow sufficient training and time for learning groupware software. In presenting learners with a new software tool, ample training and guidance needs to be provided. Becoming adept at using the groupware tool could take longer than ten weeks. For most people, groupware would be a new class of software. This learning curve coupled with learning the content of the course may require additional time as well as practice before participants become proficient at using it.

Consider the Best Uses of Tool Features for Specific Task Types. In deciding whether to use a synchronous or asynchronous tool one should consider whether the activity is convergent or divergent as Harasim (1995) and Danielsen (1994) recommend and findings in this study concur. Consideration should also be given to whether the tool is a “push” or “pull” technology. Based on usage in this case, push technologies like email ought to be considered for addressing an individual or a one-to-one dialogue. Pull technologies, on the other hand, appear to work well for larger groups and maintaining a group record.

Selecting a groupware tool. Selection criteria needs to begin with whether the tool will translate well to a learning environment. As in this case, adapting a tool originally developed for business work groups posed some challenges. These challenges emerged because the tool itself had to be adapted to fit the intended uses and not all the features were usable. Also, the tool selected has to be fully functional. Using a prototype became an issue for this group. “Quirks” and “kinks” were eventually accommodated, but neither easily nor without frustration. The interface is also crucial. Learners should not be expected to conform to the tool. Again eliminating frustration and difficulties up front can help build a positive attitude in users. Finally, the value added versus required effort in selecting a tool needs to be carefully weighed. In this case, there was too little gained as a result of exerting a lot of effort to use TWISTER.

Recommendations for Further Study

Future studies considering similar overall questions to those in this study would be remiss not to be certain that the groupware tool employed is fully functional and meets the criteria described previously in the Recommendations for Practice section. The tool should be designed to support learning environments. Hopefully, it will be possible to employ a tool that incorporated fully functional features as described in the proposed model. Additional features would include scaffolding for instructional strategies and metacognitive processes, and shared production tools.

Also, more case studies similar to this would be useful for cross-case comparisons. Similar studies might also explore content areas outside of instructional technology without the methodological limitations described in the Reflection on the Methodology section.

Examining ways to improve distance learning environments continues to be an important line of inquiry. New technologies and new pedagogies have not bridged the “psychological distance” when participants are separated by space and time. Further questions to push this research area should consider such issues as:

- What are minimum, necessary, or desired levels of interaction?
- What can be done about this issue of “clarity” and missed information in DL environments?
- What are best practices for employing push versus pull technologies and synchronous versus asynchronous tools?
- What types of tasks can be supported by the various technologies?

Summary

In this case, a great deal was learned about using a groupware tool to supplement a distance learning course delivered over a compressed video system. Despite the careful design and crafting of a student-centered distance learning environment, participants identified a wide range of challenges. Instructors and students recognized limitations in interactivity frequency and levels, some activities did not work as intended and others were compromised by the environment or participants themselves. The open and collaborative activities encouraged rapport building and enhanced interaction. Nonetheless, challenges remained.

Use of TWISTER to assist in facilitating the student-centered activities also presented challenges. The tool did not support the activities as intended. Given the range of activities, the low usage of the groupware was

surprising. Factors that influenced participation included participant characteristics and the learner-interface interaction with the tool. A lack of a compelling need may have existed, even though activities were built around TWISTER use. As for the small groups, it was evident that email, despite its lack of structure, was the preferred online communication medium. For the learners, the added value of the features afforded by groupware did not outweigh the convenience of a push technology like email. There was data to suggest that asynchronous communication better supported divergent tasks while synchronous tools supported convergent tasks.

Based on these findings, it appears that distance learning environments continue to need to be improved through devising learner-centered activities and increasing interaction. This can be accomplished by first assessing and preparing the learners for the learning environment. Additionally, instructional strategies should include short and community building activities. Finally extra time should be planned for management issues.

Incorporating a groupware tool will require extra time for training and practice. Tool design or selection considerations should include assessing the tool's functionality in a learning environment and the types of activities to be supported with the tool.

This case exemplified many of the potential challenges that can emerge in distance and online learning environments. As internet communication technologies mature, perhaps more viable groupware tools will become available and participants will become increasingly comfortable working in such environments. These factors may eliminate many of the difficulties encountered in this case. Meanwhile, in-depth case studies such as this are valuable in investigating the possibilities of the present.

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THE INFLUENCE OF DESIGNER AND CONTEXTUAL VARIABLES ON THE INCORPORATION OF MOTIVATIONAL COMPONENTS TO INSTRUCTIONAL DESIGN AND THE PERCEIVED SUCCESS OF A PROJECT

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Abstract

This study investigated designer background characteristics and contextual variables that were hypothesized to influence the incorporation of motivational components to the design of instructional materials as well as the factors that may affect the perceived level of a project's success. A hypothesized model was developed that depicted anticipated relationships (based on the literature) between the variable sets on the perceived level of success of a project. Of the 500 questionnaires mailed to instructional design practitioners, 201 valid responses were returned. Stepwise multiple linear regression analyses and path analysis techniques were used to answer the 11 research questions posed for this study and test the hypothesized model. The revised model was developed from the results of stepwise regression analyses and path analysis techniques. The study found that certain background and contextual variable influence the incorporation of motivation design components and that certain factors in the hypothesized model have a significant relationship to the perceived level of success of a project.

Problem Statement

Is motivation an important component to the design of instructional materials? Most theorists and practitioners would agree that motivation should be a part of every design. However, scholars note that research on learner motivation has lagged far behind research on the learner's cognitive characteristics (Herndon, 1987; Klein & Keller, 1990; Spitzer, 1996). Traditionally the design process have focused on analysis of the learner's cognitive characteristics. According to Richey, (1992) "learner interests are the most common attitudes addressed in ISD models" (p. 116). Much in the literature indicates that while people accept that motivation is a desirable aspect of instruction it is considered too vague and complex a concept to be applied to systematic instructional design (Farmer, 1989; Keller, 1987c; Wlodkowski, 1981).

This study investigated designer background characteristics and contextual variables that were hypothesized to influence the incorporation of motivational components to the design of instructional materials as well as the factors that may affect the perceived level of a project's success. However, the emphasis in the literature regarding background characteristics and contextual variables is primarily concerned with the influence each may have on the effectiveness of the instruction for the learners. There is little research related to the possible influences of background characteristics, attitudes, and use of instructional design elements on a designer's incorporation of motivational strategies in to the materials and on his or her perceived success of a project.

Traditional Instructional Systems Design (ISD) models generally follow a systematic approach to design and are based on learning theory. They usually prescribe conducting a learner analysis to determine knowledge and skills during the definition or analysis phase. Learner characteristics such as age (Bohlin, Milheim, & Viechnicki, 1990; Bohlin & Milheim, 1994; Richey, 1992; Wlodkowski, 1985); gender (Binns & Branch, 1994; Canada & Brusca, 1991), culture, ethnicity (Eastman & Smith, 1991; Powell, 1997), organizational context (Tessmer & Richey, 1997) are considered important elements of a thorough audience analysis. Theorists and practitioners agree that background characteristics may have a significant effect on learner motivation or learning itself. However, analysis of designers' knowledge and skills is a relatively new subject in the literature. Little is said about how background and contextual factors may affect designers as they plan instruction and determine instructional and motivational strategies.

Keller (1983b) defined motivation as "the magnitude and direction of behavior. ... it refers to the *choices* people make ... and the *degree of effort* they will exert. Motivation is influenced by a myriad of internal and external characteristics (p. 389). He (Keller, 1987a) developed the ARCS Model of Motivational Design from his theoretical model (1979), which was based on accepted theories of human motivation. ARCS is an acronym for attention, relevance, confidence, and satisfaction, the four components of the model. Keller (1987b) defined each component as follows:

- Attention -- Capturing the interest of learners; stimulating the curiosity to learn.
- Relevance -- Meeting the personal need/goals of the learner to affect a positive attitude.
- Confidence -- Helping the learners believe/feel that they will succeed and control their success.
- Satisfaction--Reinforcing accomplishment with rewards (internal and external) (p.2)

Methods and Procedures

A hypothesized model was developed, based on a review of the literature, that identified variables and their subcomponents and the possible relationships between and among them. The variables sets used in the hypothesized model were (a) designer background, (b) instructional context, (c) attitude toward motivational design, (d) use of ISD components, (e) incorporation of motivation design components, and (f) perceived level of the project's success. Each of these sets had subcomponents, which constituted the variables. The primary hypothesis was that one or more of these variables would have a correlative relationship with the designer's application of motivational components of attention; relevance, confidence, and satisfaction to the design process. A second hypothesis was that incorporation of motivation would be shown to have an impact on the perceived success of the project. (See Figure 1)

The survey instrument was an 81-item questionnaire with five sections mapped to the variable sets in the hypothesized model was designed and developed by the researcher. Before finalizing the questionnaire, it was given to 25 members of the Michigan Chapter of ISPI (International Society for Performance Improvement) The questionnaire was mailed to 500 members of ISPI throughout the 50 United States and Puerto Rico. There were 201 usable questionnaires, which constituted a 40% response rate. Descriptive statistics were reported to provide a profile of the respondents.

The characteristics in 201 respondents included the following: a fairly even representation of men (n=91, 45%) and women (n=110, 56%). Nearly all of the participants were Caucasian (n=186, 93%) with few (n=15, 7%) representing other ethnic groups. Most respondents (n=145, 72%) had a master's degree or above. The majority of the sample (n= 130, 65%) were more than 40 years old, and had an average of 13 years of design experience. Nearly all respondents (n=156, 79%) rated their design expertise as high or very high, but only 76 (38.5%) claimed to have high or very high expertise in motivational design.

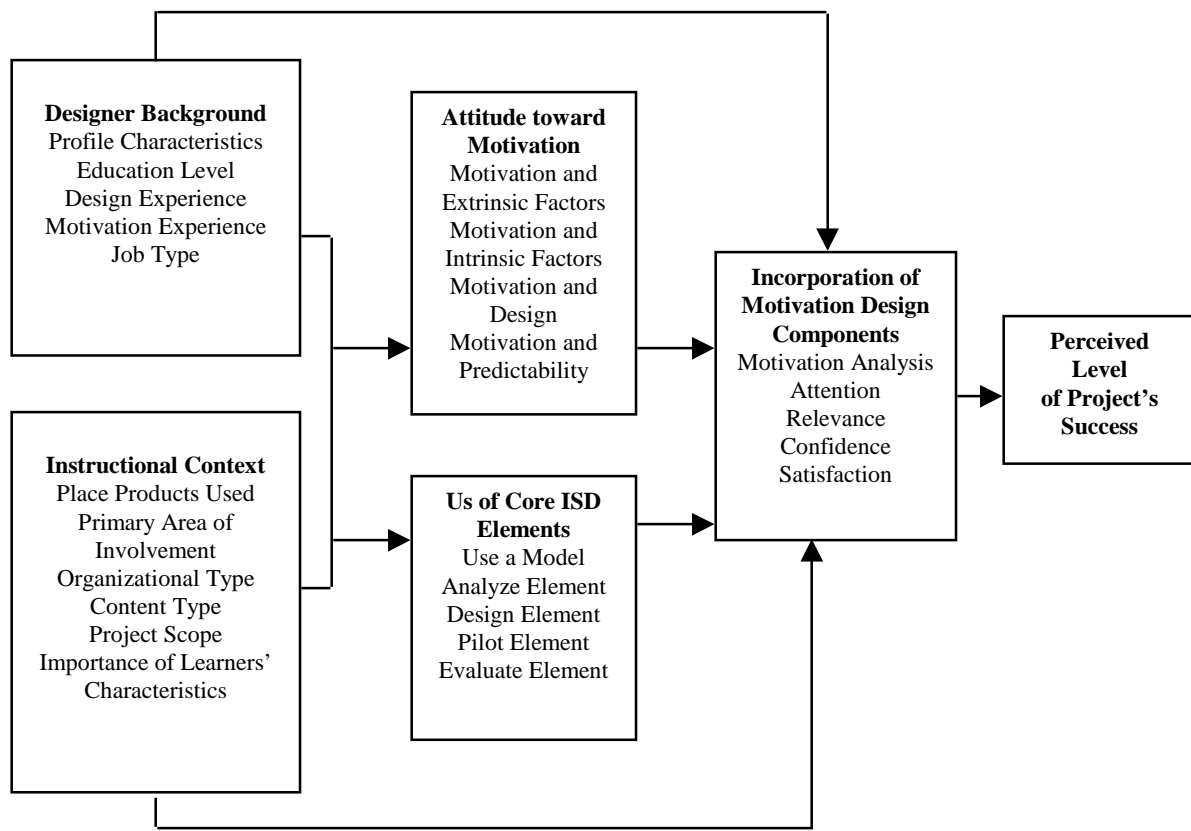
The data analyses answered 11 research questions. The hypothesized model (See Figure 1) depicted expected relationships between the following variables:

1. Designer background and attitude toward motivation.
2. Instructional context and attitude toward motivation.
3. Designer background and use of cores ISD elements.
4. Instructional context and use of core ISD elements.
5. Designer background and incorporation of motivation design components, (analysis, attention, relevance, confidence, and satisfaction).
6. Instructional context and the incorporation of motivation design components, (analysis, attention, relevance, confidence, and satisfaction).
7. Designer attitudes toward motivation and the incorporation of motivation and its components, (analysis, attention, relevance, confidence, and satisfaction). 1
8. Designer use of core ISD elements and the incorporation and the incorporation of motivation components, (analysis, attention, relevance, confidence, and satisfaction).
9. Four variables—designer background, instructional context, designer use of core ISD elements and designer attitude toward motivation—and the incorporation of motivation and its components (analysis, attention, relevance, confidence, and satisfaction).
10. The incorporation of motivation and its components, (analysis, attention, relevance, confidence, and satisfaction).
11. All five variables: designer background, instructional context, designer use of core ISD elements and designer attitude toward motivation, and the incorporation of motivation and its components (analysis, attention, relevance, confidence, and satisfaction) and the perceived level of a project's success.

Limitations of the Study

Some recognized limitations are involved in survey studies. First, despite a mailed questionnaire's ability to reach large numbers of people, the response rate is often low (Knupfer & McLellan, 1996), which may make it difficult to obtain a representative sample. Second, the mailed questionnaire is limited to volunteers, who may be different from non-respondents (Knupfer & McLellan, 1996). Third, if the sample is drawn from members of a professional organization, the sample has a possibility of being skewed toward more highly trained practitioners than the norm.

Figure 1. Hypothesized Model of Variables Related to the Incorporation of Motivational Components to Instructional Design and the Perceived Level of the Project's Success

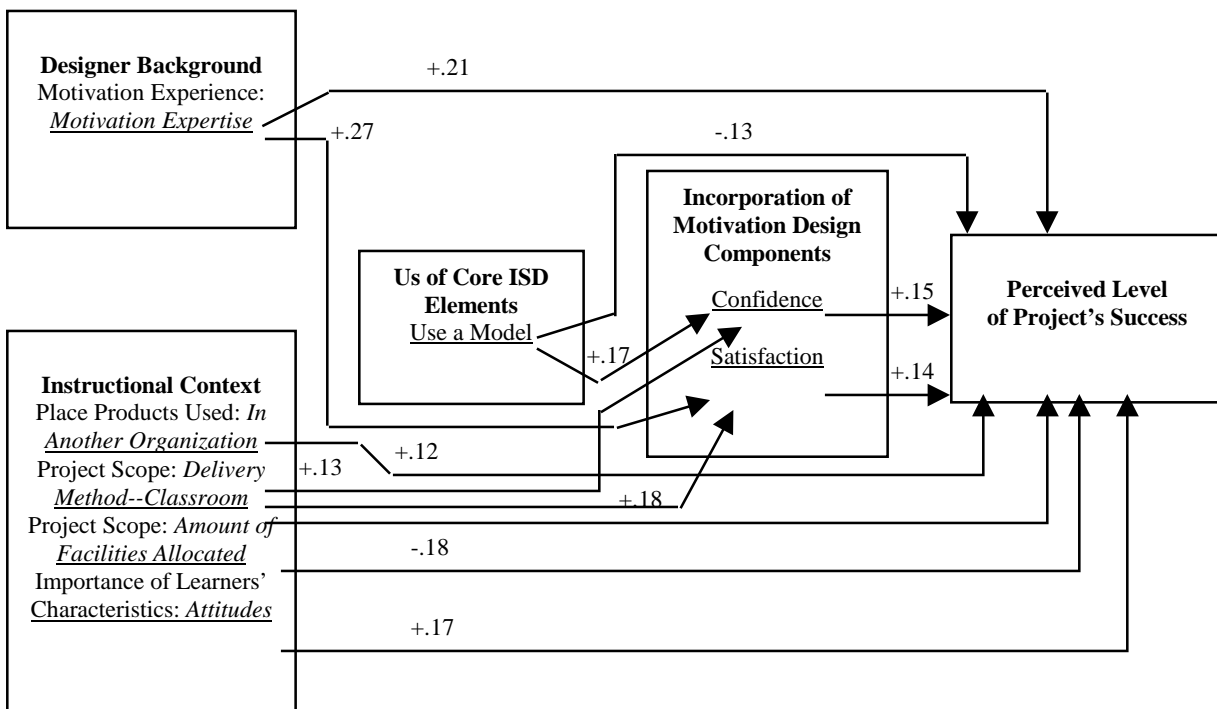


Stepwise multiple linear regression analyses and path analysis techniques were used to answer the 11 research questions posed for this study and test the hypothesized model. The revised model was developed from the results of stepwise regression analyses and path analysis techniques. To determine the relationships between the variable sets, regression analyses and path analysis were used. The results of these analyses are depicted in the revised model. (See Figure 2.)

Discussion of Findings

The revised model depicts the variables that were determined to be valid predictors of the dependent variable – perceived success of the project. One the five original variable sets, designer attitudes toward motivation, in the hypothesized model was eliminated. Four of the variable sets, (a) designer background, (b) instructional context, (c) use of core ISD elements, and (d) incorporation of motivation design components, were found to be valid predictors. Eight variables or subcomponents from the four variable sets were shown to have a direct effect on the dependent variable, perceived level of the project's success.

Figure 2. Revised Model of Variables Related to the Incorporation of Motivational Components to Instructional Design and the Perceived Level of the Project's Success



Designer Background

Respondents rated their general design expertise and motivation expertise. Designer expertise was not defined in the questionnaire. However, designer expertise has been defined in the literature as years of experience in the field as well as the ability to internalize and apply theoretical principles of instructional systems design (Atchinson, 1996; Rowland, 1992).

Motivation expertise was the only variable from designer background characteristics that directly affected perceived success of the project. This finding appeared to be consistent with McCombs' (1986) conclusion that expertise in design is one of the critical factors leading to successful application of an ISD model. Finding that motivation expertise has a direct effect on the perceived success of the project suggests that increased experience with motivational design increases the possibilities for a project's perceived success. Motivation expertise also had an indirect effect on the perceived success of the project through the confidence and satisfaction components of motivational design. The confidence component in motivational design emphasizes using strategies to guild a positive expectation for success, enhancing the student's beliefs in their competence, and ensuring personal control of learning (Keller, 1987c). The satisfaction component in motivational design emphasizes helping learners feel positive about their achievement.

Confidence-building strategies may be applied to the sequencing of content such as ordering problems from easy to hard to help ensure success, strategy applied successfully to computer courseware design (Keller & Suzuki, 1988). Additionally, strategies to increase confidence may be used to influence learners' attitudes. Motivational messages were used effectively to increase positive attitudes and learner confidence regarding the completion of a difficult course conducted in a summer workshop for teachers in Mozambique (Visser & Keller, 1990).

The influence of motivation expertise on the selection of confidence and satisfaction strategies, however, conflicts with Farmer's (1989) research that showed satisfaction to be the least addressed motivation component by designers. One explanation for this difference may be that the designers in Farmer's study involved novice designers who were graduate students in instructional technology. The designers in the present study had a mean of 13 years experience. This suggests that experienced designers with practice in the design of motivation are more likely to incorporate confidence and satisfaction strategies from the ARCS Model.

These findings pertaining to confidence and satisfaction are not consistent with research by Means, Jonassen, and Dwyer (1997), who found that relevance was the primary component that influenced motivation and learning outcomes. Although designers in the present study cited relevance most often as the key element in motivation, relevance did not appear as a predictor of project success. These contradictory findings about motivation are consistent with Farmer's (1989) conclusions about designers' decisions. He found that designers were more

likely to use “their personal intuitive feelings about what was motivating” rather than follow recommended strategies suggested by the ARCS Model (p.189). Furthermore, Farmer noted that designers’ reluctance to incorporate motivation into instruction systematically stemmed from their attitude about motivation. He observed that most subjects in his study viewed motivation as “fuzzy and uncertain” (p. 190).

The literature is inconclusive about the effectiveness of applying motivational design strategies to achieve desired instructional goals (Means et al., 1997). Some studies have found positive results, while others have found no significant effects (Moller, 1994; Naime-Deifenbach, 1991). However, one explanation for varying conclusions may be that each study was different in its goals, samples, and procedures. Therefore, more research, especially replication studies, regarding the uses and effectiveness of motivational design is needed.

Instructional Context.

Recent research into the role of context suggests that contextual variables play a role in successful training and learning (Tessmer, 1995; Tessmer & Richey, 1997). However, there is little information about the possible relationship between where the designers’ products are used (own organization or client’s organizations) designers and the perceived success of a project.

Four variables from the instructional context variable set also directly affected the perceived level of the project’s success. These contextual variables were: (a) place products used: another organization, (b) classroom/instructor-led delivery, (c) amount of facilities allocated, and (d) importance of learners’ attitudes

The first predictor was the place products were used. The respondents indicated where their products of their work were typically used--in their own organizations or in a client’s organization. This study found a positive relationship between use of the designers’ instructional products in the clients’ organizations and perceived success. It was not clear why this was so. One possible explanation may be due to the type of evaluations general done on instructional products. Designers and trainers commonly use “reaction,” or “smile sheets,” to obtain a first level evaluation of the instruction (Kirkpatrick, 1994). These evaluations are often constructed by the designer/trainer, and are scored and interpreted by the designer/trainer. Therefore, a limitation of this study is that the respondents were not asked to identify the types of evaluation methods they used to reach their conclusion about the success of the project. Further, there were no objective data collected from the learners or clients on the success of the project. The determination of the project’s success depended entirely on the respondents’ perceptions.

Classroom/instructor led delivery was the second predictor of perceived project success. The positive relationship between the two variables indicated that respondents who reported greater use of classroom delivery tended to rate the project’s success higher. Classroom delivery/instructor led delivery also indirectly influenced perceived level of project success through confidence and satisfaction. These positive relationships may be due to the fact that most of the respondents (n=166, 83%) cited instructor-led classroom instruction as the delivery type used in the selected project. Although respondents could have indicated more than one type, other delivery types such as print (n=69, 34.5%), computer (n=63, 31.5%), video (n=26, 13%) were not used as often and did not appear as significant predictors.

The third contextual variable found to be a significant predictor of perceived project success was the amount of facilities allocated. However, this was a negative relationship, which suggested that participants who estimated the amount of facilities for the projects as low or moderate were more likely to rate the success of the projects higher. This finding seems to contradict research by Tessmer and Richey (1997), who argue:

The physical condition of the immediate environment is a potent force in learning. The physical environment does not so much increase learning when it is excellent as inhibit it when it is poor. That is, a certain level of adequacy must be attained in seating, acoustics, temperature, and lighting for proper learning to take place (p.97).

However, this finding may not be completely in contrast to Tessmer and Richey’s contextual analysis. Respondents’ rated the “amount of facilities.” as low or moderate, but this may indicate that they perceived them to be “adequate.” As noted previously, more than 80% of the participants in this study indicated that their project involved classroom instruction with approximately one third using video and or computer facilities. The “low” to “moderate” classroom facilities used for classroom instruction by the participants, then, was deemed sufficient for the perceived level of project success. This finding may indicate that the amount of facilities allocated is not a critical element to successful instructor-led classes that are not dependent on superior facilities and equipment.

Importance of learners’ attitudes was the fourth contextual variable to directly predict the perceived level of a project’s success. This finding indicates that respondents who reported being concerned about learners’ attitudes were likely to perceive the project as being successful. This finding is supported by the literature. Richey (1992) notes that ISD models generally address learner interests, which are related to attitudes. A leading instructional design textbook (Rothwell & Kazanas, 1992) recommends that a needs analysis include attitudes. Since Keller (1979) and others (Bohlin, Milheim, & Viechnicki, 1991; Bohlin et al., 1990; Keller, 1987b; Keller, 1990; Richey, 1992; Wlodkowski, 1985) consider learners’ attitudes to be connected to motivation, it is important to find that practicing designers also consider attitudes of learners to be important.

Use of Core ISD Elements

Respondents rated the importance core ISD elements were to the projects identified for this study. The importance of using an ISD model (or variable “use a model”) was found to be a negative predictor of the perceived level of the project’s success. This finding indicated that importance of using an ISD model does not have a significant relationship to the perceived success of the project. This finding was not consistent with the theory of ISD, which endorses the use of an ISD model for the design and development of instructional materials. This study’s finding, however, supports research on designers and the difference between designer practice and theory (Pieters & Bergman, 1995; Rowland, 1993; Winer & Vázquez-Abad, 1995). This finding underscores the argument by Pieters and Bergman, who note that “...design is often tacit (i.e., done without knowledge that a systematic procedure is being followed)” p.123.

The importance of using an instructional design model (“use a model”) had an indirect effect through the motivation component, confidence. This effect was positive, indicating that instructional designers who considered the use of an ISD model important were more likely to include confidence-building strategies into the design of instructional materials.

Incorporation of Motivation Design Components.

The hypothesized model contained five subcomponents in the variable set, Incorporation of Motivation Design Components. Based on the ARCS Model (Keller, 1987c), this variable set included the following components: (a) motivation analysis, (b) attention, (c) relevance, (d) confidence, and (e) satisfaction. According to comments made by the respondents, effective instructional design includes the use of motivational strategies. However, the revised model showed that only confidence and satisfaction were directly related to the perceived level of the project’s success. Both of these variables were positive, which indicated that respondents who indicated they emphasized confidence and satisfaction in their designs were likely to rate the success of the project as high. It is not clear why these two strategies emerged as predictors but the others did not. An explanation may be in the contradiction that exists between theory or beliefs and actual practice. The majority of respondents (121, 60%) agreed with the statement that motivation can be analyzed effectively and applied systematically to instructional design. Nonetheless, designers in this study appeared less likely to analyze motivation, but seemed likely to include one or more of motivation components (attention, relevance, confidence, and satisfaction) when planning, developing, and implementing their projects. This lack of motivational analysis supported the general view in the field that motivation is somewhat of a vague concept that is difficult to be analyzed systematically (Farmer, 1989; Keller, 1987c). In addition, this finding showing that respondents placed more importance on confidence and satisfaction components than attention and relevance may be in accordance with Keller’s (Keller, 1987b) recommendation for the selection of components based on a learner analysis of motivational needs.

Conclusions: Implications for Practice and Recommendations for Research

The initial problem statement presented in this study suggested that one or more of the variables in the hypothesized model would affect a designer’s application of motivational components to the design process and ultimately a designer’s perceived success of the project. The relationships between these variables were analyzed.

Because this study surveyed members of ISPI who are involved in design activities, the results of their observations should provide several implications for the field.

1. Motivation expertise is the only one of the designer background characteristics that influences the designer’s perceived success of the project. This suggests that designer’s should make an effort to incorporate motivational design strategies to increase the likelihood of a successful project.
2. Background characteristics such as age, gender, race/ethnicity, and education level do not appear to be factors that influence the designer’ incorporation of motivation nor the designer’s perceived success of the project. While these factors may be important considerations for a learner analysis regarding the design of motivational strategies, these do not appear to have any relationship to the designer’s incorporation of motivational components or the success of the project.
3. Instructional context variables regarding the importance placed on learners’ attitudes was shown to have a significant relationship to the project. Designers should make sure that these learner characteristics are given significant consideration in the design of instructional materials.
4. Classroom or instructor led delivery is another contextual variable that affects the perceived success of a project. This suggests that instruction delivered via a classroom with an instructor has increased likelihood for success.
5. The importance of using of an ISD model in the design of instructional materials had a negative relationship to the perceived success of the project. This suggests that designers probably consider the reaction to the end product as more important than the process used to create the end product. Further, this may indicate that experienced designers apply tacit knowledge to the design process and incorporate various steps from different models rather than selecting just one model.

Recommendations for Further Research

The findings indicate that certain designer background and contextual variables have significant relationships to the incorporation of motivational components and to the perceived success of a project. The data

show motivation expertise is an important factor in predicting the success of a project and that certain contextual factors and design practice variables influences the outcome of a project. However, there are several issues that need further research.

Expertise had a positive impact on the perceived success of a project and the incorporation of motivation analysis. However, this study did not define or describe motivation expertise. Rowland studied instructional design expertise but motivational design expertise has not been a subject of research. More needs to be done to describe and define the practice of motivational design.

The two motivational components found to have the most impact on perceived success of the project are confidence and satisfaction. A study by Means and his colleagues show relevance is the most important motivational component. Keller, however, asserts that all four components are necessary, but one or two may be emphasized more based on a thorough learner and content analysis. Further research needs to be done to determine if one component is more essential to motivation than the others.

Most of the designers in this study designed instruction for classroom delivery. Since a greater emphasis is being placed on designing for technology, it would be interesting to replicate this study with a sample population of designers who design primarily for computer or web-based delivery.

Most of the practitioners said that they received little formal training in design of motivational strategies. Further research is needed into the university programs to determine whether or not instructors are including motivational design in their course content. Further, it would be helpful to try to determine the factors that influence their decisions.

This study found that the use of an ISD model had a negative influence on the perceived success of the project. This conclusion was consistent with studies about the gap between theory and design practice, but it is inconsistent with ISD theory. More research needs to be done on how designers make decisions and how they use ISD models as well as the factors that influence their choices.

Finally, this survey study depended on self report rather than on direct observation of designers. It would be interesting to study the actual practice of designers and their products to determine the motivational components they incorporate into the design of instructional materials and the reason for their decisions. It is important for the field to continue to study the gaps between theory and practice and the possible reasons for the gaps. And it is important to try to determine the factors that lead to a project's success.

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THE ARCS MODEL FOR DEVELOPING MOTIVATIONALLY-ADAPTIVE COMPUTER-ASSISTED INSTRUCTION

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The purpose of this study was to examine the effects of a prototype of motivationally-adaptive CAI, developed in accordance with the ARCS model of motivational design, on achievement, perceived motivation (both overall motivation and each of A, R, C, & S components), efficiency, and continuing motivation. Students studied one of three versions of CAI: motivationally-adaptive CAI, motivationally-saturated CAI, or motivationally-minimized CAI. Motivationally-adaptive CAI showed higher effectiveness, overall motivation, and attention than the other two CAIs. For relevance, motivationally-adaptive CAI was higher than motivationally-saturated CAI but not higher than motivationally-minimized CAI. For confidence and satisfaction, motivationally-adaptive CAI was not higher than the other two CAIs. For efficiency, both motivationally-adaptive CAI and motivationally-minimized CAI were higher than motivationally-saturated CAI, but only the efficiency of the motivationally-adaptive CAI was identified as having practical importance. For continuing motivation, there were no significant differences among the three CAIs, but a significant correlation was found between overall motivation and continuing motivation across three CAIs. These findings, first, support the contention that the ARCS model is useful for developing motivationally-adaptive CAI. Second, motivationally-adaptive CAI can be an effective, efficient, and motivating form of instruction which may also enhance learners' continuing motivation. Related discussions and recommendations for future study are provided.

Computer mediated-instruction is being widely used as more advanced computer and communication technology becomes available. Learners, either school-aged or adult, now learn and will have to learn more from computer-mediated instruction such as computer-assisted instruction (CAI), intelligent tutoring systems, integrated learning systems, or network-based learning environments. This trend shows that computers as instructional media are becoming now a routine part of instructional delivery systems.

However, two recent concerns regarding the wide spread used of computers have indicated the need to deal with motivation to learn during the computer-mediated instruction. One concern is that as computers are becoming widely used for instructional delivery, their novelty effects will disappear (Keller & Suzuki, 1988; Keller, 1997). Students will no longer be fascinated with learning from computer-assisted instruction as much as they once were. Then the question is how to get hold of their motivation during the computer-mediated instruction.

Several advocates of adaptive CAI have raised the other concern, which is how to include adaptive responses to student motivation. They have pointed out that few previous efforts to design adaptive CAI have considered learner motivation as a factor for which subsequent instruction is prescribed (del Soldato & du Boulay, 1995; Hativa & Lesgold, 1991; McCombs, Eschenbrenner, Jr., & O'Neil, Jr., 1973). Their main concern has been that although possible benefits of developing adaptive CAI have been found, one limitation of prior efforts (e.g., Atkinson, 1976; Holland, 1977; Houlihan, Finkelstein, & Johnson, 1992; Mills & Ragan, 1994; Ross & Morrison, 1988; Tennyson & Christen, 1988; Tennyson & Park, 1980) is that the students' motivation to learn is disregarded or assumed to be embedded in the cognitively adaptive CAI. Therefore, they have proposed the development of a motivationally-adaptive CAI that is adjusted to motivational changes for better learning outcomes, i.e., increased achievement and positive attitude toward learning.

Three approaches to the design and development of a motivating CAI can be found in the literature. The first is the Computer Feature Approach, in which specific computer features and novelty effects (Clark, 1983) are assumed to increase the appeal of CAI. For example, Brown pointed out, "the student is rewarded by the use of the machine itself" (Brown, 1986, p. 28). Also, it has been contended that "the cumulative effects of entities such as color, graphics, and animation can be instructionally and motivationally powerful" (Relan, 1992, p. 619). The second is the Principle Seeking Approach, in which prescriptive motivational design principles and tactics for CAI are identified or developed diverse theoretical and practical perspectives. For example, instructional games are recommended for the development of motivating CAI (Dempsey, Lucassen, Gilley, & Rasmussen, 1993; Malone, 1981; Malouf, 1988). Cooperative learning on CAI (Johnson & Johnson, 1986) is also suggested, as is learner control of CAI (Klein & Keller, 1990). The third is the Model Establishing Approach. The relationships between motivational theories and computer features are identified and incorporated into a practical model for designing motivating CAI. For example, Lee & Boling (1996) proposed the framework of motivational screen design. Keller and Suzuki (1988) proposed a set of motivational strategies for designing a motivating courseware based on the

ARCS model. Keller & Keller (1991) and Keller & Keller (1992) later developed this into a framework for designing motivating multimedia instruction.

All of these three approaches may be used for the development of a motivating CAI. However, they all have limitations. The Computer Feature Approach does not address the decreasing motivational effects of computer features whose novelty effects will disappear as learners become more familiar with computers. The Principle Seeking Approach has a value in that it provides more specific and practical guidelines. However, it is limited in that its approach tends to focus on limited and specific aspects of motivation, whereas motivation to learn needs to be understood more comprehensively. For example, not all CAI programs can be developed as instructional games. The Model Establishing Approach appears to be the most useful in that it provides a frame of reference that will guide instructional designers. But it is also incomplete in that it suggests that all the motivational strategies need to be identified and pre-sequenced before instructional delivery.

Furthermore, there is a common problem across the three approaches. That is, they do not address the continuously changing nature of motivation to learn. One of the reasons for this could be that all of the decisions about what types of motivational tactics to include have to be made at the design stage and cannot be modified once the instruction is ready for delivery. This means that every student receives exactly the same package. However, students who are highly motivated before starting CAI will not always remain motivated throughout the whole learning process. And conversely, some students who are not motivated before beginning CAI may become motivated as they proceed through the process. Therefore, it would be highly desirable to enable the CAI package to be responsive to motivational differences within the same learner at different points in time.

Regarding these problems of the three traditional approaches, a recommendation has been made consistently in the literature of motivation that we should provide optimal motivational strategies to learners (Brophy, 1987; Lepper, 1988). If learners are already motivated, they should not be exposed to any more unnecessary motivational tactics (Astleitner & Keller, 1995; Keller, 1983, 1987 a,b,c). In that case, just sustaining their motivation is recommended. In contrast, learners' motivation should be enhanced when they are de-motivated. In this study, as a way of providing optimal motivational strategies, the idea of adaptive provision of motivational strategies was tested on computer-assisted instruction.

A few pioneering efforts have discussed and tried the development of motivationally adaptive CAI (Astleitner & Keller, 1995; del Soldato and du Boulay, 1995; Rezabek, 1994). However, these efforts have several shortcomings. First, few have been supported by positive empirical data with respect to increased performance and motivation. For example, Rezabek just discussed the use of intrinsic motivational strategies for the development of motivationally-adaptive instructional system. Astleitner & Keller (1995) suggested a simulation approach for designing motivationally-adaptive CAI, but they mainly provided ideas on how a computer can predict motivational states. Reporting the positive formative evaluation results on the program called "MORE", del Soldato and du Boulay (1995) suggested the need for further study on its effects on performance and motivation. Therefore, studies to investigate the actual effects of motivationally-adaptive CAI on outcomes such as achievement, perceived motivation, continuing motivation, and efficiency need to be conducted.

Second, the content of instruction has been mostly composed of a battery of test-items. For example, del Soldato and du Boulay (1995) developed an intelligent tutoring system where the system presented test-items to be solved by learners, and then both instructional strategies and motivational strategies were prescribed based on student performance. However, there is no reason that contents in the motivationally-adaptive CAI should be limited to test-items. Therefore, there needs to be a study that investigates the possibility of developing motivationally-adaptive CAI which teaches diverse types of content such as verbal information, concepts, principles, etc. (Gagne, 1985). Regarding this need, del Soldato & du Boulay suggested that "a richer domain representation, including, for example, a wider variety of links between topics, would provide space for further elaboration of motivational tactics." (p. 373)

Third, the previous ideas suggested by Astleitner & Keller (1995), and del Soldato and du Boulay (1995) require challenging efforts for instructional designers to understand and utilize and utilize their models for designing instruction. For example, Astleitner & Keller's approach requires instructional designers to obtain parameters, such as incentive value, to be used for simulation. Del Soldato and du Boulay's approach may require instructional designers to face the complexity of programming intelligent-tutoring systems. Therefore, it would be desirable to produce a generic, motivationally-adaptive CAI which can be designed in a simpler and more generalizable way. This product would provide confidence to instructional designers in dealing with motivational problems in designing CAI because they would not need to worry about all the complicated computer-related logic and calculations.

Finally, there is a need to use an integrated model which will guide instructional designers. Park (1996) points out that a micro-adaptive instructional system using computer technology has been based on "a particular model or theory of learning, and its adaptation of the learning environment is rather sophisticated (p. 646)." Likewise, also for the development of motivationally-adaptive CAI, we need to find a practical model that is theoretically validated and practically field-tested. In fact, one reason that there has not been much effort made to design a motivationally-adaptive CAI may be the lack of a practical model which can guide the diagnosis and

prescription (Astleitner & Keller, 1995). Although McCombs, Eschenbrenner, Jr., & O'Neil, Jr.(1973) drew attention to the need for designing the motivationally-adaptive CAI in 1973, it was not until recently that actual efforts were made to develop such a system.

In this study, the ARCS model is used as a framework for the development of motivationally-adaptive CAI. Motivation is something inside the learner's mind, and it is important to stimulate or sustain learners' motivation to learn for their active learning. As a way of addressing this issue, the ARCS (Attention, Relevance, Confidence, and Satisfaction) model was proposed by Keller(1979,1983,1987a,b,c). He developed it as a conceptual tool and process for designing instruction that is appealing, in addition to being efficient and instructionally effective.

Generally, in the case of external adaptation, an adaptive CAI needs to have two functions which are essential to meet instructional needs (Ross, Rakow, and Bush,1980; Carrier & Jonassen, 1988). First, an adaptive CAI needs to diagnose the state of learners. That is, learner characteristics to which instruction is adapted must be continuously identified and measured. Second, the adaptive CAI should have the capability to provide the most appropriate instruction to address the identified state of learners. Similarly, motivationally-adaptive CAI should have the same two characteristics.

For example, CAI cannot be motivationally adaptive if it fails to identify the learner's motivational levels at more than one point of time in learning. Because the learner's motivational level can continuously change throughout instruction, any CAI which is developed based on a one-time motivational analysis prior to developing a course may not work. Also, motivationally-adaptive CAI should be able to provide instruction which is precisely adapted to meet the learner's motivational state.

This need requires us to use the ARCS model differently from the way it has been used for motivational design. In fact, the ARCS model has been applied to the enhancement of different types of instruction with respect to content and method of delivery. For example, with respect to delivery, it has been applied to classroom instruction, self-directed learning materials, and mediated instruction such as CAI (Keller & Keller, 1991; Keller & Suzuki, 1988). Its primary application has been in the initial development of materials based on the entry-level motivation of students

With this in view, the central question of this study is to investigate whether the ARCS model can help instructional designers design CAI which is motivationally individualized or adaptive to the learners' motivational needs. Keller's ARCS model seems to provide a basis for meeting the above two functions, i.e., diagnosis and prescription, of a motivationally adaptive CAI. For the former, audience analysis is emphasized, and for the latter, Keller & Suzuki (1988) propose sets of prescriptive strategies based on the ARCS model.

Moreover, the ARCS model is developed from a thorough literature review on motivational theory. The four components, attention, relevance, confidence, and satisfaction, are based on a general macro theory of motivation (Keller, 1979,1983) and have been verified through several validation studies and discussions (Bickford, 1989; Keller, 1984; Means, Jonassen, & Dwyer, 1997; Klein & Freitag,1992; Newby, 1991; Nwagbara, 1993; Small & Gluck, 1994; Visser & Keller, 1990). Mostly, the use of the ARCS model has been supported by empirical results showing increased motivation, achievement, and continuing motivation. However, no study has been conducted to investigate the use of the ARCS model for the development of the motivationally-adaptive CAI. To apply it, there are two major steps: diagnosis of motivational states and prescription of tactics.

Diagnosing Motivational State

Keller (1983,1987 a, b, c) emphasized the importance of audience motivational analysis before designing motivational enhancements to instruction. The learner's motivational level can be estimated based on the designer's personal experience, objectively assessed from collected and analyzed data, or by both (1987b). An audience motivational analysis is generally conducted for each component of attention, relevance, confidence, and satisfaction, although the decisions as to how specific to be will depend on the criticality of the decision, the anticipated obstacles, and the consequences of failure.

For example, for an instructor-led course, the process questions (Figure 1) presented by Keller (1987a or b) can be used as checklists because they are well categorized into four components of motivation (ARCS), enabling comprehensive check-ups. Designers can use those questions for their "best guess" process or for developing an instrument for measuring motivation. In either case, it is the designers' initial responsibility to identify the learners' levels of motivation. An instructor can then more or less continuously monitor motivation and change tactics as necessary. This fact has an important implication for instructional designers when they try to use the ARCS model for designing the motivationally-adaptive CAI: there should be measurement tools embedded in the instructional program which continuously monitor learners' motivational change as an experienced tutor does. For example, the audience analysis needs to be conducted several times throughout the instruction.

Figure 1 *Process Questions and Motivational Strategies (adapted from Keller, 1987a)*

Questions for Components	Suggested Strategies
Attention <ul style="list-style-type: none"> What can I do to capture their interest? How can I stimulate an attitude of inquiry? How can I maintain their attention? 	<ul style="list-style-type: none"> Create curiosity, wonderment by using novel approaches, injecting personal and/or emotional material. Increase curiosity by asking questions, creating paradoxes, generating inquiry, and nurturing thinking challenges. Sustain interest by variations in presentation style, concrete analogies, human-interest examples, and unexpected events.
Relevance <ul style="list-style-type: none"> How can I best meet my learner's needs? (Do I know their needs?) How and when can I provide my learners with appropriate choices, responsibilities, and influences? How can I tie the instruction to the learner's experiences? 	<ul style="list-style-type: none"> Provide statements or examples of the utility of the instruction and either present goals or have learners define them. Make instruction responsive to learner motives and values by providing personal achievement opportunities, cooperative activities, leadership responsibilities, and positive role models. Make the material and concepts familiar by providing concrete examples and analogies related to the learner's work.
Confidence <ul style="list-style-type: none"> How can I assist in building a positive expectation for success? How will the learning experience support or enhance the students' beliefs in their competence? How will the learners clearly know their success is based on their efforts and abilities? 	<ul style="list-style-type: none"> Establish trust and positive expectations by explaining the requirements for success and the evaluative criteria. Increase belief in competence by providing many, varied, and challenging experiences which increase learning success. Use techniques that offer personal control (whenever possible) and provide feedback that attributes success to personal effort.
Satisfaction <ul style="list-style-type: none"> How can I provide meaningful opportunities for learners to use their newly-acquired knowledge and skill? What will provide reinforcement to the learners' successes? How can I assist the student anchoring a positive feeling about their accomplishments? 	<ul style="list-style-type: none"> Provide feedback and other information that reinforces positive feelings for personal effort and accomplishment. Use verbal praise, real or symbolic rewards, and incentives, or let learners present the results of their efforts ("show and tell") to reward success. Make performance requirements consistent with stated expectations, and provide consistent measurement standards for all learners' tasks and accomplishments.

Two issues arise when audience analysis is conducted by the computer. One is the need for comprehensive assessment of motivation, the other is the method of assessment. As far as comprehensiveness is concerned, although motivational levels of all four components (attention, relevance, confidence, and satisfaction) can be assessed in the case of the instructor-led course, CAI has some limitations in this regard.

The reason for measuring motivation in adaptive CAI is to provide formative input that can be used to determine what motivational tactics to use in the subsequent part of the program. The measures of attention, relevance, and confidence can easily be used for formative feedback. Measures of satisfaction that are taken at intervals during the program could also be used for formative feedback and for the selection of subsequent motivational tactics, but in many respects satisfaction measures will be more summative in nature. This will be especially true in relatively short episodes of instruction. Although the analysis of satisfaction can be conducted several times, it is difficult to provide adaptive motivational strategies to address the measured level of satisfaction. Satisfaction could be eliminated from this initial study of adaptive CAI without affecting the theoretical or practical foundation of the study. It is important however to use all three of the other categories because of their interactive nature. If the treatment were long, with several lessons or units of work, then it would be important to monitor satisfaction of each point.

Second, the assessment method to be used in audience analysis is another concern. Although Keller (1987b) contends that the full range of measurement possibilities can be considered, in the case of CAI there is an inevitable limitation that it is the computer, not a human tutor, who assesses or monitors the learner's motivational change.

In this study, self-report measures were used for embedded audience analyses throughout the instruction. Although self-report measures can have problems with respect to reliability and validity, the researcher judged that it might be the simplest method which can be easily understood and utilized by most instructional designers. Keller (1987b) says that straightforward self-report measures can be very useful when they focus on an identified area of concern. For example, in this study, each learner was asked to report his or her motivation in terms of its direction and magnitude with respect to attention, relevance, and confidence. In addition, as a way of complementing the weakness of self-report measures, measures of performance scores on the quiz were also used in conjunction with their motivational self-assessments.

Prescribing Motivational Strategies

Based on the ARCS model, Keller and Suzuki (1988) suggested a set of motivational strategies for designing a CAI program. They say that CAI developed with the ARCS model is expected to be motivating compared to ones not developed in accordance with the ARCS model. Of course, any CAI can be motivating provided that the instructional designer's skills, experience, and creativity are adequate whether or not they have any knowledge of the ARCS model. The ARCS model simply tries to codify this knowledge gained from the research literature and the examples of successful practitioners. However, there can be a benefit to using the ARCS model, or some other systematic approach to motivational design for guidance and for documenting results in a way that can be used by others. This is where Keller's ARCS model and motivational strategies suggested by Keller and Suzuki could be used with its systematic but holistic problem solving approach. Motivational strategies, well organized in terms of ARCS components, are expected to help ensure the motivational quality of CAI.

However, little research has been done on whether the adaptive use of motivational strategies suggested by Keller & Suzuki can increase the appeal and effectiveness of CAI by being adjusted to motivational changes of learners, compared with those used in a CAI program which is not motivationally-adaptive. Visser and Keller (1990) applied the ARCS model in an adaptive way and reported promising results for an instructor-led course. Their application was "based on continuous diagnosis of the audience and subsequent formulation or reformulation of a solution (p. 472)."

Building on this concept and other research, the purpose of this study was to investigate the use of the ARCS model in developing a motivationally-adaptive CAI which is appealing, will enable learners to study more effectively and efficiently, and will enable learners to have more continuing motivation. To achieve this purpose, it was necessary to prepare a prototypical CAI that is motivationally-adaptive and to compare it to two different motivationally non-adaptive versions of CAI. The first non-adaptive version (motivationally-saturated CAI) is enhanced with a full set of motivational strategies, and the second (motivationally-minimized CAI) has virtually no motivational strategies added.

It was expected that the motivationally-adaptive CAI would be most motivating to learners because it was designed to a) avoid providing excessive motivational strategies that would distract or annoy learners who already found the instruction to be motivating, and b) to overcome motivational deficiencies among learners who were bored or otherwise demotivated by the content. It was also expected that the motivationally-adaptive CAI would be most effective in terms of learning achievement, and successful in producing the highest continuing motivation. Finally, the efficiency of the three versions of CAI was determined by comparing achievement to time spent on the lesson. It was expected that the motivationally-adaptive version would be most efficient.

Method

Subjects and Design

Subjects were 66 tenth grade students from the Developmental Research School (DRS) affiliated with a large university in the Southeastern United States. Students are selected and admitted to the DRS to be representative of Florida's school-age population in terms of academic ability, race, sex, and socio-economic status. Subjects were selected from three different classes taught by the same biology teacher. The classes represented two different levels of ability, with the higher being the college prep group.

Subjects who had been identified by the biology teacher as not having studied the contents were randomly assigned to three conditions of one independent variable (motivationally-adaptive CAI, motivationally-saturated CAI, and motivationally-minimized CAI). The dependent variables were effectiveness (learning), efficiency (amount of learning per time spent), motivation (both overall motivation and each of attention, relevance, confidence, and satisfaction), and continuing motivation.

Materials

Three versions of hypercard computer-assisted instruction were developed that contained the same contents on Genetics. The contents were adopted and modified from three sources: a print-based biology instructional module developed by Osman (1992), a hypertext CAI developed by Park (1993), and a textbook entitled *Biology* (Goodman et al., 1989). Genetics was chosen for three reasons. First, the content of the instruction needed to be facts, concepts, and principles (Gagne, 1985) as mentioned earlier in this paper. Second, the reading ability level was appropriate to tenth grade students (Park, 1993). Third, it was judged that the content needed to be somewhat technical and must not be easily understood without student effort. It was confirmed through interviews with biology teachers that, although the students appeared to know much about genetics, in fact, their understanding of the details tended to be poor.

Each version of CAI included three sections: first, (Introduction, Gregor Mendel, Mendel's Experiment, The Principle of Dominance); second, (The Principle of Segregation, The Principle of Independence Assortment, The Principle of Chance and Probability), and third, (Predicting the Results of Genetic Crosses, The Punnett

Square). Students using the three versions of CAI were asked by the computer for their motivational attitudes just prior to beginning each of the three sections. Each time, they were asked about their attitudes toward the interestingness (attention), usefulness (relevance), and confidence in learning the instruction. Immediately following the motivational analysis, they were presented with their assigned version of the instructional material (motivationally-saturated, adaptive, or minimized). At the end of the instruction, they were asked the continuing motivation question. The flow of events is illustrated in Figure 2

Figure 2 Flow of instruction in three versions of CAI

-
1. Present the introduction and first embedded motivational analysis

I find the subject of genetics interesting.	Yes or No
Learning genetics will be useful to me.	Yes or No
I feel confident that I can learn genetics.	Yes or No
 2. Present the first section of instruction and four-item quiz
 3. Present the second embedded motivational analysis

I find the subject of genetics interesting.	Yes or No
Learning genetics will be useful to me.	Yes or No
I feel confident that I can learn genetics.	Yes or No
 4. Present the second section of instruction and four-item item quiz
 5. Present the third embedded motivational analysis

I find the subject of genetics interesting.	Yes or No
Learning genetics will be useful to me.	Yes or No
I feel confident that I can learn genetics.	Yes or No
 6. Present the third section of instruction
 7. Present the continuing motivation survey
 8. Present the post-test and simplified IMMS survey

For the motivationally-minimized version CAI, any motivational strategies embedded in Osman's text, Park's CAI, and the textbook were eliminated. This was to ensure that the developed CAI would not have any motivating features for the students. However, through the formative evaluation with experts in instructional design, strategies that were judged as contributing to instructional effectiveness were kept to maintain the inherent quality of the instruction. The motivationally-minimized CAI included 3,017 expository words and 210 sentences with several inserted technical drawings. The Hupercard stack size was 112 k, and it contained 59 cards.

The motivationally-minimized CAI was not expected to be highly motivating to students except in two possible situations: when the topics of the content themselves are motivating to learners, or when the computer itself may have motivating effects. However, these two situations were not expected to affect a large number of learners because of the technical nature of the content. It was also expected that there would be a minimal novelty effect of using the computer because of the previous computer-usage experience of learners as confirmed by their teachers. In any case, any effects of these types were expected to be a constant across treatments.

Motivationally-saturated CAI was developed from the motivationally-minimized version. Using the ARCS model, the motivational strategies presented by Keller & Suzuki (1988) and those obtained from interviews with two biology teachers were reviewed, and all the appropriate ones (24 strategies in total), as judged by the researchers, were incorporated into instruction for enhancing and sustaining attention, relevance, and confidence. The criteria used for the selection, based on Keller (1987b), were that motivational strategies should:

- not take up too much instructional time,
- not detract from the instructional objectives.
- fall within the time and money constraints of the development and implementation aspects of the instruction,
- be acceptable to the audience,
- be compatible with the delivery system,
- be appropriate for the contents,
- not take up much CPU memory,
- be developed using hypercard 2.2,
- not bother multiple learners in the classroom.

The strategies finally selected are presented in Figure 3. The motivationally-saturated CAI contained 3,306 expository words and 273 sentences. It also included additional words (1,835) and sentences (247) for motivational strategies, with technical drawings and tables inserted. The stack size was 393 k, and it contained 107 cards.

Figure 3. Selected Motivational Strategies

Attention Enhancing Strategies

- AE1 Use inverse and flash in text and patterns in pictures as attention getters
- AE2 Engage the learner's interest by using question-response-feedback interaction that requires active thinking
- AE3 Present problem solving situation in a context of exploration and partial revelations of knowledge

Attention Sustaining Strategies

- AS1 Keep instructional segments relatively short with progressive disclosure
- AS2 Make effective use of screen display to facilitate ease of reading
- AS3 Intermingle information presentation screens with interactive screens
- AS4 Use a consistent screen format but with occasional variation
- AS5 Use visual enhancement functionally to support the instruction and general theme of the lesson
- AS6 Avoid dysfunctional attention-getting effects such as a flashing word that distracts learner's concentration
- AS7 Use underlines, italics, or bigger font sizes for the headings or key words

Relevance Enhancing Strategies

- RE1 Use examples from content areas and situation that are familiar to the learners
- RE2 Clearly state the objectives in terms of the importance or utility of the lesson

Relevance Sustaining Strategies

- RS1 Use personal pronouns and the learners' name when appropriate
- RS2 Use graphic illustrations to embed abstract or unfamiliar concepts in a familiar setting

Confidence Enhancing Strategies

- CE1 Use words and phrases that help attributes success to the learners' effort and ability
- CE2 Clearly present the objectives and the overall structure of the lesson
- CE3 Explain the evaluative criteria and provide opportunities for practice with feedback
- CE4 Mention the prerequisite knowledge, skills, or attitudes that will help the learner succeed at the task
- CE5 Tell the learner how many items are going to be in a test or drill, and whether it will be timed.
- CE6 Provide summary
- CE7 Use a menu-driven structure to provide learner control over access to different part of the courseware

Confidence Sustaining Strategies

- CS1 Allow the learner to escape and return to the menu at any time, and if feasible, to page backwards.
- CS2 Give the learner control over pacing by hitting a key to go from one screen to the next
- CS3 Match learning requirements to prerequisite knowledge and skills to prevent excessive challenge or boredom.

One thing to be mentioned is that motivational strategies used in this study were classified into two categories of enhancing and sustaining strategies. This distinction was necessary because Keller (1983, 1987 a, b, c) distinguishes "enhancing motivation" from "sustaining motivation." He says that strategies for motivational enhancement are provided to learners who are not motivated, while strategies for sustaining motivation are provided, as kind of hygiene factors, to learners who show the desired levels of motivation. For example, in the case of the component of 'attention,' "animation, inverse, flash, sound and other audio and visual capabilities of the computer" (from Figure 3) were categorized as attention-getting strategies. However, "consistent screen format, but including occasional variation" were categorized as attention-sustaining strategies.

Because the motivationally-saturated CAI incorporated all the motivational strategies (both enhancing and sustaining strategies) for all three components (attention, relevance, and confidence), it might seem that the motivationally-saturated CAI would maximize learner motivation. However, research based on application of the ARCS model (e.g., Visser & Keller, 1990) did not support the excessive use of motivational strategies. For example, if a student already feels confident, the confidence enhancement strategies are not recommended to be used in instruction. In this study, the title, "motivationally-enhanced CAI" was simply defined as one which has motivational strategies for both enhancing and sustaining across all three components: attention, relevance, and confidence. Satisfaction was not considered here, as discussed earlier in this paper.

Motivationally-adaptive CAI had all the same features as the motivationally-saturated CAI, except that it adaptively provided the learners only with the appropriate motivational strategies. With the motivationally-minimized and motivationally-saturated CAI, all the students were given the same package through the three sections

of the instruction, regardless of the results of the embedded audience analyses. However, with the motivationally-adaptive CAI, if a learner was analyzed as having low confidence, high attention, and high relevance, this version provided the instruction which aimed to enhance and sustain confidence, while sustaining the attention and relevance level. More specifically, at the outset, learners were asked to report their initial motivation (First Embedded Motivational Analysis). They indicated whether the instruction was attention-getting, relevant, and appropriately challenging. This resulted in one of eight possible combinations of responses (see Column 1 in Figure 4). Students were then given the appropriate combination of sustaining and enhancing motivational strategies (see Types 1, 3, 5, 7, 9, 11, 13, and 15 in Column 4 of Figure 4). The feedback associated with each of these types was not given after the First Embedded Motivational Analysis as it did not apply at that time.

After reporting their motivation the second and third times (Second and Third Embedded Motivational Analysis), each student took a four-item quiz. The quiz was provided to check whether the self-reported confidence level was consistent with the performance scores on the quiz. For example, a student who reported high confidence and obtained a high quiz score was considered to have matched responses, but a student who reported high confidence and had a low quiz score was given a different type of feedback. The results of this quiz were categorized into two levels (see Column 2 in Figure 4): pass (scores higher than 2.5) vs. fail (scores lower than 2.5). The joining of eight combinations of motivational responses and two levels of quiz outcomes resulted in a total of sixteen types of student response (see Figure 4, Column 4). The appropriate type of motivational enhancements and feedback were then implemented for each student.

Measurement

Motivation (both overall motivation and each of attention, relevance, confidence, and satisfaction) was measured through a simplified version of Keller's (1993) Instructional Materials Motivational Scale (IMMS), which measures the motivational features of instructional material in terms of attention, relevance, confidence, and satisfaction. Internal consistency estimates for the IMMS total score and subscales are generally in the range of .81 to .96. The simplified IMMS used for this study had 16 items, four items for each component of attention, relevance, confidence, and satisfaction respectively. The reliability coefficient, Cronbach's Alpha, for the overall motivation measure was .92, and it was .79, .73, .70, and .85 for attention, relevance, confidence, and satisfaction, respectively.

Figure 4 Types of Instruction for Adaptive CAI

A = Perceived attention;
R = Perceived relevance
C = Perceived confidence
Y = Yes, I have attention, relevance, or confidence
N = No, I don't have attention, relevance, or confidence
NP= Enhancing strategies are not provided but sustaining strategies are provided.
P = Both enhancing strategies and sustaining strategies are provided.

Column 1			Column 2	Column 3			Column 4
Perceived Motivation			Quiz: 4 items	Motivational Strategies			Types
A	R	C	Score	For Attention	For Relevance	For Confidence	Type
Y	Y	Y	> 2.5	NP	NP	NP	1
				* Say, "Very Good score!", then provide the next topics. * If the score is 4, say "Excellent score."			
			< 2.5	NP	NP	NP	2
				* Say "Good try. Try hard to raise your scores.", then provide review + next topics.			
Y	Y	N	> 2.5	NP	NP	P	3
				* Say, "Very Good score! Your confidence should be growing stronger.", then provide the next topics with confidence strategies. * If the score is 4, say "Excellent score."			
			< 2.5	NP	NP	P	4
				* Say, "Good try. Try hard to raise your scores and confidence level." then, provide review + next topics with confidence strategies.			
Y	N	Y	> 2.5	NP	P	NP	5
				* Say, "Very Good score! Was it irrelevant to you?", then, provide next topics with relevance strategies. * If the score is 4, say "Excellent score."			
			< 2.5	NP	P	NP	6
				* Say, "Good try. Try hard to raise your scores. Was it irrelevant to you?", then provide review + next topics with relevance strategies.			
Y	N	N	> 2.5	NP	P	P	7
				* Say, "Very Good score! Was it irrelevant to you? Your confidence should be growing stronger.", then, provide next topics with relevance and confidence strategies. * If the score is 4, say "Excellent score."			
			< 2.5	NP	P	P	8
				* Say, "Good try. Try hard to raise your scores and confidence level. Was it irrelevant to you?" then provide review + next topics with confidence and relevance strategies.			
N	Y	Y	> 2.5	P	NP	NP	9
				* Say, "Very Good score! Was it boring to you?", then, provide the next topics with attention strategies. * If the score is 4, say "Excellent score."			
			< 2.5	P	NP	NP	10
				* Say, "Good try. Try hard to raise your scores. Was it boring to you?", then provide review + next topic with attention strategies.			
N	Y	N	> 2.5	P	NP	P	11
				* Say, "Very Good score! Your confidence should be growing stronger. Was it boring to you?", then provide next topics with confidence and attention strategies. * If the score is 4, say "Excellent score."			
			< 2.5	P	NP	P	12
				* Say, "Good try. Try hard to raise your scores and confidence level. Was it boring to you?", then provide review + next topics with confidence and attention strategies.			
N	N	Y	> 2.5	P	P	NP	13
				* Say, "Very Good score! Was it boring and irrelevant to you?", then, provide the next topics with attention and relevance strategies. * If the score is 4, say "Excellent score."			
			< 2.5	P	P	NP	14
				* Say, "Good try. Try hard to raise your scores. Was it boring and irrelevant to you?", then provide review + next topics with attention and relevance strategies.			
N	N	N	> 2.5	P	P	P	15
				* Say, "Very Good score! Your confidence should be growing stronger. Was it boring and irrelevant to you?" then provide next topics with attention, relevance, and confidence strategies. * If the score is 4, say "Excellent score."			
N	N	N	< 2.5	P	P	P	16
				* Say, "Good try. Try hard to raise your scores and confidence level. Was it boring and irrelevant to you?" then provide review + next topics with attention, relevance, and confidence strategies.			

Learning achievement (effectiveness) was measured by a posttest of learners' understanding of the instructional content (facts, concepts, and principles). The test included 13 multiple-choice items which were adopted and revised from a test with 24 items used in a prior study (Park, 1993). Park reported the reliability of the test as .78, using the K-R 20 formula. In order for students to complete all the requirements within the experimental time, the number of test items was reduced to 13 items with each item being worth one point. Two subject matter experts (biology teachers) validated the test according to the learning objectives using a table of specifications for the content of instruction. Cronbach's alpha of the test was .69. The reduction in reliability compared to Park's (1993) could be due to either the reduced length of the posttest or the differences in the subjects.

Continuing motivation was measured by asking students whether they wanted to learn more in the future on the same or similar content (Figure 2). Students were told to report their continuing motivation on a Likert-type item with five anchors (1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, 5 = Strongly Agree). The item asked, "The lesson was motivating to me. I would like to learn more about the same subject matter later."

Efficiency was obtained by multiplying 1,000 to the ratio of performance on the post test to study time. The computer tracked the time (measured in seconds) used by each student. For instance, if a student scored 8 using 2,000 seconds, 8 was divided by 2,000, and then multiplied by 1,000. His efficiency was 4.

To control for the confounding effect of prior achievement, students' scores in science on the Metropolitan Achievement Test 7 were obtained and used in an analysis of covariance for effectiveness and efficiency.

Procedure

One month before the experiments, the students were measured on their pre-motivation to learn genetics. This was done to conduct audience motivational analysis as recommended by the ARCS Model. The one-way ANOVA revealed no significant difference among randomly assigned groups for their motivation to learn genetics ($F = .4024, p = .6706$). Also a significant difference was not found among groups on scores for attention ($F = .3839, p = .6830$), relevance ($F = .4652, p = .6304$), confidence ($F = .6718, p = .5149$), and satisfaction ($F = .0956, p = .9090$).

The experiments were conducted at a learning resource center in a university building near the students' school. Three 80-minute sessions (one session a day) were set up in accordance with the students' regular class periods. Students participated in the one of three motivational design conditions to which they were randomly assigned. They were instructed to study the materials with the emphasis that posttests and a survey would be given after their learning. The computer assignment and explanation took about 10 to 15 minutes. They were also told to raise their hands when they were ready for the test. Then, learners were allowed to study as long as they wanted, and the computer recorded their use of time. The average time used by students was 30.49 minutes (Minimum: 14.6; Maximum: 46.52). When students finished the lesson, their continuing motivation was measured on the computer, which was followed by both the post-test and the simplified IMMS.

Data analysis

To test for differences in motivation (both overall motivation and each of attention, relevance, confidence, and satisfaction) and continuing motivation among learners in three versions of CAI, one-way analysis of variance (ANOVA) was used. To check the results of ANOVA of the four sub-components of motivation, a one-way MANOVA was conducted. This was done because the sub-components of attention, relevance, confidence, and satisfaction showed significant correlation's. The MANOVA results agreed with those obtained from the ANOVA. To test for differences in effectiveness (learning achievement) and efficiency, one-way analyses of covariance (ANCOVA) were used with students' science scores on Metropolitan Achievement Test 7 as a covariate. Both ANOVA and ANCOVA were followed by Fisher's LSD pairwise comparison procedure if a significant difference was found among treatments. Alpha was set at .05 for all statistical tests. All these analyses were done with the Statistical Package for the Social Science (SPSS Windows V. 6.0).

Results

Motivation

One-way ANOVA conducted on overall motivation scores revealed a significant difference for the treatments, $F(2, 57) = 4.46, p < .05$. Approximately 14% of the difference in motivation was explained by the treatments. Observed power was .74. Fisher's LSD pairwise comparison procedures revealed that students in the motivationally-adaptive CAI ($M=52.73, SD=12.09$) showed higher motivation than those in both motivationally-saturated ($M=43.63, SD=9.38$) and motivationally-minimized CAI ($M=42.84, SD=13.75$).

Regarding attention, one-way ANOVA revealed a significant difference for the treatments, $F(2, 57) = 5.07, p < .01$. Approximately 15% of the difference in attention was explained by the treatment, and observed power was .80. Fisher's LSD pairwise comparison procedures revealed that students in the motivationally-adaptive CAI ($M=13.36, SD=3.36$) showed higher attention than those in both motivationally-saturated ($M=10.95, SD=3.19$) and motivationally-minimized CAI ($M=10.00, SD=3.96$).

Regarding relevance, one-way ANOVA revealed a significant difference for the treatments, $F(2, 57) = 4.24$, $p < .05$. Approximately 13% of the differences in relevance was explained by the treatment, and observed power was .72. Fisher's LSD pairwise comparison procedures revealed that students in the motivationally-adaptive CAI ($M=12.50$, $SD=3.47$) showed higher relevance than those in motivationally-saturated CAI ($M=9.42$, $SD=2.97$). There was not a significant difference for confidence and satisfaction.

Effectiveness

The correlation coefficient, Pearson r , between science scores and posttest scores was .5402 ($p = .001$). One-way ANCOVA conducted on achievement scores revealed a significant difference for the treatments, $F(2, 56) = 5.28$, $p < .01$. Approximately 16% of the difference in achievement was explained by the treatments. Observed power was .82. Fisher's LSD pairwise comparison procedures revealed that students in the motivationally-adaptive CAI ($M=7.18$, $SD=2.50$) performed significantly better than those in both motivationally-saturated ($M=5.84$, $SD=3.11$) and motivationally-minimized CAI ($M=6.68$, $SD=3.35$).

To investigate the validity of the rationale for the assumption that increased motivation will produce more effectiveness, the correlation between overall motivation and adjusted posttest scores was calculated. The observed posttest scores were transformed into adjusted scores for the covariate on the validated assumption of homogeneity of regression coefficient. The correlation coefficient Pearson r was .2546 ($p=.05$). This implies that about 6.5% of the achievement variance can be explained by the differences in overall motivation when the confounding effects of the covariate are systematically taken out. This explained variance is larger than the 2.5% that was reported by Bickford (1989), who used the ARCS model for printed material instruction non-adaptively.

Continuing Motivation

Although the students in the motivationally-adaptive CAI ($M=3.18$, $SD=1.10$) showed higher continuing motivation than both the motivationally-saturated ($M=2.42$, $SD=1.07$) and motivationally-minimized CAI ($M=2.63$, $SD=.96$), one-way ANCOVA conducted did not reveal a significant difference for the treatments, $F(2, 57) = 2.93$, $p = .06$. Approximately 9% of the difference in continuing motivation was explained by the treatment. Observed power was .549.

Efficiency

The correlation coefficient, Pearson r , between science scores and the efficiency measure was .4728 ($p=.001$). One-way ANCOVA conducted on efficiency revealed a significant difference for the treatments, $F(2, 55) = 5.17$, $p < .01$. Approximately 16% of the difference in efficiency was explained by the treatment, and observed power was .81. Fisher's LSD pairwise comparison procedures revealed that students in both the motivationally-adaptive CAI ($M=4.01$, $SD=1.65$) and motivationally-minimized CAI ($M=4.62$, $SD=2.25$) showed higher efficiency than those in the motivationally-saturated CAI ($M=3.11$, $SD=2.11$).

Table 1

Means and Standard Deviations for Dependent Variables

Variables		CAI Versions			Total
		Minimized	Saturated	Adaptive	
Motivation ¹					
Overall Motivation	n	19	19	22	60
	M	42.84	43.63	52.73	46.72
	SD	13.75	9.38	12.09	12.57
Attention ²	n	19	19	22	60
	M	10.00	10.95	13.36	11.53
	SD	3.96	3.19	3.36	3.74
Relevance ²	n	19	19	22	60
	M	11.00	9.42	12.50	11.05
	SD	3.64	2.97	3.47	3.56
Confidence ²	n	19	19	22	60
	M	11.95	12.00	13.95	12.70
	SD	4.02	2.98	3.32	3.53
Satisfaction ²	n	19	19	22	60
	M	10.42	11.26	12.95	11.62
	SD	4.22	3.36	3.92	3.94
Effectiveness ^{3,5}	n	19	19	22	60
	M	6.68(6.25)	5.84(5.52)	7.18(7.94)	6.60
	SD	3.35	3.11	2.50	2.99
Continuing Motivation ⁴	n	19	19	22	60
	M	2.63	2.42	3.18	2.77
	SD	.96	1.07	1.10	1.08
Efficiency ⁵	n	19	19	22	60
	M	4.62(4.45)	3.11(2.89)	4.01(4.42)	3.91
	SD	2.25	2.11	1.65	2.05

*1: range for overall motivation (16-80)

*2: range for attention, relevance, confidence, and satisfaction (4-20)

*3: range for effectiveness (0-13)

*4: range for continuing motivation (1-5)

*5: adjusted scores for a covariate in parenthesis

Discussion

The purpose of this study was to investigate the effects of a motivationally-adaptive CAI developed in accordance with the ARCS model. For this purpose, a prototypical motivationally-adaptive CAI was developed and compared to a motivationally-saturated CAI and a motivationally-minimized CAI for its effects on motivation (overall motivation, attention, relevance, confidence, and satisfaction), effectiveness, continuing motivation, and efficiency.

Results indicated that motivationally-adaptive CAI was superior to the other two CAIs for the enhancement of overall motivation and attention. Students in the motivationally-adaptive CAI may not have been deprived of motivational intervention or may not have been overly manipulated. Therefore, the results support the suggestion that the amount of motivational emphasis or strategies need to be optimal rather than excessive or scarce (Brophy, 1987; Keller, 1983, 1987 a,b,c; Lepper, 1988; Suzuki & Keller, 1998).

In fact, despite the emphasis on the optimal use of motivational strategies in the literature, few systematic ways on “how to” have been suggested for motivational enhancement of instruction. Wlodkowski (1981) has demonstrated how to preplan to incorporate motivational strategies into specific parts of a lesson. The ARCS model provides an audience analysis process that facilitates preplanning of motivational tactics that are adapted to learner requirements. However, in both models, adaptation of the plan can be done only in instructor-led settings and depends on instructor insight to maintain the appropriate levels. The results of this study suggest that the adaptive use of motivational strategies based on direct student input can also succeed and can be incorporated effectively into computer-assisted instruction.

More specifically, the motivationally-adaptive CAI was adaptive in two aspects that allowed for the optimal provision of motivational strategies. First, the distinction between sustaining strategies and enhancing strategies was a unique feature of the program. Through the occasional (three times) embedded audience analyses, students self-reported as being motivated were provided only with sustaining strategies, while students diagnosed as not having optimal motivation were prescribed with enhancing and sustaining strategies. This way, students were expected to receive only the exact amount of motivational intervention that was needed.

Second, the program was adaptive in terms of appropriate types of motivational strategies. Students were diagnosed for their self-perceived attention, relevance, and confidence level based on their “Yes” or “No” responses to each corresponding question. This came up with 8 types of student motivational profiles. For example, for the first audience analysis at the outset of instruction, if a student responded “Yes” to attention and relevance questions and “No” to the confidence question, he was provided with instruction which included sustaining strategies for attention and relevance while enhancing and sustaining strategies for confidence.

This kind of elaborated adaptation was expected to be more effective to motivate learners than other approaches such as those suggested by del Soldate & du Bouleuy(1995), who focused only on confidence, because the elaborated adaptation dealt with motivation more comprehensively rather than narrowly focusing on specific aspects of motivation. In this study, motivation was prescribed for attention, relevance, and confidence. Although satisfaction was not prescribed due to experimental constraints, the results support the contention for comprehensive and adaptive prescription that has been lacking in the previous efforts.

Regarding the other sub-components of motivation, the adaptive use of motivational strategies was partly supported. For relevance, students in the motivationally-adaptive CAI showed higher scores than the motivationally-saturated CAI but not the motivationally-minimized CAI. Regarding confidence and satisfaction, although students in the motivationally-adaptive CAI showed the highest scores, significant differences were not found among three CAIs.

These findings may be explained as follows. In the case of relevance, the fact that students in the motivationally-saturated CAI showed the lowest relevance score supports the contention that motivational strategies need to be prescribed optimally, i.e., adaptively. In the motivationally-saturated CAI, strategies for all three components, attention, relevance, and confidence were provided and distributed throughout the instruction. This means that students had to be exposed to much more additional content than those who were either in the motivationally-adaptive or motivationally-minimized CAI.

For example, the number of total words used in the motivationally-saturated CAI was 5,141, while the motivationally-minimized CAI had only 3,017 words. Of the difference (2,124), 1,835 words were used for motivational strategies, and this extra burden of words might have hindered the relevance strategies from influencing students. That is, students who were distracted by all the motivational strategies may not have noticed the relevance that was intended to be provided by a relatively small number of relevance strategies. Furthermore, when few number of relevance strategies were integrated with other strategies, their own effects could have been reduced. Also, most of the relevance strategies that were provided in the text format may not have been salient to learners unless the students had high motivational needs for relevance of the contents. In contrast, students in the motivationally-adaptive CAI were provided relevance strategies only when they were looking for the usefulness or value of the content.

The fact that there was no significant difference for relevance between the motivationally-minimized CAI and the motivationally-adaptive CAI was interesting and drew the researchers attention. The question was what would have produced the unexpected relevance level in the motivationally-minimized CAI. One possible explanation would be that students’ exposure only to the content, without distraction, possibly allowed them to recognize the relevance as they learned more about the content even though they were not given specific relevance strategies. This inference may be supported by the fact that students in the motivationally-minimized CAI showed higher achievement than those in the motivationally-saturated CAI who were distracted by all the motivational strategies. However, the difference in achievement between these two treatments was not significant, so additional research would have to be done to confirm or negate this inference.

In sum, the inference is that there might have been increased relevance which came from the students’ achievement in the motivationally-minimized CAI, and its amount might have been approximately the same as the small amount of relevance saturated in the motivationally-adaptive CAI. One possible rationale for this inference is that the average relevance score across the three treatments was 11.05 (SD=3.56), which is at 44 percentile, below the mid-point of the range (4-20). This implies that overall relevance reported across those three treatments is quite low, and possibly has floor-effects. Therefore, although the relevance level for the motivationally-adaptive CAI was 12.50 (SD=3.47, at 53 percentile) which is slightly above the average, it was not significantly larger than that (11.05) for the motivationally-minimized CAI. To resolve this, further research would be necessary.

Another interesting finding is that there were no differences in confidence among the three conditions. This can be interpreted in two ways. First, it is possible that the confidence strategies prescribed were not strong enough to address the motivational needs. In fact, this is a possible inference in that all the powerful computer features could not be used due to the restraints of experimental conditions. Second, provision of review opportunities would have resulted in non-significant differences in confidence among the three conditions. Research results show that review opportunities are effective strategies for increasing students’ confidence (Bickford,1989). Therefore, review opportunities that were provided before and after taking each quiz may have evenly contributed to maintaining or enhancing learners’ confidence across the three conditions. Further investigation of this inference needs to be done in future studies.

Regarding satisfaction, there were no differences among the three treatments. However, this finding did not get the researchers' attention because each CAI version was designed not to contain satisfaction strategies. Without systematic manipulation of satisfaction, students may have provided their own satisfaction on a random basis.

Aside from the motivational benefits of the adaptive use of the ARCS model, another expected benefit is to increase achievement scores. Although motivation to learn is not the only predictor of student achievement, it seemed reasonable to predict that if motivationally-adaptive CAI is more motivating than the other two CAIs, it would also show the highest effectiveness. The results of this study supported this expectation.

Regarding continuing motivation, Keller (1983, 1987a, b) points out that the more highly motivated the learners are during their learning, the better chance of their having high continuing motivation after their learning. However, although students in the motivationally-adaptive CAI showed the highest continuing motivation, the amount was not enough to be significantly different from those of students in the other two CAIs. Considering the positive test results for overall motivation, the motivationally-adaptive CAI should have produced more continuing motivation than the other two CAIs.

One interpretation of this inconsistent finding is that motivationally enhanced treatments is not the sole predictor of continuing motivation. If other confounding factors influenced continuing motivation, it would be difficult to have significant differences across the three conditions. Also, the observed power for ANOVA on continuing motivation was .549. This shows that a larger sample size would have revealed the significant differences among the three conditions, and a longer treatment may also be beneficial.

The above interpretation is also indirectly evidenced by the correlation (Pearson r , .6573, $p=.000$) between overall motivation and continuing motivation, although not all of the treatments conditions had a significant correlation with continuing motivation.. The motivationally-adaptive CAI showed the highest correlation (.8155, $p=.0000$), while the motivationally-minimized CAI was also significant ($r=.6424$ ($p = .003$)). It is interesting that the motivationally-saturated CAI showed the lowest correlation, .3426, which was not significant ($p=.151$). These correlation's may indicate that the motivationally-adaptive CAI has more chance of increasing both motivation and continuing motivation than the other two CAIs. Why the motivationally-saturated CAI did not show significant correlation between motivation and continuing motivation should be further investigated.

For efficiency, it was expected that learners in the motivationally-adaptive CAI would need less time to finish their learning than those who had to go through all the motivational strategies in the motivationally-saturated CAI. Also, it was expected that the motivationally-minimized CAI would require less time to finish than the other conditions because no motivational strategies were provided. The ANCOVA on efficiency showed that there are differences across the three treatments, and Fisher's LSD analysis revealed that the motivationally-adaptive and motivationally-minimized CAIs showed higher efficiency than the motivationally-saturated CAI. These findings support the need for providing motivational strategies adaptively for efficiency. The excessive provision of motivational strategies in the motivationally-saturated CAI resulted, as expected, in lower efficiency than the motivationally-minimized CAI, while the motivationally-adaptive CAI showed the same efficiency with the motivationally-minimized CAI.

Overall, the idea of motivationally-adaptive CAI was empirically supported by the data in terms of its effectiveness, efficiency, and overall motivation. The data also indicated that there is a significant correlation between motivation and continuing motivation. These findings support the adaptive provision of motivational strategies in CAI.

One theoretical implication of these findings is that motivation to learn can be a useful indicator of learning readiness. Indicators of learning readiness used in previous studies in adaptive CAI have been mostly cognitive variables (e.g., Atkinson, 1976; Hativa & Lesgold, 1991; Houlihan, Finkelstein, & Johnson, 1992; Mills & Ragan, 1994; Ross & Morrison, 1988; Tennyson & Christen, 1988; Tennyson & Park, 1980). However, the results of this study support the contention that motivation could be a strong predictor of learners' future performance and motivation because students' motivation at one point of time is a reflection of all their previous experience in both affective and cognitive domains. That is, students' previous attitudes, values, learning style, IQ, GPA, abilities, and aptitudes have influence on their current motivation to which motivational strategies can be prescribed adaptively.

As an initial attempt to design and develop a motivationally-adaptive CAI, this study has limitations that might reduce the generalizability of the results and conclusions. First, the potential range of motivational strategies could not be fully actualized due to constraints of available hardware and software. For example, after instruction, many students commented on the lack of colors, animation, and sounds for more motivational features. Some important conditions (Astleitner & Keller, 1995) for motivated learners such self-created task solution, opportunities for advanced topics, and control over important parts of the learning environment were not used.

Second, the time for the experiment was short. The average time was 30.49 minutes across three conditions (motivationally-minimized CAI: 24.37, saturated CAI: 35.45, adaptive CAI: 31.21). Considering the limited use of motivational strategies as discussed above, this short term exposure to motivational strategies could have been another reason for showing several insignificant differences despite the overall positive results that were found.

Third, the use of self-report methods for measuring motivation were limited in that they required students to indicate their perceived motivation level, which might have been different from their actual amount of effort which is a more accurate measure of motivational behavior. Also, the embedded motivational analyses may have been intrusive, requiring students to stop their process of learning. A more natural way of measuring motivation would be desirable.

Fourth, too much information presented within a short period of time may have caused cognitive overload which reduced the achievement and motivation across all three conditions. Astleitner & Keller (1995) pointed out that an excess of information makes it more difficult for the learner to maintain a sense of control and comprehensibility in the learning environment.

Fifth, motivational strategies used in this study may have not addressed the real motivational needs of students, resulting in fewer effects than expected. For example, students reported their motivational state for each component of attention, relevance, and confidence, and motivational strategies were prescribed based on this information. However, there might be a need to focus on the sub-categories of each component for more reliable diagnosis and prescription. For example, confidence is composed of the sub-components of motive matching, goal orientation, and familiarity. If motivational analysis can be done for each of these sub-components, adaptive CAI might be more effective in enhancing students' confidence.

Despite the limitations in this prototype development study, there was overall support for the adaptive treatment, and there are several areas that would be useful for continued study. First, this study showed that about 14% of perceived motivation was explained by treatments with limited use of computer features. It is recommended that future studies will utilize more powerful computer features such as sound, color, animation, video, and interaction. The motivationally-adaptive CAI could then be even more motivating to learners.

Second, it is recommended to elaborate the ARCS model or to devise new models which can be used for the development of motivationally-adaptive CAI. Although this study pioneered the use of the ARCS model for the development of motivationally-adaptive CAI, there is a need for further development of this or other models that can be used for the design and development of motivationally-adaptive courseware for computer, multimedia, or network-based learning environments (Astleitner & Keller, 1995). A future elaboration of the model should incorporate a more detailed and transparent motivational diagnosis system and a more reliable prescription system with a database of situation-specific motivational strategies. For example, motivational strategies for conventional CAI may be different from those for multimedia learning environments, which utilize multi-sensory effects.

Third, research is necessary to investigate the relationship among pre-motivation, prior achievement, cognitive aptitude, perceived motivation, computer attitude, and continuing motivation in motivationally-adaptive CAI in comparison with non-adaptive CAI. Continuing research on these issues will provide the foundation that will foster research efforts for designing and developing a more advanced motivationally-adaptive CAI.

In conclusion, the results of this study indicate the possible value of the ARCS model as a guiding process for designing motivationally-adaptive CAI. It also demonstrates that self-reports of motivation can be a valid indicator of learning readiness to which motivational strategies are adaptively prescribed. And, the study demonstrates that it is feasible to design motivationally-adaptive instruction for a self-paced learning setting, such as CAI. Further research should lead to more sophisticated and effective applications of motivationally adaptive design.

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INTERNATIONAL TEAM TEACHING: A PARTNERSHIP BETWEEN MEXICO AND TEXAS

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Abstract

In this case study, we report on collaborative activities among four fourth grade teachers and their students over a year and explore the effectiveness of distance learning for international team teaching. Two classes in Mexico City conducted school activities with two classes in College Station, Texas. We asked—What are some school activities that successfully bring children of Mexican and Texan cultures together to learn with, about, and from each other? What similarities and differences in language skills and pastimes exist between the children of both cultures? What prevailing impressions did Mexican and Texan children have of each other prior to their distance learning activities? The activities in the partnership were designed to help the students understand each other's cultures by walking in each other's footsteps. Mexican children had enough experience of U.S culture to be able to accurately describe the culture in poetry. On the other hand, most Texan children had little knowledge of Mexico and had to write about their own culture, create an imaginary place, or refer to stereotypes in order to create a poem.

Background and Theoretical Perspective

In this case study, we report on collaborative activities among four fourth grade teachers and their students over a year and explore the effectiveness of distance learning for international team teaching. Two classes in Mexico City conducted school activities with two classes in College Station, Texas. In a previous study, diverse students collaborated across Texas on multicultural activities, which helped them grow in self-esteem and multicultural understanding (Cifuentes, Murphy, & Davis, 1998). The cross-classroom collaboration, Cultural Connections, made it possible for students to expand their world-views in preparation for contributing in our increasingly multicultural environment. The previous study demonstrated that in networked classrooms students can connect with distant others to learn about and from their perspectives and to increase their multicultural understanding. In addition, distance technologies can foster team teaching across cultures and geographical distances within Texas. Four overarching themes emerged from the data: growth, empowerment, comfort with technology, and mentoring. These themes permeated each data source and applied to all participants of the Texas project. Participants grew personally and intellectually. They felt empowered to achieve goals. They became comfortable with technology, and they provided and/or received mentoring. Students mentored and learned from each other. They also had the benefit of receiving mentoring from both their local and distant teachers. We expect that the international Cultural Connections project will have similar yet unique effects.

Distance technologies expand the range of opportunities for students to build relationships with people of different cultures. In the current social-constructivist conception of learning, "education is the shared way of thinking about one's self, the community, and the world" (Riel, 1995, p. 219). Therefore, schools might play a significant role in nurturing students' positive identity formation, spirit of community, and multicultural perspectives by providing them with opportunities to build distant relationships. In order to become more tolerant and respectful citizens, students need to develop relationships with people from diverse cultures and backgrounds (Moffett, 1994). Geographical and cultural isolation can limit opportunities for relationship building beyond one's culture. However, cross-classroom collaboratives allow students to connect with distant others from around the world. The collaborative learning process has the potential to transform individual participants' perspectives from parochial to global (Cummins & Sayers, 1995).

In the current study we applied the Cultural Connections model with an international team of teachers. Predominantly Mexican students in Sierra Nevada Bilingual School in Mexico City collaborated with diverse students in Rock Prairie Elementary School in College Station, Texas, primarily via interactive videoconference with occasional email. To facilitate building a broad world-view in their students, educators provided collaborative learning experiences for social construction of meaning. Telecommunications were used to expand the range of exposure to multicultural interactions (Cummins & Sayers, 1995).

Research Questions

Participating teachers conducted at least six distance learning experiences with their students over a school year. They planned the shared units of study using telecommunications. In this study we asked—

1. What are some school activities that successfully bring children of Mexican and Texan cultures together to learn with, about, and from each other?

2. What similarities and differences in language skills and pastimes exist between the children of both cultures?
3. What prevailing impressions did Mexican and Texan children have of each other prior to their distance learning activities?

Methods

Four teachers, two in Mexico City and two in College Station, TX, partnered for planning and implementation of curricular activities with their students. The forty-one fourth grade students in two classes in College Station and the forty-six fourth grade students in two classes in Mexico City were active in the partnership throughout the academic year. The Mexican school was a private school that met in a converted home in an exclusive neighborhood of the city. The Texan school was public. The school partners in both Texas and Mexico City were equipped with interactive compressed video systems at local distance learning centers, multimedia software, and Internet connections. Project administrators in both Texas and Mexico helped with planning and facilitation of connections. As in the Texas partnerships, several of the curricular activities were stimulated by the book *I Felt Like I Was From Another Planet* (Dresser, 1994). For example, in a pilot study, the students conducted an activity on table manners by acting out and discussing the table manners typical of their own cultures. In the main study, teachers conducted ongoing activities between September and June.

The investigation relied on arts-based case study methods. We conducted content analyses of each of several data sources: (a) lesson plans and observations of lesson implementation, (b) students' poems about each others' nations, (c) students' stories about a day in the life of a child in the other culture, (d) student questionnaires, (e) student collages, and (f) student self-profiles. We looked for emergent themes and gained consensus on the extent to which the data sources revealed answers to the research questions. As a result, we provide rich description of the project in order to answer the research questions.

Findings and Discussion

Question 1: What are some school activities that successfully bring children of Mexican and Texan cultures together to learn about each other?

The activities in the partnership were designed to help the students understand each other's cultures by walking in each other's footsteps. First, all four classes attended poetry writing workshops in which they wrote poems about the other nation. Though many students, particularly the Texans, had only a vague concept of the other nation, they were asked to pretend that they were the others' nation and to write an "I am..." poem of images and activities that define that nation. Secondly, the students wrote a story of a day in the life of a fourth grader in the others' country. In addition, they filled out a survey that provided some indication of the values and artistic interests of each child (see Appendix A). They also created a student profile sheet with their picture on it that described their families, favorite subjects in school, favorite foods, and special interests. They shared these poems, stories, surveys, and profiles with each other during the school year.

The classes met twice for one and one-half hours of videoconferencing in which they introduced themselves, showed collages of images that represented their family and interests, and shared personal ancestry. In a third videoconference they conducted the activity described below:

The Alamo: A Distance Learning Activity

Objectives:

As a result of participating in the activities students will be able to--

1. describe why the battle of the Alamo occurred.
2. create a dramatic representation of the battle.
3. write an essay comparing the U.S. and Mexican interpretations of the story of the Alamo.

Resources:

1. Brief story of the Alamo without mention of the names of Mexico, the U.S. or the Alamo (see Appendix B).
2. Chapters covering the story of the Alamo from the Texas history text and from the Mexican history text.

Activities:

Preliminary to the videoconference:

1. Students read a short story associated with the story behind the battle of the Alamo. The names Mexico, the U.S., and the Alamo are changed so that students can read objectively.
2. Students pretend that they are a person at the battle. They choose a side that they are on and write a diary entry about what they do and what happens to them.
3. The teacher tells students that the facts they read are about the Alamo of 1836.
4. Students read chapters from the Texas text and the Mexican text and conduct supportive reading activities.
5. The whole class identifies similarities and differences between the stories told in the texts.
6. Each student writes a comparative essay regarding interpretations of the battle of the Alamo.

7. In small groups or as a whole class, students develop a brief (10 minute) reenactment of a story about the Alamo.
8. Teacher selects one (or more) short stories for presentation to the distant audience.
9. Teacher selects one (or more) comparative essay for presentation to the distant audience.
10. Teacher selects one reenactment for presentation to the distant audience.

Activities during the videoconference:

1. Students alternate across sites to read their diary entries.
2. Students alternate across sites to perform their reenactments.
3. Students alternate across sites to read their comparative essays.

Activities back in the classroom:

1. Share what they remember from the diaries, reenactments, and essays.
2. Review what was learned about the reasons for and events of the battle of the Alamo and the different perspectives of Mexico and the U.S.

Approximately a month after the videoconference in which students explored the 1836 battle for Texas, the classes videoconferenced to share folktales and songs with each other. For the next videoconference students created a school mural and shared pictures of the murals in their city and town and discussed their contents. For a final videoconference they exchanged recipes and party traditions and had a shared celebration. The Texans had a fiesta while the Mexicans had a party.

The students participated fully in the above activities and took great interest in each other. Through the activities students tried to get into the shoes of another culture and acquired curiosity about each others' perspectives. Each activity led to a flood of student questioning regarding the life of the distant others. Students saw that they were both similar and different from each other in many ways. Each of the activities initiated by the project appeared to bring the children together for greater understanding of each other's similarities and differences.

Question 2: What similarities and differences in language skills and pastimes exist between the children of both cultures?

Five of the 41 Texan students knew two languages while the rest knew only English. Second languages were Hindi, Icelandic, Spanish, Chinese and Korean. All of the 46 Mexican students were at least bilingual in Spanish and English and eight of the Mexican students spoke languages other than Spanish and English. Those languages included French, Italian, German, Portuguese, and Hebrew. As was expected, the two groups had English in common. Although the Mexican students spoke English fluently, the American students had difficulty attending to the Mexicans' speech via videoconference. Understanding the strong Spanish accent via videoconference technology required great concentration on the part of the Texan fourth graders. In addition, that most Texans could only speak or read in English proved to be a significant barrier. For instance, we had to have the Spanish text chapter regarding the Texas Revolution translated so that the students could study the Mexican perspective.

Learning about and comparing ancestry was important to the project because it helped children recognize that we are multicultural societies and are interconnected through our transience. Students across groups had, of course, different ancestries, but were pleased to learn of similarities as well. Three of the Mexican children were born outside Mexico. Two were born in the U.S. including one who was born in Houston. Another was born in Caracas, Venezuela. All other Mexican children were born in Mexico. Similarly, only two of the Texan children were born outside the U.S., one in India and the other in South Korea. Going back just one generation, however, the students revealed that many of their families are new to their nations. Seven of the Mexican children had parents who were born in the U.S. and nine other children had parents born in six other countries. Ten of the Texan children had parents who were born outside of the U.S. Two of those children's parents were born in Mexico.

Thorough analysis of the survey's contents will reveal a great deal more about shared and disparate interests among the children. Preliminary findings inform us regarding student's perceived similarities and differences. After students met to share their collages, their discussion led to their drawing the following conclusions: "They (the distant class) are the same as us!" They exhibited the same taste for pizza and tacos, admiration of hair ribbons and watches for the girls, high regard for Michael Jordan, sports, and fast cars, for the boys, and appreciation of rock music across genders. The Texan children observed that the Mexican children were also different from them in many ways. They all spoke at least two languages; their names all sounded different from the Texans; they traveled more than the Texan children; they created more "decorative" collages; they spoke English with an accent; and soccer was generally the favorite sport (while the Texans preferred football or baseball). All but one Mexican student had been to the U.S., while only two Texans had been to Mexico.

Question 3: What prevailing impressions did Mexican and Texan children have of each other prior to their distance learning activities?

A preliminary examination of the poems that students wrote about each other's countries prior to meetings revealed that the Mexican children had enough experience of U.S. culture to be able to accurately describe the culture in poetry. On the other hand, most Texan children had little knowledge of Mexico and had to write about their own culture, create an imaginary place, or refer to stereotypes. During the poetry workshop, students were encouraged to write both good and bad things about each other's countries. Most importantly they were to be honest in their imagery.

Poetic imagery in the Mexican student's poems included pervasive institutions such as Toys-R-Us and shopping malls; defining places such as Disneyland and Las Vegas; prevalent foods such as ice cream, popcorn, and hamburgers; and symbols such as the Statue of Liberty and the Golden Gate Bridge. Several Mexicans wrote of the clean air in the U.S. that contrasts with that in Mexico City. The imagery of the U.S. was generally positive and accurate, however, some Mexican students captured both negative and positive aspects of the U.S. in their poems. One student referred to the historic connection between Mexico and the U.S. when he wrote, "I am formed by old parts of Mexico."

I am the United States by Nicholas Aguilar

I am the United States,
I am a smelly place,
I am the taller building,
I am scratching the sky,
I am teaching children,
I am turning them bright,
I am a glorious state,
I am playing in the street,
I am breathing air,
I am a tornado,
I am killing them all,
I am a little polluted,
I am driving all around,
I am a car blowing his horn,
I am going down on a toboggan,
I am swimming in the pool,
I am a noisy place,
I am the United States,
I am Sylvester Stalone,
I am going on a bicycle.

I am the United States by Emiliano Gordillo

I am a kid playing on a patio
I am a house
I am a school and I see kids playing
I am green grass and persons step on me
I am water flowing through the Mississippi River
I am a rock that blocks water
I am white sand and kids play with me
I am the United States
I am an acorn falling from a tree
I am light and I give light to persons
I am the flag of the United States
I am the 50 stars of the flag and kids sing for me

I am the United States by Jose Lach

I touch land and I touch all the happiness and sadness.
I am a big person with many people in me and I can Not move and if I move a disaster comes in me.

I am the biggest in America and I am a person with a country full of rivers
I am a country with many people
I am a country between Mexico and Canada
I am full of big shops, and you can come and visit me
And it will make me happier and I'll make you happy
I am a very old place
I am formed by old parts of Mexico

If you come I'll be glad to make you play and I'll be glad to keep you safe.
I am very clean
I am not full of pollution

Poetic imagery in the Texan students' poems included language from the poetry writing workshop such as graveyards, beer cans, peaches, and churches. Texans seemed to draw from their local community rather than from pictures or travels in Mexico to find images to include in their poems. They wrote of general characteristics such as seasons without knowing for sure that they were describing Mexico. As with the Mexican writers, the Texans' imagery of Mexico was generally positive, however many of the images were neither unique to Mexico or even characteristic of Mexico. Accurate imagery included piñatas, courtyards, tortillas, and sombreros.

I Am Mexico by James Knight

I am a road
I am a peach in a person's hand
I am a sun in the summer
I am snow in the winter
I am leaves in the fall
I am flowers in the spring
I am rocks in the dirt
I am wood in the weeds

I Am Mexico by Toura Go

I am Mexico with tortillas in the air.
I am a country with ghosts around me
I am summer with all the sun
I am the moon the wind the sun
I am a store with Mexican food
I am a country with hardly any rain
I am a country with lots of parades
With ghost piñatas and Mexican songs we celebrate a birthday
My sleep is filled with dreams I never had before
I am a country called Mexico

I Am Mexico by Cyndi Hall

I am Mexico
I am the corn in the fields
I am the drawbridge between rivers and dry land
I'm the flowers in the yard,
I am out in a blizzard
I am the rain in a thunderstorm
I am the waves in the ocean
I'm the fish in the lake
I'm trees that grow in springtime
I am the fire in the fireplace
I'm the home on someone's land,
I'm the graves in the courtyard
I'm the guns in the closet
I am chili in the pan
I am horses in the stalls
I'm the church in the grass
I'm the clouds in the sky
I am the stars shiny way up high
I'm the relationship between two lovers

Educational and Scientific Implications

The year of Cultural Connections between Mexican and Texan children is still in progress. The data described above have been collected. However, more thorough analyses need to be conducted for in-depth understanding of answers to the research questions. Still, the story of this case of international team teaching provides a model for others to expand their learning communities beyond national borders. We have learned of the importance of administrators in facilitating the processes and supporting the teachers who implement distance learning in the K-12 environment.

As we continue to explore the research questions above and gain insight into the effects of distance learning on K-12 students, we will also ask, "How closely do students' impressions of their distant partners match their self-impressions?" as well as, "What impressions do Mexican and Texan children have of each other after a year of distance learning together?" By comparing perceptions and misconceptions of students before and after the year of experiences we will gain further insight into the effects. We will also compare effects of multicultural activities that require children to walk in each other's shoes vs. those that involve the more typical approach of sharing one's own culture.

A Web board for student online discussion has been created and teachers have been informed for months of its existence, but they have yet to have their students use the space for collaborative writing. In the future we plan to facilitate integration of the Web board as well as desktop videoconferencing to support student collaboration. By incorporating a variety of distance technologies, students will have greater opportunity to gain mutual understanding.

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Appendix A

Student Survey

1. Have you ever traveled to another country?	8. What kind(s) of music do you like to listen to?
2. If so where?	9. Do you create art? And if so, describe your favorites (music, drawing, painting, dancing, sculpting, or writing).
3. How many languages can you speak?	10. What kinds of reading do you like? Books, newspapers, comic books, magazines, etc.
4. What language(s) do you speak?	11. About what subjects do you like to read?
5. What language do you speak at home the most?	12. How do you know right from wrong?
6. How do you feel about studying English?	13. If there is time and you would like to, draw a picture here:
7. If you could create the ideal day, how would you spend it?	

Appendix B

THE BATTLE OF COTTONWOOD RIDGE

Read the following explanation of why the Battle of Cottonwood Ridge was fought. Pretend you are from The Nation or from The Country and write a diary entry telling why you believe Cottonwood Ridge is yours, what you do about it during the battle, and who finally wins Cottonwood Ridge.

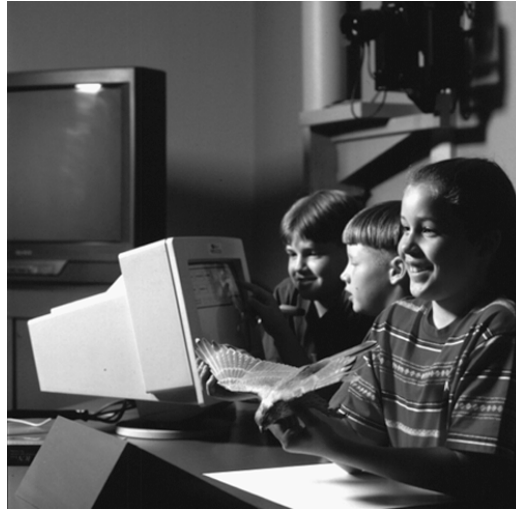
There once was a beautiful place called Cottonwood Ridge where Spaniards set up a mission whose purposes were to (1) convert native Americans to Christianity, (2) educate them, and (3) establish a Spanish territory. Cottonwood Ridge served as a Spanish mission for almost 100 years until a terrible sickness killed all of the people living there except the Native Americans.

People who were ruled by Spain lived in The Nation to the south of Cottonwood Ridge and there were people from The Country to the East of Cottonwood Ridge. People from The Nation and people from The Country both started to settle the land around Cottonwood Ridge.

Then the people from The Nation fought a war with Spain and gained independence so that they could rule themselves. Part of winning the war meant that they won Cottonwood Ridge from the Spaniards. They banned granting land to people from The Country.

People from France said that they owned Cottonwood Ridge and they sold it to the people from The Country. Now the people from The Nation and the people from The Country both believed that they ruled Cottonwood Ridge. They fought a battle over who would rule the land surrounding Cottonwood Ridge.

TECHNOLOGY, TEACHING, AND LEARNING IN IOWA HIGH SCHOOLS



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Purpose: This project was part of the program evaluation of the Iowa Distance Education Alliance, a Star Schools Project funded by the U.S. Department of Education. The program was at a point where it was necessary to take a step back and examine the overall widespread usage of technology in Iowa's schools to serve as baseline for future activities and to support informed decision making.

Design: Descriptive and qualitative.

Population: Thirty Iowa high schools were selected to represent the state. Interviews were conducted with students, faculty, and administration at each of these schools.

Methods: Results from interviews with students, faculty, and administrators were transcribed and analyzed. Individual case studies have been written for each site describing the setting, current level of technology and technology use, perceived impact of technology, and factors contributing to the current state of technology use at that site. Additional analysis was conducted to determine relationships among the various variables including district size, geographical location, reported level of technology use, actual technology use, perceived impact, and critical factors.

Findings: The primary uses of technology are for word processing, Internet research, and vocational applications. The more technologically advanced schools are incorporating multimedia production into the curriculum as well. This integration of technology into the curriculum is occurring despite multiple barriers, the most significant of which are lack of vision, time, money, access, training, and technology support. The integration of technology in Iowa's classrooms has triggered some important changes. Teachers and students report changes in teaching methods, increased student-directed learning, increased access to information, as well as more motivated learning for both students and teachers.

Purpose

This multi-site case study was conducted as part of the program evaluation of Iowa's Star Schools Project, Iowa Distance Education Alliance. Thirty high school sites were selected to represent the state of Iowa based on:

1. district enrollment,
2. rural or urban setting,
3. technology use, and
4. geographical location.

Data collection incorporated document review, site-visit observations, one-on-one interviews, and focus group interviews. In addition, survey data collected by the Iowa Department of Education provided demographic and technology data for each site selected. This study provided both qualitative and quantitative baseline data about the status of technology use in education in Iowa. Research questions included:

1. How is technology making a difference in the learning process for Iowa high school students?
2. How does technology change what and how teachers teach?

In general, what is the current state of technology and technology use in Iowa high schools?

Rationale

Statewide research on technology integration in Iowa schools has focused on quantitative data. Specifically, the Iowa Department of Education technology survey has requested information on the number of computers in the school, the number of students per computer, the number of schools with access to the Internet and other numerical data. This baseline data was intended to “describe the status of Iowa public school technology, to reflect needs, and to facilitate the school improvement process” (IDOE, 1997).

While statistics are helpful, they don’t seem to hold up to closer scrutiny. How schools interpreted the questions varied widely among districts. In computing the number of students per computer, many districts included computers that are dedicated to administrative uses and inaccessible to students. In addition, older model computers (only capable of word processing) were counted the same as more powerful computers capable of full multimedia computing. Schools reported Internet access even if the only access they had was one line in the administrator’s office or the media center.

Technology integration is more than installing hardware and software. In order to understand the process of change involved with technology integration it is imperative to speak with the people involved. The baseline study focused on the people involved in integrating technology in the schools rather than counting hardware and software. To better understand the change process as it relates to technology integration, it is important to know what motivates districts to integrate technology into the curriculum, how problems are addressed, and how technology is changing teaching and learning. This information will assist policy makers to determine where additional support is needed as the technological landscape in our schools continues to change.

Relevant Literature Review

Despite the potential many believed technology had for revolutionizing education, education has changed little in the past decades (David, 1994). While access to technology in schools continues to increase, the overall change in teaching and learning has been minimal (Zappone, 1991). The International Society for Technology in Education (ISTE) identified the need for teachers to model computer use in the classroom and to naturally integrate technology in the curriculum in relevant ways that prepare students to face the challenges of the next century (Friske, et. al., 1995). However, few schools are succeeding in helping teachers and students actually infuse computers into their daily lives. (OTA, 1995).

Change theory provided a framework for examining the process that occurs when districts attempt to integrate technology into the curriculum. Because of its focus on the individuals involved in the change process, Hall’s Concerns Based Adoption Model (CBAM) was particularly useful (Hall, 1974b). CBAM provided a structure for examining the very complex process that occurs when educational institutions become involved in adopting innovations.

CBAM views the teacher as the focal point in school improvement efforts, yet acknowledges significant social and organizational influences as well. The model focuses on two facets of the individual’s developmental growth in relation to the innovation. These components provide a reference for interpreting an individual’s level of concern and level of use in relationship to technology integration.

Sample

In order to capture the true reality of technology in Iowa’s high schools, 30 schools were selected to represent the state. In addition to requiring two schools from each of the 15 Regions in the state, we used three selection criteria: population density, enrollment and current technology level.

The two charts shown below compare the schools we visited to all public school districts based on population density and enrollment. We tried to reflect the state on these statistics. Population density (Chart 1) ranged from 10.5 individuals per square mile to a high of 2388.5 people per square mile. The number of students (Chart 2) in the district ranged from a low of 202 to a high of 32,033.

The results of the State Department of Education Technology survey were used to determine current levels of technology. Across the state the average number of students per computers was about six. The 15 high technology schools visited had fewer than four students per computer. In contrast, the 15 low technology schools reported an

average of over 14 students per computer. All schools said they had Internet access and sixty percent were connected to the Iowa Communications Network.

Chart 1: Comparison of Statewide Districts and Visited Districts by Population Density

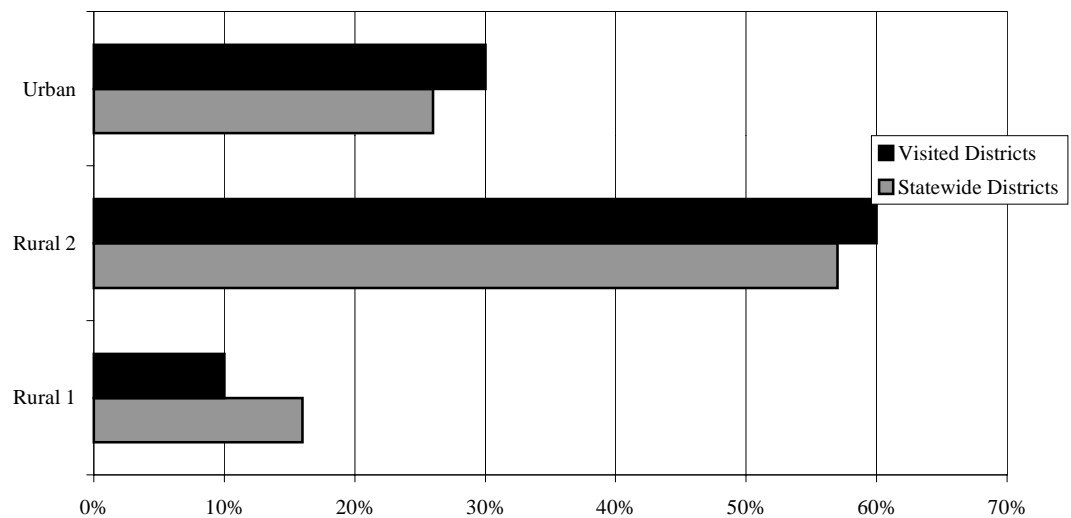
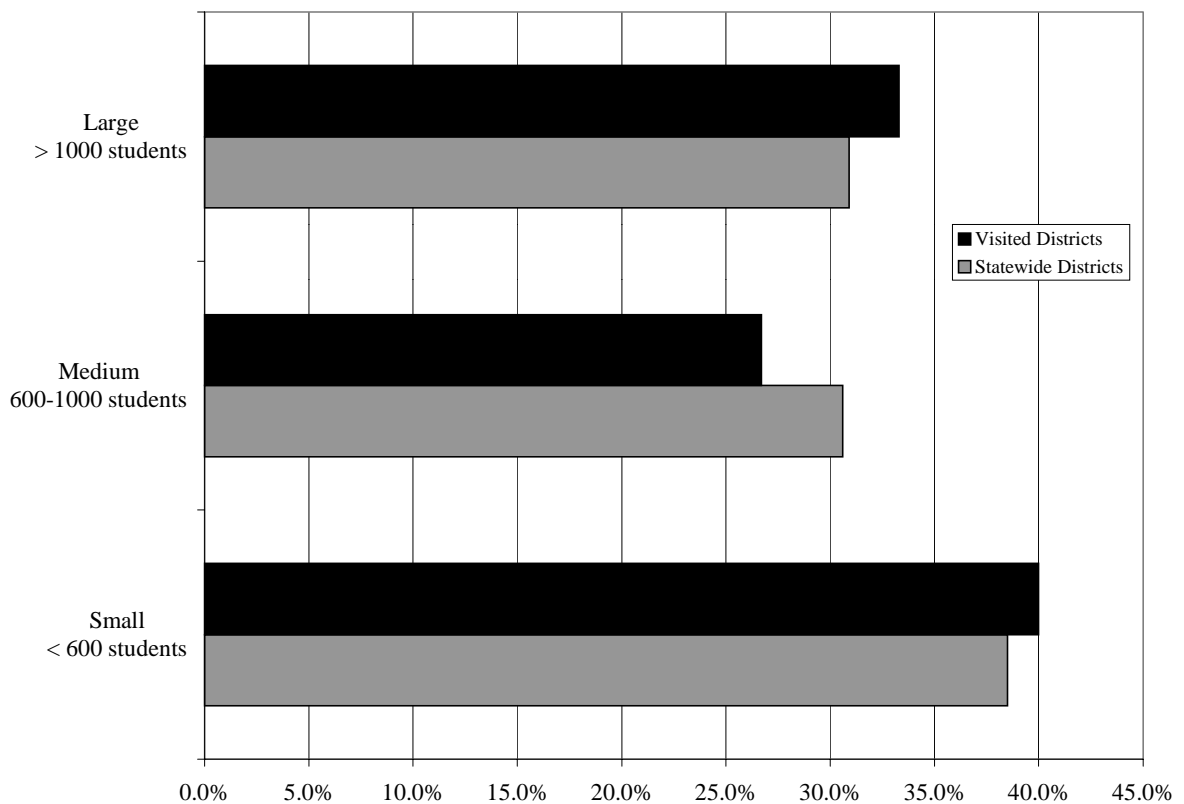


Chart 2: Comparison of Statewide districts and Visited Schools by District Enrollment



We covered every corner and region of the state in our desire to understand technology integration in Iowa. We traveled to schools in small town Iowa, consolidated schools located in the middle of farmland, and major urban area schools. The level of technology we found was as diverse as the settings. Frequently, our assumptions about

where we thought we would find high levels of technology integration proved to be wrong. Some seemingly isolated schools were surprisingly technology rich. We visited schools where technology was not recognized as a high priority. We also visited schools where both teachers and administrators have identified the need for technology integration and actively planned for effective integration of technology into the school curriculum. And, as was to be expected, we found many schools in varying degrees between the two extremes.

Limitations of the Study

Three delimiting factors of the study were identified: technology level, teacher/student selection, and researcher biases. Technology level was used as a site selection criteria. However, pupil to computer ratios varied considerably around the state, between AEAs, and within each AEA. The selection of a high and low technology school within each AEA provided more of a continuum representing a range of technology levels instead of a statewide representation of extremes.

Researchers had little or no control over the selection of students and teachers for the focus group sessions. While a random group was requested, at some sites it appeared that teachers particularly had been selected for their technology expertise. It is suspected that our sample of teachers may be slightly skewed as a result of this. Student selection appeared to be more random.

The third delimiting factor resulted from the number of researchers required for the data collection phase of this study. While all researchers were trained and provided with guidelines and questions, natural biases in the way the questions were asked and the prompts used may have affected the responses of individuals participating in the focus groups and one-on-one interviews.

Data Collection

Because of the political interest in this study, a large number of sites were selected to allow generalizability. Thirty high schools were selected to represent a cross-section of the state. All Area Education Agencies (AEAs) were represented. In addition, sites were selected to reflect state statistics on enrollment, population density, and technology.

A site visit was arranged with each site to include one-on-one interviews with the principal and the technology coordinator, focus group interviews with a group of teachers and with a group of students, and a tour of the facility. All research teams were trained and provided with interview guides and observation checklists. One researcher was responsible for recording all interviews but to insure accuracy all interviews were taped except in rare instances where permission was denied.

Data collection began during the third week of March 1998, and continued through the middle of May. Each of the thirty selected high schools was visited for the majority of a school day by two researchers. The typical visit began with a one-hour interview with the high school principal, followed by a tour of the school. The tour was usually led by the technology coordinator, a teacher highly involved in technology at the school, or the principal. The researchers usually spent the lunch hour in the faculty dining area, discussing technology casually with teachers. The focus group with students was often held right after lunch, typically with a random group of students who were assigned to study hall for that period. The teacher focus group was typically held right after school.

The data gathered at each school was used to write a case study for each site visited. Primarily the lead researcher for each site wrote these case studies, but the assistant researcher reviewed the case study draft and provided input and clarification. This member checking process allowed for review, verification and comment. Conclusions were revised and clarified based on recommendations from the member-checking process.

Next, the text of the focus group sessions and principal interviews was formatted for use with a computer software program for qualitative research. The Non-numerical Unstructured Data Indexing Searching and Theorizing (NUD*IST) software allows for efficient management of the large amount of data collected for the project, detailed exploration of the data, and makes it easier to see patterns in the data.

Two researchers coded the text of the focus group sessions and interviews. Each researcher coded data into a core group of agreed upon categories, and each researcher was allowed to create new categories as needed. After all documents had been coded, the researchers discussed and justified additions. Some coding categories were combined at this point.

When the coding phase of the research was completed, researchers checked inter-coder reliability to look for potential coding problems. Four key categories with subcategories were chosen to test reliability. There was complete agreement (100%) in three of the four categories. The category called "vision" had a very low reliability – 25%. The original four subcategories were not discrete, and therefore it was difficult to place some text units in only one category. The four subcategories were then collapsed into two categories, making them discrete.

The focus group data was then triangulated with other data collected at the site: the principal interview, the focus group discussion with students at the school, the technology coordinator interview, observational data, and the district technology plan. Triangulation helped to pinpoint the accuracy of conclusions through the use of several

sources of data. It also helped prevent the researcher from accepting the validity of his or her initial impressions without further substantiation and served to control for researcher biases.

Results

Analysis of data indicated a great diversity of technology integration in Iowa's high schools. Original thoughts about a relationship between size of district and level of technology do not appear to be supported by the data. In addition, data seems to conflict with previous conceptions related to the level of technology in rural districts. Data also seems to be providing a clearer picture of technology than was available with previous quantitative data.

A look at the current state of technology in Iowa High Schools indicated four most common uses of technology by both teachers and students. This included word processing, Internet, vocational applications, and multimedia uses. The vast majority (over 80%) of the teachers and students in our sample reported having a computer at home and approximately 50% indicated they had Internet access at home.

When teachers were asked to define integration of technology, the majority identified technology as a tool. Many indicated that integrating technology allowed them to vary the instructional approach and to provide educational experiences that would be difficult to do otherwise. Many saw technology integration as the way to connect schoolwork to the "real" world.

There was a difference in response between teachers at high technology schools and teachers at low technology schools. Teachers at low technology schools seemed to focus on why they couldn't integrate technology. The lack of access seemed to cloud their vision of what might be possible.

Teachers identified several factors that motivated them to integrate technology. One major factor was increased enthusiasm for learning. Teachers indicated their enthusiasm increased in addition to their students' enthusiasm for learning when technology was used as part of the curriculum. This encouraged both teachers and students to get excited about the content area in new ways. Teachers also indicated that they used technology because it helped them to prepare students for the future. They saw student preparation for entering either the workforce or college as a primary motivating factor for using technology. Other motivating factors included administrative support or directive, and the influence of colleagues.

Again, there appeared to be a difference between high and low technology schools. Teachers at low technology schools tended to avoid identify motivating factors and instead point out why they couldn't use technology.

It became evident that there were several barriers to technology integration. Barriers included inadequate training, inadequate access, lack of time, and lack of a common vision for technology integration. Of these, vision seemed to be the most critical.

Where technology was being successfully integrated, there was a vision holder who could clearly identify expectations of technology use. In some schools the vision holder was an administrator, either the superintendent or principal, in others it was a group of teachers.

What we want to do is make the technology so that when you come into a classroom you don't come out thinking "what a wonderful technology we have in the classroom", you come out thinking about the wonderful student learning that is going on. Whether it is a microscope, scanner, or computer, we want that technology to assist all our students so that they can learn. It's a big shift in the way our teachers will be presenting information....There are still a lot of good things happening in terms of hands on learning, but we want technology to come in where it's very pertinent and very relevant.

Principal

Where technology was being integrated, teachers reported several changes occurring. First of all was the role of the teacher. Classrooms become more student centered and the teachers become facilitators of learning. Use of lecture is down and students are given more responsibility for their own learning.

Not only did the role of the teacher change but the role of the student also changed. Students were more motivated. They were going out and getting information rather than waiting for a teacher to provide the information. Technology also allowed teachers to individualize lessons and meet the needs of a variety of students.

Other important changes identified by teachers included additional information sources, increased efficiency and increased teacher collaboration/cooperation.

In summary, we found that the majority of teachers view technology as a tool. They are motivated to use technology because of their own desire to learn and grow professionally and by their desire to provide this same opportunity for their students. While there are many barriers to successful integration of technology, schools with a vision are overcoming these barriers and seeing important changes occurring in the classroom.

Significance

Two aspects of this study make significant contributions to the field of program evaluation and technology integration. The methodology used in this study serves as a model for others conducting needs assessments or impact

studies related to program evaluation. In addition, the results of this study provided insight into the change process related to technology integration. It allows stakeholders to make informed decisions and allocate funds and programs so technology can make the most impact on teaching and learning and overall school improvement.

Recommendations made to stake holders identified three areas that need to be addressed to assist schools in making a successful transition to full integration of technology. These areas included training, access, and technology vision/planning.

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USING DISCOURSE ANALYSIS AS A RESEARCH TOOL FOR UNDERSTANDING USER NAVIGATION MODELS

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Introduction

The purpose of this paper is to examine how discourse analysis can be used as a methodology for understanding the mental models that influence how people navigate the Internet. Discourse analysis provides a methodology with which to articulate the relationships between language, social context, and the cognitive processes that underlie discourse perception and production. This paper describes the results of a pilot study that asked participants about how they navigate the Internet, as well as, how they conceptualize space and time while using the World Wide Web. By providing a clearer sense of how people construct their experience while on the Internet, this study begins to present techniques for analyzing end-users that help to clarify more culturally relevant technology-based pedagogies. The goal of this paper is to discern strategies for studying people to help design educational media, like educational web sites, that not only take into consideration how educational media is structured, but that also consider the guiding mental models that influence people's learning on the Internet. In meeting this goal this paper argues that, "It's not just what you do while learning on the Internet, or even just how you are doing it, it's always who you are and what you're doing when you are learning."

"Discourses" have come to mean more than language to include such categories as visual representations, as well as texts (Fairclough, 1992), including World Wide Web content that combine words and images. For the purposes of this study, discourse analysis will mean studying how language is embedded in social practice through which diverse social entities are formed and transformed as the result of history and practice. In this sense, discourses are always social and the result of histories. All of the discourses that an individual participates in are based upon individual identities and social affiliations that can be incompatible and produce conflicts that are often confronted based upon individual social positions. Discourse analysis provides tools with which to describe how the complexities of multiple and conflicting social identities influence how individuals navigate and understand electronic information spaces. This study will use discourse analysis to begin to articulate the mental pictures that influence people's perceptions. I will call these mental pictures **cultural models**.

Cultural models have been developed by Gee (1996) and Strauss and Quinn (1997) to study mental models in social contexts. While Gee's approach to cultural models describes how people conceptualize literacy and the social and political implications of these perceptions, Strauss and Quinn's approach tries to integrate a cognitive approach to understanding opinion formation by showing how individuals negotiate attitudes based upon internal schemas that are influenced by social and cultural contexts.

The Internet provides a unique context for educational research. Not only is it increasingly occupying the public imagination as an important medium for learning, it is also being positioned by large telecommunication, computer industry, and entertainment corporate interests as a medium for people to carry out the daily functions of middle class life such as shopping, banking, entertainment, etc.. Because the Internet can now be accessed from a variety of locations including home, school, work, the library, etc. and because of the decentralized nature of Internet content, the World Wide Web allows for different conceptions of time and space compared to other educational media like video and CD-ROMs. Depending upon how one has access to the Internet, it is open 24 hours a day, 7 days a week in any place in the world where access exists. One's sense of time and space, experienced through cultural models about time and space, can become compressed or expanded depending on how one approaches this medium. One's cultural models define much of the Internet learning experience. This study begins to see how people are using the Internet in relation to how they conceptualize themselves, Internet content, and time and space while navigating the World Wide Web, as well as, if it is possible to discern the cultural models that people bring to these areas of interest.

Four people were interviewed for this study and their answers were audio taped and transcribed. Each interview took approximately 20-30 minutes. Participants were asked questions about how they used the Internet, what they liked and disliked about particular web sites that they frequent, and about their experiences in relation to the way that they conceptualize time and space while using the web. Specific questions asked of each participant include:

1. How long have you been using computers?
2. How long have you been using the World Wide Web?
3. How often do you use the web each week?
4. How long do you use the web each day?
5. Tell me about a site that you particularly like.
6. Tell me about a site that you particularly dislike.
7. For what kinds of things do you use the web?
8. What is your perception of time when you use the Internet?

Follow-up questions were then asked to clarify their answers to the above questions.

Cultural Models

Gee (1996) calls cultural models, “pictures of simplified worlds in which prototypical events unfold.” He notes that people are often unaware of their cultural models and therefore cultural models appear to be “natural” and inevitable even though cultural models vary across social groups and change over time. According to Gee, “They allow us to function in the world with ease, but at the price of stereotypes and routinized thought and perception.” Cultural models form the basis of choices and guesses about meaning within particular communities -- they always include a conception of what is acceptable and unacceptable to do within that cultural model. Gee states, “It’s not just *what* you say, or even just how you say it, it’s always who you are and what you’re doing when you say it.”

Strauss & Quinn’s work has shown how people’s cultural models interact with each other and how they interact within various contexts. Cultural models vary in both content and form. The process of cultural model interaction can take the form of **integration**; as people modify their cultural models to make them more consistent with each other. They also observe that people are capable of possessing inconsistent cultural models without experiencing a sense of dissonance. They call the process of maintaining two inconsistent models **compartmentalization**. According to Strauss and Quinn belief systems are partly integrated and partly compartmentalized. When looking at people’s cultural models, Strauss and Quinn observed three things: 1) the content (i.e. the ideas expressed) of people’s talk, 2) the voice (i.e. characteristic mode of expression) they use to express the content, and 3) the temporal continuity and discontinuity (i.e. expressed in connected or disconnected discourse contexts) in the expression of the content. The analysis of the interview transcripts focused on these three areas of observation, as well as, the social language(s) that participants used to answer the questions.

A **social language** conveys a socially situated identity that communicates affiliations based on profession, ethnicity, race, gender, nation, etc. (i.e. social identities), as well as, communicates status within and between those affiliations. Individual often switch between social languages depending on who they are communicating with and how they want to communicate themselves to the other person. Looking at a person’s social language reveals who they think themselves to be within a communication and who they think their audience to be.

Participant Profiles

The four participants represent a convenience sample of Education graduate students at a large Mid-west research university. They have been using the Internet for at least 2 years. Pseudonyms are used in this paper to assure participant confidentiality. Participants were asked to be a part of a study that is interested in looking at the ways that people use the Internet. In order to help avoid sensitizing the participants to the questions, participants were not given specifics about the study until after the interviews when the study was explained to them in more detail.

The profiles of the four participants include:

Ron -Ron is a European American in his early forties. He served in the military during his twenties where he worked in electronics. After his tour, he worked as a Park Ranger and educator for the US Park Service, before becoming a school district technology coordinator. In the past year he has returned to school to pursue a Ph.D. in Educational Technology. Ron has a great deal of experience using computers and helping others use computers and uses the Internet two to three hours a day to look at technology news and current events.

Patricia - Patricia is a Mexican American in her mid-twenties. She is bilingual and grew up in Austin, Texas where she visits frequently to see her family. She earned her Bachelors degree in Communication Arts and is currently employed in the production department of a public television station. She is also presently working on her Master’s degree in Educational Technology and eventually hopes to design new media, like CD-ROMs, for children. She is particularly interested in creating new media that are geared towards multilingual children.

Laura – Laura is a European American in her late twenties. She earned an undergraduate degree in Secondary Education, German, and Political Science. Currently she is employed as a librarian in the university’s Instructional Media Center. She is working on her Master’s degree in a Library graduate school where she is studying to become a library media specialist. As a library media specialist she hopes to help teachers integrate the Internet into their curriculum. She considers her experience using the Internet and computers as intermediate.

Jan – Jan is a European American in her late thirties. She earned her bachelors degree in art. She has spent most of her working life in advertising as a graphic design consultant in marketing and advertising. Currently she is teaching in the Journalism department at the university in which this study was conducted where she is also working on her Ph.D. Of the three participants she is the least experienced with computers. During the time of the study, she had just purchased a new computer and was looking forward to spending more time learning new software and spending time on the Internet.

All of the participants had frequent access to the Internet either through the university, work, or at home and often through various combinations of the three. The participant's experience with computers and the Internet is summarized in *table 1*.

Table 1

Participant	Computer Experience	Internet Experience	Internet Use
Ron	Advanced	4 years	Daily 10-12 hrs / week
Patricia	Low to Moderate	1-2 years	Not Daily 3 hrs/week
Laura	Moderate	3 years	Daily 2-3 hours/week
Jan	Low	1 year	Not Daily (2-3 times/week) 3-4 hours/week

Data Analysis

Since the purpose of the study was to begin to find the participants cultural models of Internet usage and conceptions of time and space when using the Internet, the analysis was divided into sections of **usage**, **time** and **space**. The analysis will show schemas present for each of these categories, as well as, how at times these categories overlap, reference each other, and occasionally contradict each other. For the purpose of this paper **schemas** will represent the major themes that emerged from the interviews. Schemas will act as data organizers, as well as, indicators of cultural models. The data suggested that the participants had not spent a great deal of time reflecting on the ways that they use the Internet; therefore they rarely consciously went on a meta-cognitive level in their, mostly short, answers. This seemed to be the first time that they had thought about these issues.

It appeared as if the more time that the participants had spent using the Internet, the more that they felt capable of analyzing their Internet usage. This relationship was generally also true for their confidence in critiquing Internet content. Patricia, for example, gave "contextualizing signals"⁹ (i.e. a speaker's signals about what they take the context to be and what sort of person s/he takes the listener to be) that indicated that she was not confident in her answers. She often criticized her answers and devalued her opinions. The following sample from Patricia's interview, occurred just before she talked about her favorite web site:

wool
you can go to the.
taa
wool, it's interesting
cause usually you kinda
I'm trying to think
cuz I haven't been on it in a while
but

Usage

Most of the data collected in the interviews relates to how the participants use the Internet in both their professional and personal lives. The major schema that emerged from all the participants was the **Internet as Information Resources** schema. This schema constructs the Internet as a place to retrieve information that benefits one's school or professional work, as well as, a place to acquire information for one's personal use like travel information. As will be related below, this schema perhaps best fits their social identities as graduate students. Within this schema there seemed to be two subtle distinctions, one developed by the participants who had used the web in a business context, and the other who had only used the web in school. The participants who had used the web as an information resource in business (Ron & Jan) seemed to be much more focused and deliberate in the way they used the web than those who had just used it predominantly at the University (Patricia & Laura).

The following quotes help to show how the **Internet as Information Resources** schema gets constructed:

⁹ Gee (1996)

Patricia:

3. Most of the things that I use it
umm...for information
things mainly related to school
I really don't use it a whole lot as personal
and I want to
but I just for some reason
I just don't

Interviewer: How often do you think you use it a week, like how many hours would you approximate?

Patricia:

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none">1. Hours a week?
Not very much.
I'd probably have to say 3
I mean, you know
Sometimes more like when I'm trying to find a lot of things
like where I'm trying to find clip art
or I'm. I have to find information
then I probably spend a lot more
but I've never actually calculated | <ol style="list-style-type: none">2. I mean I can spend 2-3 hours a day on it
and that's finding
trying to find information that I need
but that doesn't come a lot
that doesn't
I don't usually try to
because I usually do it a little |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Patricia sees herself as different from the "norm" of Internet users because she doesn't feel as if she uses it for personal reasons, calling herself an "oddball" because of this. Later in the Interview she does state a personal use of the Internet by observing that she uses it to look up airline fares. Even this practice has a utilitarian component since she mostly flies back to Austin to be with her family. "I go to Austin a lot". Living in two cultures, spending time in her family's culture seems to be important to her. Nevertheless, this falls firmly into the **Internet as Resource** schema.

Like Jan, Patricia said she does not use it for "pleasure" when she is in school, "When school starts I do everything in relation to school." It is interesting, however, that when asked to name a site that she particularly likes it is Martha Stewart's site, a place that has very little to do with school. The Martha Stewart web site seemed to predominantly be a marketing vehicle for Martha Stewart with its prominent sponsorship by the "Gap" and "BMW".

Maybe much of the **Internet as Resource** model is derived from a cultural identity of a graduate student where there is always work to be done, assignments to complete, reading to do, papers to write, etc.. Perhaps it is difficult to admit using the Internet for pleasure when it seems more appropriate for a graduate student to use it as an academic resource. Jan seems to support this hypothesis:

1. no, only
and it's only a function of my circumstances in school
I think that I can use
easily get lost on it
 2. like if you had the same interview with me in August
I think it would be a very different interview
because I would have the summer to just be a human being
using the web verses a graduate student under pressure
- In her view being a "human being" is not equated with being a graduate student.

Patricia echoes Jan's feelings:

1. I mean, I do
I have used it for pleasure
but that doesn't happen for very long but
but that usually more in like Christmas break
or in the summer when I don't have school

As a librarian Laura seems to mostly look at the Internet as a resource for *other* people.

1. umm, I'd say
well now it's probably daily
just because with my work at the education library on campus
a lot of the materials we find
are on the Internet for people so

Interviewer: ok, so you use it for your job (working at the reference desk at a library) when you're working and then as far as personal use?

Laura:

1. I'd say maybe once a week.
Depends on what I'm really interested in finding
If there's something that I want to find out
then I'll use it more.

She estimates that she uses it about an hour a week for personal use. Laura also uses the Internet as a replacement for newspapers and, like Ron, keeps up with current events using the Web.

Ron is the only participant in the study that admitted to, as he put it, “truly surf”, following links without any particular purpose in mind. I call this Schema the **Internet as Information Frontier**. In this schema, a person chooses to spend free time following links without any particular purpose in mind. Ron follows this strategy about once a week, “Yea, it’s probably like one day a week when I’ll spend at some point just flippin’ around just following, following the links.” This usually occurs on Saturday. There may exist a gender component in the responses in relation to how one accesses the Web, where the act of moving around is more important to males and the final destination is more important to females. While one could not draw any general conclusions from this, the data did seem to support this hypothesis for the participants of this study and is exemplified in this exchange with Patricia:

Patricia: yea, I like to go just straight to it
Interviewer: right, without having to go through interim steps
Patricia: steps and yea
that usually
and I think that probably turns me off
more than anything else
Because I’m like “oh, forget it”

Jan in describing how she uses the Internet says, “so I’m kinda an observer.” Although her first experience with the Internet was more free floating and exploratory, she had not settled into the **Internet as Information Frontier** as a regular part of her Internet experience. Nevertheless, she anticipated using the web more freely in the summer when she didn’t have the responsibility of being a graduate student. It would be interesting to be able to watch the participants surf the Internet without the expectations presented by an interview. Would female participants experience the **Internet as Information Frontier** schema more than they would admit?

Space

An important Internet component for all participants was the **Internet as Interesting Visual Space** schema. All of the participants expressed in various ways how they were more attracted to as Laura put it, “visually interesting material”. Ron, for example, uses visuals that he is attracted to as queues to look deeper into information at a site. In talking about the CNN site he notes:

1. At a glance you can see
well the headline news
and if anything is happening
that I’m interested in
I can go right there and
and to get more details right away
and eventually see a video clip
and some visuals
and news about that

In general, all four participants did not want to use the Internet to read lots of text. They expressed a particular dislike for sites that are text-heavy. Laura says:

1. because
if a site has really, umm
to much text
or too boring
then I probably won’t stay there very long
which is not necessarily
a reflection on the content

Jan answers a question about her favorite web site with:

1. there’s a media literacy site
that I absolutely love
cause it has the most cool graphics
and it’s so much fun

She also dislikes sites with too much text:

1. I’m not at all enthralled by real textual pages
I kind of find em to be really dry
and dull
and I really just find them
dry and dull

It should be noted that computer monitors, depending on their quality, often make it difficult to read a great deal of text and can easily cause eyestrain. It is difficult to say whether or not this is the cause of the consistent call for less text and more graphics, although some of the responses indicated that it has had some bearing on this attitude. Laura also communicated a dislike for text-heavy sites and addressed the difficulty of reading from a computer monitor below:

Interviewer: Can you think of a particularly bad site that you didn't like?

Laura:

1. boy, lately
I've had to do a lot of readings
for my library classes
a lot of reserve readings have been on the Internet
that have just been
you know
full text things
2. and umm and so those are really
I mean
that's probably just the exercise of reading off the screen
for pages and pages
you know

Participants, in general, wanted to be able to easily jump to the information that they wanted. This schema is called, **Internet as organized Information Space**. Ron expressed his dislike for sites that had search features that don't work as he expects them to:

1. Sometimes you go into a company's site
and there will be a search button
implying that you can just search the site with this one button
and find a couple of links pointing in the right direction
2. But you click on a search button
and it either says "not working right now "
or it just doesn't point you to where you want to go anyway
so that's
that's a real turn off there
when features don't work like you expect them to

The last stanza echoes a common criticism that content presentation on the Internet is still inconsistent and that standards still do not exist in terms of individual expectations and larger medium wide expectations. The technology and techniques with which to organize data on the Internet are still quite early in their development.

Patricia, referring to why she likes the Martha Stewart site notes:

1. you go to her home page
and then I look at the tabs that say
you know television, magazine
I don't remember
blah blah, blah
and then you can click to that and go to it
and then
and then usually you can make
like one more click to get to the information
Like if it's a recipe on I don't know some kind of food

Later she says:

1. I think what turns me off
when I have to keep going layer after layer after layer
just to get what I want

When asked about a site that she particularly liked Laura described her use of Yahoo, a reference site that organizes listings of millions of web sites by subject. She says:

1. I used to use Infoseek and Excite
as the web engines
and then I finally realized that Yahoo
is much better for the type of searching that I like to do
the way it groups it

Later she states, "I'm interested in what kinds of sites people find helpful, user friendly." Laura helps library patrons find information on the web. When asked about a favorite site other than a search engine or directory site she described a peanut butter site saying:

1. it's just that the graphics
the graphics are nice
but not overwhelming
and the text is simple

2. and I guess I like that kind
not too much text
at least at first and then the categories are
it's easy to understand,
it's easy to navigate
and um it's fairly quick as well.

Included with her perspective is the **Internet as Interesting Visual Space** schema:

1. I guess it was jazzy enough, too
jazzy is also a bad word
but umm, nice enough looking to keep my interest as well

As exemplified in this answer, Laura's answers were often couched in self-doubt. She was not confident in the opinions that she presented about the Internet. If one just looks at her triple major as an undergraduate (Secondary Education, German, and Political Science) and from conversations before, during and after the interview, it is apparent that she is an intelligent person with a broad liberal arts background. It was not immediately apparent what was operating to cause this doubt, whether it was something about my presence as an interviewer, or something unique about the Internet that challenged her confidence as an informed consumer and critic, or something about her own confidence, in general.

The Internet raises new issues about the perceived authority of the content within a web site. Typical measures of validity (i.e. books produced by established publishers) do not exist and individuals must judge content according to more individualistic criteria influenced by schemas and cultural models. Who creates the information spaces on the Internet (i.e. authorship) seems to take on a different meaning compared to other sources of information like books.

Jan was the only person who directly spoke of the authorship of a site. Speaking of the media literacy site that she likes, "somebody very sophisticated put this together." The perception from participant's answers is that a web site is not created by a person like a book, but is created by the organization or institution that hosts the site. Unless the site actually states the author's name, it seems as if people don't conceive of authorship in the typical text-based author/reader relationship. The content is just all "out there", loosely connected but part of a whole with indistinguishable authors. Patricia, when describing using the web for school, does pay attention to how "legitimate" information is before using it in a paper. For her, information that is produced by governments is considered "legitimate". In doing a paper about literacy in Brazil she said, "and then we ended up using, like, a lot of, like, government sites."

Jan's fine arts and graphic arts background gave her authority to describe the media literacy site that she liked in more technical graphic design terms. She was quite confident in using this social language. It also was apparent that she is accustomed to dealing with people who don't share the same social language. She goes to extra lengths to explain to me what she likes about the media literacy site in stanza 1 below. In stanza 2 she speaks of the graphics in the media literacy site from the perspective of an artist and finally in stanza 3, she speaks of her dislike of animated icons on the web and makes a claim that "most people find them distracting." What gives her the authority to make this claim? Perhaps her background in advertising, according to her, gives her insight into what people like?

1. I think ...wool
going back to that web site on media literacy
what drew me was colors
and the energy
but I also think what's really, REally, REALLY important is simplicity and white space
that's what we call it in graphic design
where this
there's a place
there's a space for the eye to flow around
rather than just
putting too much on the page
I think that's hard to visually read
umm so I think you need to have things really clean
2. and that doesn't mean that they're not
like this this illustration on this media literacy page
was very kinetic and energetic
but then around it it was real clean
and so it was almost like a painting on a wall
and you had a sense of just
of space of it's own
so even of itself it was busy
the whole page wasn't busy

3. a pet peeve of mine
from a design standpoint
is those icons that do things for no purpose
you know, spinning things or flashing things
I just want to like ZAP them
I find them really distracting
I think most people find them distracting
it's really bad design

While the participants were not asked if they use the Internet to communicate with other people, Jan is the only person who raised the issue:

1. I remember being able to leave notes for people
because I was trying to find out
at that point
I was looking for information on Tiger Woods
I was really curious about what people thought of the new ads
that had come out
2. and I needed to get a couple of copies of things that I couldn't get my hands on
and so I was like finding these places where you could leave notes for people
and I was just
and I was so intrigued
and then I kept on trying to find more places that I could have a dialogue with people
or you know
find people with common interests
it's really engaging

This **Internet as Communication Space** schema would have been interesting to explore in greater detail with the participants. The Internet provides numerous opportunities to communicate with strangers about specific areas of interest.

Time

According to Barbara Adam (1995) everyone constructs their own meanings about time based upon their social, cultural, emotional, physical and psychological circumstance to create what she calls "social time". She notes that western style education has worked to socialize, habituate, and train people into a "clock time" approach to time which, in turn, has the effects of displacing the variety of times that comprise the multi-dimensionality of everyday life. The time of clocks and calendars (e.g. schedules, deadlines), "clock time" is only one aspect of social time. Because the Internet is always "open", those who use it are not confronted by the limitations of clock time and in turn, are liberated to construct their own unique forms of "social time."

While each participant was asked whether they ever lost their sense of time when using the Internet, rarely did they answer "yes". All the participants were very aware of the time they spent using the Internet and did not often lose their sense of time. Even Ron, who spends one day each week, "just surfing" plans this time deliberately. For him, as for the other participants it rarely happens by mistake.

When it does occur and they spend more time than anticipated, it is because they find something unexpected. For example, this occurred when Ron was looking at Apple computer's advertising firm, Chiatt/Day, to see some examples of their work. He was drawn into the site by the amount of information it offers about advertising and how the company researches people's buying habits and tastes. He spent "two or three hours" looking at the content that the site provided.

1. It was actually insight into the human psyche
more than anything else
or was actually just fascinating
they were talking about
it was about advertising
but it was also talking about things
about demographics in there
and what people are doing in different stages of there life
and how it wasn't as crass as how they manipulate you
2. but it was really interesting to learn that sort of thing
it had a very practical use
since it was an advertising company
it was practically oriented
it wasn't just esoteric

This information allowed him to go into **Internet Time**, when he either was not aware of the passage of time or didn't care. It would be interesting to see under what conditions people enter into **Internet Time**. Again, I

suspect that people go into **Internet Time** more frequently than they might like to admit, perhaps because the Internet occupies a unique position as both sources of information and entertainment. And therefore, it is more acceptable to use it as a source of information than as a place for entertainment. Granted, people use television both as a source of information and entertainment, however the line between the two is less clear. Rarely will a graduate student use the television to research a paper. It would be interesting to explore how, if it all, **Internet Time** may conflict with the **Resource** schema.

Ron describes Internet Time like a “flow”:

1. If there are not many distractions around me
yes, time can fly by pretty quickly
If people are in the room
or if I’m trying to do something else
like perhaps do the laundry or something like that
that will interrupt that flow

Later he says more:

Interviewer: Do you find that the element of surprise is something that intrigues you about sites in general? When you find something you don’t expect to find and that’s what might keep you there?

Ron: Yeah, I think that it produces, you know,
some sort of rush in my mind
you go somewhere and all of sudden you just
you go into that special time mode
where time is passing by and you’re not conscious of it
your just following link after link after link
and could be reading and reading and reading
whereas you hadn’t intended to do that when you got there
That is exciting and it’s fun.

Conclusions

The study constitutes a beginning for using discourse analysis as a methodology to understand the cultural models that influence how people navigate the Internet. While the sample studied for this project was small, the data produced by the interviews produced distinct themes and schemas that could be further developed with a larger sample and longer interviews into articulations of more general cultural models. The study functioned as a productive pilot for future research by showing that social identities and social languages contribute to how end-users perceive and understand Internet content, as well as , how these factors contribute to their sense of time and space on the Internet. For example, the study revealed that factors other than experience with the Internet influence the way that participants used and analyzed Internet content. Professional experience with information processing or visual design or business allowed participants to be more confident consumers through social languages developed in their professional life. In such cases, cultural models as computer or Internet novices were contradicted by cultural models developed through professional experience. In these circumstances they were able to compartmentalize the two cultural models (novice and professional) which allowed both to exist simultaneously.

Using discourse analysis to understand how people construct their Internet learning experience shows that discourses, social languages, and cultural models are fluid, dynamic and often contradictory. Such a methodology provides insights for educational media designers and researchers that help them to understand that even the best designed media, using traditional instructional design techniques, may not be effective because they fail to address how learning is a cultural process as much as a cognitive process. Using the techniques described above, educational technology researchers can develop a language to account for the cultural aspects that influence learning using technology. With increasingly multiethnic and multiracial populations in many parts of the world it will become more difficult to ignore how cultural models, based on various forms of difference, impact learning.

In order to more fully develop these ideas it will require studies that ask more in-depth questions about the participant’s educational and professional background, as well as, their perceptions about how the Internet functions as an educational, information, and communication space for them. Further research might include studying people as they use the web using a protocol analysis. While protocol analysis present problems in that thinking aloud may alter a person’s behavior, it might provide insight into the ways a person approaches constructing knowledge on the Internet that an interview may never reveal. For example, people may idealize or simplify ways that they use the Internet in an interview, where as actually using the Internet they may feel less self conscious and compelled to “make sense” of their habits. Even videotaping or monitoring the sites that a person visits while using the Internet would provide important information about the way people use the Internet. The computer can easily record each web site that a person visits and the amount of time that they spend at a site. The combination of the three types of data (interview, protocol analysis, and direct monitoring of usage) could provide a valuable source of data triangulation. Such a strategy would also be helpful in showing the schema contradictions, which often exist when looking closely at how people process information and construct knowledge.

Finally, it should be noted that discourse analysis in the context of educational media research is not being suggested as a means to create more efficient forms of instructional design that address just the right cultural models in just the right ways. Instead by showing the complex ways that cultural models, social identities, and social languages contribute to Internet-based learning experience it highlights that new design paradigms are needed that work within multiple discourses across gender, race, ethnicity, class, nation, etc. These new design models would strive to work within ambiguity and uncertainty rather than strive for efficiency. Discourse analysis provides a set of tools with which to begin this rethinking process by mapping and naming the complexities of this shifting terrain.

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PERSON-ENVIRONMENT INTERACTION IN THE VIRTUAL CLASSROOM: AN INITIAL EXAMINATION

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Abstract

Can a class that never actually meets within a classroom have a classroom environment? This study explores the perceptions of distance education students of their classroom environment using the College/University Classroom Environment Inventory (CUCEI). It is important to evaluate the environmental impact of the classroom on the student so the instructor can fully understand the dynamics of the class which might affect learning and instruction. This initial examination of the virtual classroom environment found that a majority of the students did perceive that there existed a classroom environment and provided helpful instructor feedback. Further iterations are necessary to develop a deeper understanding of the potential use of the instrument.

Introduction

Distance Learning is by no means a new phenomenon. However, the new technologies provide a twist to distance learning that is making it grow and expand at overwhelming numbers. The National Center for Educational Statistics reports that in 1995, a third of US post-secondary schools offered distance education courses with another quarter of the population planning to do so in the next three years. When you then consider the rapid proliferation of internet-based courses as a distance learning option and then consider that the World Wide Web (WWW) has only been "popular" for the past 5 years, it is indeed overwhelming.

While the numbers alone are enough to amaze and dazzle, what is more interesting are the instructional design and pedagogical issues that form the basis of these courses (Ritchie & Hoffman, 1997). The technical skills to build a course-web site and all the accompanying technologies are merely psychomotor skills ranging from the simple to the highly complex, and many courseware packages now remedy the need for instructors to worry about developing those skills (Hansen & Frick, 1997). Hill (1997) lists some of these key issues, which include the pedagogical, technological, organizational, institutional, and ethical. What is missing from these areas of research focus is the psychosocial environment of the classroom. Research has demonstrated that the classroom environment, in terms of psychosocial factors, accounts for appreciable amounts of variance in the cognitive and affective outcomes for students (Fraser, 1981).

However, can a classroom environment which is in fact not physically tangible, and it exists on the "virtual space" be assessed? And, if there really is such a thing as a virtual classroom environment, can it be assessed using already proven techniques for classroom environment assessment. That query is the focus of this preliminary examination of the virtual classroom environment.

Background

Individuals do not act outside the context of their environment. The bond of this physical and social environment interaction with the individual has troubled philosophers since the time of Aristotle (Huebner, 1980). The question therefore consistently posed is how can the environment serve to enhance the development and learning of the student?

The study of the classroom environment accesses and assesses the shared perceptions of the instructors and students situated in that environment (Fraser, 1989). The advantage of this type of assessment over outsider observational data collection is that both students and instructors have the long-term viewpoint of the class and are not basing their perceptions on small sample observations. The instructors and students also place their assessment in context with other educational experiences.

Moos (1974) provides a scheme where there are three classifications to describe human environments. The first is the relationship dimension which describes the nature and intensity of personal relationship and the extent to which there is mutual support and assistance. The second dimension is called the personal development dimension and concerns the degree to which personal growth and self-enhancement occur within an environment. The third dimension is systems maintenance which measures how orderly and responsive the environment is to change.

A number of instruments have been developed to assess a variety of human environments, including k-12 classrooms, psychiatric hospitals, prisons, and residence halls. One instrument developed by Moos and Trickett (1974) is called the Classroom Environment Scale (CES) and has been used in many of these environments even

though its initial development was for the secondary classroom. DeYoung (1977) piloted a short-form of the CES at the university level.

Another instrument developed specifically for higher education is called the College and University Classroom Environment Inventory (CUCEI). This instrument has seven scales which cover the areas of Personalization, Involvement, Student Cohesiveness, Satisfaction, Task Orientation, Innovation, and Individualization (Fraser, 1986). The scales determine the fit between a student's perception of the actual classroom environment and their preferred environment. The CUCEI was developed expressly for the purpose of assessing environments of higher education classrooms and was developed for classes of 30 students or less and not intended for large lecture classes or lab settings.

In possible conflict with the assessment of a classroom environment (the traditional physical space) is the concept of the virtual classroom, such as courses offered over the World Wide Web. Through Internet classrooms, students and faculty can communicate asynchronously and synchronously. Learning on the Internet can take the form of (a) electronic mail (e-mail) and electronic discussion groups (listservs or chat rooms); (b) bulletin boards or newsgroups; (c) downloadable course materials or tutorials; (d) interactive tutorials on the Web; (e) real-time, interactive conferencing; and (f) infomatics, the use of on-line databases (Kerka, 1996). These methods provide usage, response and impact considerations different from the traditional classroom setting (Kuehn, 1994).

The study of classroom environment is critical if teachers want to be able to exercise control over the environment to the betterment of learning. However, with the growth of distance learning, it is also important to determine what instructor and student perceptions are of the virtual environment. Verduin and Clark (1991) state that the separation of teacher and learner does not allow for a truly shared learning experience, but Moore (1973, 1994) concludes that distance learners must be emotionally independent, self-motivated, and more autonomous in order to compensate for the transactional distance in the distance classroom. Initial examinations are being made of student perceptions of this learning environment (Powers & Mitchell, 1997). This study showed that students do perceive that at least two of Moos' dimensions are present (personal development and relationship). The question does remain unanswered as to whether an effective person-environment fit is taking place and the extent to which the instructor might be able to control those factors. This paper describes a pilot study which makes an initial examination of the virtual classroom environment in terms of traditional measures.

Methodology

This study details the results of a pilot study which examined the classroom climate or environment of a virtual course. Study participants were graduate students enrolled in three different courses offered at a distance over the World Wide Web (WWW). Each of the three courses was offered by the same instructor and was designed following the same design principles. One course dealt with the history and theories of Instructional Technology. The second course focused on information technology and media literacy. The topic of the third course was on the technologies of distance learning. Twenty students were enrolled in these three different courses.

The courses consisted of lecture notes placed by the instructor on the WWW, readings of seminal works on the topics, classroom discussion completed through web conferencing and email discussion groups, synchronous chat sessions and presentations made by the students and posted to the WWW. Course requirements included consistent, regular weekly participation in class discussion on the web and response to peers' presentations and ideas.

As an exploratory study into the evaluation and assessment of the virtual classroom environment, data was gathered from a variety of sources. First, a traditional classroom environmental assessment tool was used. Each student (20) was mailed a copy of the College and University Classroom Environment Inventory (CUCEI) (Fraser, Treagust & Dennis, 1986). See Table 1 for sample questions from the CUCEI. The CUCEI is composed of 49 questions which rate seven different factors of the college classroom environment: Student cohesiveness; individualization; innovation; involvement; personalization; satisfaction; and task orientation. Comprehensive validation research has been completed on this instrument to confirm the internal consistency reliability and discriminant validity of the instrument (Fraser et al, 1986). Students rate each question on a four-point scale of Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

Table 1: Sample Items from CUCEI

<u>Student Cohesiveness</u> 5. Students know exactly what has to be done in our class. 7. All students in the class are expected to do the same work, in the same way, and in the same time. (scores reversed)	<u>Individualization</u> 8. The instructor talks individually with students. 14. Students are generally allowed to work at their own pace.
<u>Innovation</u> 15. The instructor goes out of his/her way to help students. 19. The group often gets sidetracked instead of sticking to the point. (score reversed)	<u>Involvement</u> 23. Students in this class pay attention to what others are saying. 25. Classes are a waste of time. (scores reversed).
<u>Personalization</u> 32. Classes are boring. (scores reversed). 33. Class assignments are clear so that everyone knows what to do.	<u>Satisfaction</u> 37. There are opportunities for students to express their opinions in this class. 39. Students enjoy going to this class.
<u>Task Orientation</u> 44. The instructor dominates class discussion. (scores reversed) 46. Classes are interesting.	

This instrument can be delivered in two different formats, preferred and actual. The questions as worded in Table1 represent the actual format, i.e. how students perceive a classroom environment to actually be. In the preferred form, the questions would be the same, but the word "would" is inserted. For example, "Students would know exactly what has to be done in our class. For the purposes of this study, only the actual form was used because the research team wanted to determine if this instrument could play a role in the evaluation of virtual classroom environments.

Twenty students were mailed a copy of the CUCEI, along with an explanation letter and a postage-paid, addressed return envelope. Thirteen surveys (65%) were returned in sufficient time to be included in this discussion. The data from the surveys was entered into SPSS for analysis. Sums were generated for each environmental scale and then means and standard deviations were found for each of these sums (the CUCEI is scored on a 1-5 scale with 1 being Strongly Agree, 5 being Strongly Disagree and 3 given to no answer). Additionally, for investigating the usefulness of the instrument for virtual classrooms, means were generated for each survey item, as well as frequency data for each item to determine the degree to which students considered the questions to be answerable from the perspective of a virtual classroom.

In addition to the data collected with the CUCEI, qualitative information from the course was also collected in order to assist with interpretation of CUCEI results. The data included papers and presentations, discussion questions, on-line lectures, peer discussion and feedback, and student reflective journals and time logs. All qualitative data was content analyzed in terms of the factors of the CUCEI. This process was completed to examine what factors the students and the instructor perceived as important virtual classroom climate issues.

Results and Discussion

The information received from administration of the CUCEI provided valuable information about the classroom environment of a web-based class. The results of the survey provided quantifiable data to support the qualitative information gathered and the instructor's impressions. First, the results which lead to the viability of the use of the CUCEI in this context will be examined, followed by a discussion on the student assessment of their virtual classroom environment.

Use of CUCEI for Virtual Classes

Of the forty-nine questions asked in the CUCEI, one or more students did not answer 15 of the questions. At first glance that seems to be a large percentage of the total number of questions. However, it is important to see how many students didn't answer these questions in order to make determinations on the viability of the instrument (See Table 2).

The researchers predetermined that one or two blank responses was not a critical issue. There could be numerous reasons why a student does not answer a certain item. When three or more students do not answer that same item, then the time must be taken to examine the possible reasons behind the lack of response. Of the original 15 items which received at least one non-answer, only 6 remained when this qualifier is used. These six items appear

to fall into two different categories: lack of a tangible, physical classroom to assess and the nature of an asynchronous web-based environment.

When students participate in a web-based course, their "classroom" could be one of dozens of places. For example, a student might consider the computer lab where s/he works to be his/her classroom. A student who works mostly or entirely at home might consider that particular space to be where s/he attends class. Other students might be able to think in the more abstract and consider the web site itself to be the classroom in which they will function. Finally, other students may not be able to conceptualize a classroom that does not exist within four walls, has desks, tables and chairs, chalkboard, and needs a good cleaning.

Therefore it is not surprising that those questions that appear to concern a physical classroom space were unanswerable to students. In particular, those questions that deal with the arrangement of the room and the degree to which the instructor moves around the room. The mean score for Item 29 (instructor moves around classroom) was 2.69, indicating that those students who answered the item tended to agree with the question. The mean score for Item 34 (seating arrangement) was 2.38, once again indicated that those who responded agreed with the statement. One example, and a typical example, of how some students might struggle with the concept of a virtual classroom that doesn't have the characteristics of a traditional classroom is represented in this quote from a student who is trying to figure out where all the discussion points fall together:

I noticed that [another student] sent the responses to her questions [the listserv]. This is not our chat line, do we use this address only for our assignments? Thanks again for your help I am working on getting a picture, but have not been successful up to this date.

The student has had no problems with the assignments; rather her frustration lies in figuring out where in the virtual classroom she needs to go to tell the class as a whole something. This type of struggle would not be typical in the traditional seminar classroom.

Table 2 - Frequency Data on Unanswered CUCEI Items

Item	Scale	Frequency
4. The students look forward to coming to class.	Cohesiveness	3
13. New and different ways of teaching are seldom used in the class.	Individualization	1
16. Student "clock watch" in this class.	Innovation	2
19. The group often gets sidetracked instead of sticking to the point.	Innovation	2
21. Students have a say in how class time is spent.	Innovation	2
25. Classes are a waste of time.	Involvement	2
28. The instructor seldom moves around the classroom to talk with students.	Personalization	5
31. It takes a long time to get to know everybody by his/her first name in this class.	Personalization	1
32. Classes are boring.	Personalization	1
34. The seating in this class is arranged in the same way each week.	Personalization	7
39. Students enjoy going to this class.	Satisfaction	3
40. This class seldom starts on time.	Satisfaction	3
41. The instructor often thinks of unusual class activities.	Satisfaction	3
45. Students in this class are not very interested in getting to know other students.	Task Orientation	1
46. Classes are interesting.		1

The remaining troublesome items fall under the category of the asynchronous nature of the classes (i.e., students' access course materials at any time). These items concern student going to a class (which might be construed as physically going) and class starting time. The mean for item 4 (students look forward coming to class) was 2.23 and shows that the students who did answer the item agreed with the question, and the same with Item 39 (students enjoy going to class) with a mean of 2.15. In terms of the issue of class starting time (Item 40), even though 3 students didn't feel as though they could answer the question, the mean of 1.92 indicates strong agreement with the

statement. The final item under this category, involving unusual class activities (Item 41), had a mean of 2.69, and again demonstrates agreement with the statement. Under this category, each of these items were left unanswered by 3 students, and the same students each time.

E-mail and listservs are examples of asynchronous communication. The message can be read, studied, and a response sent at staggered times and at the participant's convenience. E-mail provides students direct contact with each other and the instructor without the time restraints of office hours and class time, or space restraints of distance (Kerka, 1996; Partee, 1996). The flexibility of asynchronous class structures superimposed on the responsibility necessary to function in an asynchronous environment may cause problems for some students and generate uncertainty as to when and where they should be doing class work, as demonstrated in the following journal entry by a student:

I am sorry. I read your message about not posting until Tuesday afternoon, but I posted my 15th questions today. I am trying to get ahead because I am going to be gone next week. So sorry. Let me know if I need to send again. Thanks for your patience. When do we need to be available to chat tomorrow?

Although none of what the student worried about was a serious problem, the ability to do class work at times other than regular classroom hours was providing some dissonance for her.

Overall, the CUCEI items appeared to fair well in the virtual classroom. The two items that were most difficult for students to answer were not impossible for everyone to answer. Furthermore, the difficulty which might arise from conceptualization of the virtual classroom environment might be alleviated as the prevalence of web-based courses grows and student experience and understanding of the environment also grows.

Assessment of the Virtual Classroom Environment

The CUCEI assesses seven different factors of the classroom environment. On each of these factors, an individual's total score of 7 would indicate high satisfaction (Strongly Agree) with the environment, and a score of 35 would indicate high dissatisfaction (Strongly Disagree). Table 3 provides the minimum, maximum, mean and standard deviation score for each scale.

Scale	Minimum Sum	Maximum Sum	Mean	Std. Dev.
Student Cohesiveness	9	23	14.23	3.98
Individualization	10	25	14.07	4.09
Innovation	9	23	14.46	4.33
Involvement	9	19	14.54	2.84
Personalization	12	26	16.23	3.66
Satisfaction	7	24	13.15	4.45
Task Orientation	9	22	14.84	3.46

For the most part, the scores from each scale are similar to the others scales. The mean scores for the seven items indicate high agreement with the statements in the survey depicting the classroom environment. The strongest degree of agreement appears to be on the Involvement scale. Students felt that the instructor was involved with the students and that the students were able to be involved and participate with each other. This information from the instrument provides invaluable feedback because it addresses one of the biggest fears both students and faculty have about internet- based courses, and distance education courses in general. However, the ability of students to adapt to this environment and to take the initiative for making those connections among participants is exemplified in this message that a student sent as a welcome message (unsolicited) to all other students in the class:

I'm looking forward to working with you all, those who were in class today and those who I'll meet in cyberspace.
Good luck.

For those students who desire and need the involvement with others, the virtual environment may require and force them to be more active about developing relationships as opposed to passively awaiting others to do so for them.

It is also interesting to note that the other scale that stands out is the Personalization scale. This scale not only had higher minimum, maximum, and mean scores, but also four of the seven items on the scale were not answered by at least one individual. Two of these four items were the items that had large numbers of students not responding (Items 29 and 34). This scale concerns how students assess the environment in terms of responsiveness to them as a person, and to what degree they are able to assert their personality. Again, the difficulty some students felt about answering questions dealing with the make-up of the classroom might have affected the overall results of the scale. Students in these three web-based courses spend a great deal of time presenting their work to all students in the class and receiving constructive feedback. Students consistently comment about how much they appreciate hearing from the peers about their work and the recognition it places upon their efforts, as well as the way this sharing forced them to reflect back on their own work:

Very impressive and detailed paper. Your insight on aspects on privacy and the Internet was very good. You raised many questions and forced me to rethink many simple ideas such as the privacy US mail has and the lack of privacy Internet communication has. I look forward to learning from your perspective.

Overall, the CUC EI provided valuable feedback about the classroom environment. It placed the comments collected by students in another framework that was more quantifiable. As an assessment tool of the virtual environment, it generally appeared to provide good information.

Conclusion

The CUC EI appears to be promising in its ability to assess the virtual classroom environment and provide instructors with valuable information about student perceptions of the environment. One thing this pilot study did not do was to complete a pre-test of the instrument that would provide students' preferred environment. As a follow-up study, it would be interesting to assess students' preferred classroom environment and contrast that with the actual environment. However, to understand the virtual classroom environment better and because a virtual classroom environment can be in many ways substantially different than the traditional classroom, it might be important to assess two different preferred classroom environments. The first administration would examine the preferred classroom environment in general terms. The next administration would examine the students' preferred distance classroom environment, followed by assessing the actual perceptions of the virtual classroom.

Fraser (1981) describes how classroom environmental research can provide a practical basis for aligning the environment to make a better person-environment fit. For example, even though an instructor may not choose for pedagogical reasons to make all adjustments to bring profiles in line, the assessments allow the instructor to know how much weight is placed upon certain scales, i.e., greater emphasis on student cohesiveness than individualization. Finally, the use of the assessment instrument also serves as tool to encourage all those involved to develop greater understanding of the virtual classroom

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ASYNCHRONOUS AND SYNCHRONOUS PERFORMANCE SOLUTIONS: DEVELOPING A COMMUNITY OF TECHNOLOGY-USING TEACHERS

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Abstract

A theoretical model that permits graduate students to interact with adult learners in an authentic situation by addressing a performance problem—developing a community of technology-using teachers by using asynchronous and synchronous performance solutions—is examined with implications presented for future use.

A body of research suggests that instruction in computer usage may decrease computer anxiety and increase certain attitudes toward computers, thus opening a window of understanding about the possibilities this technology may offer (Loyd and Gressard, 1986; Madsen and Sebastiani, 1987; Maddux, Johnson and Harlow, 1993; Savenye, Davidson, and Orr, 1992). Designing effective computer-based technology solutions, however, continues to concern both teachers and students.

The potential of applying newer technologies may be hindered if access to computers and peripheral equipment, time, and support are limited. Furthermore, adult learners may experience disquietude if issues important to them, such as, connections to a learning community, peer support and a balance between active and reflective modes of learning are overlooked (Brookfield, 1991).

Project Goal and Objectives

A model for the development of a community of technology-using teachers was designed and evaluated. Asynchronous and synchronous performance solutions were employed that permitted graduate students to interact with adult learners—the teachers—as they addressed an authentic performance problem. The underlying concept was that an integrated design that connects two different groups of adult learners with online resources and easily transportable peripheral computer devices might have potential to contribute to the graduate students' future design of technology-based solutions and simultaneously deliver technical solutions to the teachers. Both synchronous and asynchronous connectivity between the two groups was offered primarily online through email, a web-site, and teleconferencing.

Emphasis was placed on developing effective performance solutions (Mager, 1992) that would encourage the teachers to experiment with, and employ, educational applications for computer peripherals in their instructional science modules. The peripheral devices included video digitizers with zoom and electronic white board functions, digital cameras, handheld PCs with database applications, and laptops equipped with science probes. The graduate students were expected to establish and maintain communication with the teachers; deliver performance solutions for using the newer technologies that the teachers judged to be effective; formatively evaluate the teachers' capabilities with, and attitudes toward, newer technologies; and assess and reflect upon their work with adult learners and as adult learners themselves.

Participants

Ten public school teachers at a small public K-6 elementary school located in the western region of the United States volunteered to collaborate with eleven students enrolled in a graduate course that emphasized theoretical and practical aspects of planning for professional development in technology. These Department of Educational Technology students at a major public university created an instructional design intended to support the teachers' needs for integrating technology into classroom science curriculum. Two specialists, a science specialist within the school system and a university evaluator, also joined with the educational technology instructor to complete this learning community.

Performance Solutions

During the design phase, the graduate students analyzed the teachers' technology needs. Those needs centered on online usage, digital imaging, digital data display for large group viewing, and technology integration into traditional curriculum.

The graduate students focused on ways to provide access to newer technologies that appeared relevant to these identified needs of the teachers. They planned time for their mentoring relationship with the teachers, and for offering ongoing support through synchronous and asynchronous contact. They also sought to determine which aspects they might best address without face-to-face (F2F) training. They provided printed job aids and a web site with documentation on frequently asked questions about the identified technologies to offer ongoing guidance despite the diverse schedules of the two groups of participants. Identified technologies were placed at the school on long-term loan to increase access. Performance solutions and support for basic applications of email management, web-based searching for teaching and learning materials, and integration of newer computer peripherals into science instruction were developed. After a synchronous introductory approach of the project and themselves—a F2F meeting during one of the teachers' inservice days—asynchronous email contact and a dedicated web site were offered to the teachers. Contact options also included F2F meetings and telephone calls between mentors and mentees, videoconferencing through hardware and software placed at both the school and university sites, and portions of regularly scheduled inservice days with graduate student teams.

The teachers guided the graduate students in developing performance solutions that would be effective for teaching aspects of technology usage related to science standards to an adult audience. Both types of adult learners could engage in dual roles of learners and students by developing a collaborative environment through the various options for ongoing email messaging and continuous access to a web site dedicated to the project. One university student served the dual role of school technology coordinator and master's student, providing a valuable, visible link between both groups.

Financial Support

Financing from a Dwight D. Eisenhower Professional Development Grant permitted the purchase of the laptop computers and peripheral computer equipment, planned as the beginning of an equipment pool available for long term loan for professional development activities initiated in subsequent offerings of the university course. Funds also made possible the employment of a part-time graduate assistant to serve as a liaison between the university and school populations. A university professor with expertise in evaluation and science education and a science specialist from the school system were also employed. Both served to connect the graduate students with the science curriculum and resources relevant to the school system. The university professor also played a critical role in design, delivery, evaluation, and reporting. The science educator continued working with the teachers after the graduate students' semester ended, by guiding the teachers toward more advanced uses of the peripherals to improve their students' science learning.

Evaluation

The project underwent formative and summative evaluation.

Formative Evaluation

The graduate students were responsible for formatively evaluating the project by gathering data to initially measure:

1. The teachers' ability to:
 - use basic email functions on the web browser.
 - locate relevant instructional materials, particularly in science, using a web browser.
 - use one or more of the newer computer peripheral devices at a basic level for instructional purposes.
 - create instructional modules in science that integrate one or more of the newer computer peripheral devices at a basic level.
2. The teachers' assessment of the performance solutions that the graduate students developed.
3. The teachers' attitudes toward computers.

The students were required to design their own evaluation approaches for items 1 and 2. For item 3, they were provided with the 40-item Computer Attitude Survey (Loyd and Gressard, 1984) to measure overall attitude and domains of anxiety, confidence, liking, and use.

Summative Evaluation

The evaluator for the project observed the university classes and the students' evaluative data; made school site visitations; reviewed the graduate students', university instructors' and teachers' email correspondence;

consulted with the university instructor; and reviewed the teachers' ideas for technology-based science lessons. She also had access to the graduate students' written summaries of their reflections about their work with these adult learners—the teacher. Their reflections were framed within Brookfield's (1991) eight insights on adult learning. The teachers' skills and knowledge about, and attitudes toward, using newer technologies to teach science in terms of each participant and as a group were also evaluated. The teachers provided some insights into their subsequent work with their pupils as a result of their initiating their new knowledge and skills.

Discussion and Implications

The results of creating an authentic performance problem for university graduate students with a selected school site—the community of learners—are reflected in terms of the initial technology issues of access, time, and support.

Access

The teachers responded to access from mentor-guided, hands-on experiences and to newer equipment on long-term loan at the school by selectively experimenting with the newer technologies. Strong response was shown to searching the web for science resources and using the digital camera to capture images. Some interest was shown in web browser use of email beyond the school's intranet and converting digital computer signals to analog ones with a video converter for display on a classroom television. No interest was shown in using a handheld personal computer. Although only one teacher experimented with the science probes, his involvement with it, led to him to include it in his summer science program. Access to a practical context resulted in the graduate students' design, delivery, and evaluation of performance solutions customized for a specific audience.

Time

Issues of time for professional development remained a concern regardless of delivery mode. Despite external guidance, busy teacher volunteers may not necessarily engage fully with newer technologies when there is limited non-teaching time set aside for these activities. When they spent time exploring applications of the newer technologies with a science specialist and examining model lessons, they, and some teachers who joined the project at a later date, did generate ideas for integrating the newer technologies into their science lessons. These ideas have potential to become fully detailed lessons to be tested with their pupils.

The contributions of the new teachers at the conclusion of the project indicate the positive impact that a credible and authoritative teacher can have for adult learners (Brookfield, 1991). Although the sample size for this project does not warrant strong generalizations, future instructional designers may choose to study the effect of identifying specialists for their audience when developing and delivering technology-based performance solutions.

Support

Synchronous support from the university students was the preference of teachers who were novices at using technology. So strong was this preference, that some teachers only began communicating with their mentors after very traditional communication was used, such as telephone calls and on-site visits, despite repeated attempts to initiate online contact. One mentor and mentee experimented with a newly installed videoteleconferencing system between the two sites, but technical problems interfered with that process.

Although the university students originally planned to stress asynchronous use, the active response that the synchronous methods brought about encouraged them to emphasize those delivery modes. Their early plan to incorporate job aids as guides to effectively using the targeted technologies was also retained. Creating these guides required the university students to analyze key features of the peripheral devices and develop concise, clear print-based guides to encourage independent use of the technologies by the teachers.

Future Directions

Responses from teachers at the school who completed the Loyd and Gressard Computer Attitude Survey (1986) indicate slight differences between participating project teachers and nonparticipants. The teachers in the project were slightly more positive about liking computers; recognizing their usefulness; and feeling less anxious about them. The nonparticipating teachers were somewhat more confident. While no statistically based conclusions are warranted because of the low sample size, the results provide a window that opens onto future examination of participating teachers' prevailing attitudes of positive change. Further study is also warranted to determine if the higher level of confidence shown among the non-participants is a factor of greater expertise or the opposite. If the latter situation, it may reflect lack of awareness of the challenges planned integration and technical issues can pose for newer technology users.

This project did result in shaping a theoretical model for professional development for inservice technology-based performance solutions that engages graduate students directly in authentic school-site situations. It

also guided the two principal university professors involved in the project to plan for a university-based learning community between graduate students in an educational technology and a science education course for technology enhancement of K-12 science curriculum.

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DESIGNING ON-LINE INSTRUCTION USING MULTIDISCIPLINARY APPROACHES

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Instruction Support at Arizona State University is a multidisciplinary group integrating academia with Information Technology. Unique features having to do with the status of computing at the University have led to the establishment of the Instruction Support Lab, which has produced a series of successful initiatives regarding web courses. In particular, a close relationship with the College of Education allows the Instruction Support Lab to offer a high level of assistance in web course design and technology integration to faculty members. The IS Lab, having tested a variety of approaches to the creation of web courses, has chosen two. Software packages are made available, with training provided, and these packages may be enhanced if desired by individually developed websites. A Multidisciplinary, real-world team approach, modified to include instructional designers, is a second method. There are pros and cons to both approaches; lessons learned have been documented. Web course examples of principles discussed are archived on the corresponding presentation website, at <http://is.asu.edu/aect/multi/>.

Introduction

It surprised many when Nicholas Negroponte, who in the past has spoken of the web as creating “a totally new, global social fabric”(1995), announced in *Wired* (1998) the end of the digital revolution. The implication was not that we would now cease to use computers, but that computers, and the changes they bring with them, have become commonplaces of our existence. One could argue with Negroponte’s statement, yet in its very publication this remark signals the end of an era: for one hallmark of this revolution has been that a thinker in tune with the times could create new realities with a word (Davis, 1998; Rheingold, 1993a). Logos has had incredible power in these last years: writers, thinkers, educators could formulate a goal and then, thanks to electronic communication, quickly find a group of like minds with which to plan and implement means of reaching that goal. With this in mind, it is an appropriate time to detail the history of Instruction Support at Arizona State University, sharing methods that might be useful to others, and sharing lessons learned in the first two and one-half years of the Instruction Support Lab.

The Instruction Support Lab was founded in the summer of 1996, as an open door for faculty to the Instruction Support group in central Information Technology at ASU. Instruction Support itself came into being as part of a deliberate restructuring of central computing that brought an academic influence into Information Technology, in particular from the College of Education. This restructuring began with the creation of an academic position, the Vice Provost for Information Technology, filled by a professor from the Department of Computer Science and Engineering, and continued with the creation of the Instruction and Research department. A professor from the College of Education was brought in to head Instruction Support, and he was joined by two more researchers from the College of Education.

Much of the Lab’s development has centered around the evolution of web courses and web supported courses. Very quickly, users proliferated. In the summer of 1997, before the Lab was even one year old, the Lab staff began searching for ways to streamline development work. Caught between the need to develop interactive websites and the need to serve faculty members new to the web, the Lab staff began designing templates and interfaces so that faculty members could set up web pages, quizzes and bulletin boards without knowing HTML. As other solutions arrived on the market they were tested and offered to professors who were willing to try them out. As there was no one solution that provided all the features we identified as important in a web course, IS continued to develop our own applications. We also kept in constant touch with what our colleagues in the commercial world were thinking and doing by following discussions on professional mailing lists. We had seen from the beginning that real-world development is always the product of a multimedia team (Nielsen, 1995), and we began refining this concept for academic purposes.

Major Arguments

That the lab has not remained static, but has been able to adjust support for technology integration in the face of a technology that changes daily, is the real hallmark of success. Three areas in particular in which we can point to specific successes are first, new areas of support in Information Technology that have developed from lab initiatives; second, students who have “graduated” from the lab; and third, courses and other projects developed in Instruction Support. Web courses and web-supported courses have been a central area in terms of faculty requests for

support, with over forty courses affected by the Lab. A number of Lab projects having to do with improving web course development have spun off into other areas. Each of these projects, having grown too large for the Lab, is now being developed/offered to faculty elsewhere in Instruction Support and Information Technology. For instance, support for those using web course creation software packages such as WebCT has moved out of the lab to Instruction Support's Education area. Support for collaboration software, pioneered with faculty members in the Lab, has also moved out to a production environment. Our initial efforts in creating scripts for interactivity resulted in the funding of an IS graduate student to complete a set of interfaces by which online quizzes could be created and administered. Our efforts to develop a web course creation package resulted in the project being funded. Student successes include three students who are now full-time staff members at ASU, a student who became one of the three-member webmaster team at ASU, and students who received excellent job offers upon graduation or earlier.

Key features contributing to the Instruction Support Lab

Four key features that have led to these successful web courses, initiatives, and students are, first, the previously-mentioned integration at ASU of academia and computing; second, a university-wide policy of decentralization with regard to computing resources; third, a lab mission that includes many levels of support as well as research and development; and fourth, an openness in the lab itself to real-world methods. The previously-mentioned change in the nature of Information Technology is the first key feature affecting the Lab. At its inception the IS Lab replaced a modest lab where faculty came for tasks such as printing. The new academic focus made it possible for representatives of Information Technology who understood the needs of faculty to reach out to the Colleges; improved access for faculty members to IT; and allowed IS Lab staff members to advise faculty on good instructional design. In the past, no web course support had been offered other than to one law professor who had come to the faculty lab to learn HTML. Now that same professor was offered instructional design support; help with graphics that were carefully crafted to enhance instruction while simultaneously following the rules of good web design; and interactivity. An invitation to collaborate in research could also be extended since Instruction Support now had researchers to evaluate major projects and present the results at academic conferences, or publish them in scholarly journals.

The second key feature affecting the Lab's success is that, as ASU Provost Milton Glick (1999) has stated, Arizona State University is a decentralized campus with regard to computing resources. We in Instruction Support feel it is inappropriate to mandate technology solutions across the board where instruction is concerned, just as it would be inappropriate to mandate that all professors use the same instructional strategies regardless of academic discipline. In 1999, solutions for instructional problems are still being developed; no one solution can be relied on to take care of all needs, whether it is a web course management system, an instructional strategy, or a particular platform. In keeping with this position, ASU has allowed differing support structures to arise. Currently there are three primary support structures for web courses. ASU professors desiring support can work with Information Technology's Instruction Support, with the College of Extended Education, or with a new entity, the Center for Learning and Teaching Excellence. Each has a different focus; faculty members can use more than one if they desire. Instruction Support offers an individualized approach that allows/requires the faculty member to participate in development. Extended Education is our distance education arm at ASU; faculty using their services may supply a course already developed by the professor, supply only the content and have the graphics developed, or experiment with "canned" content. The Center for Learning and Teaching Excellence is expected to serve as a bridge between the two, focusing on faculty development but familiar with the changing offerings of other support areas.

The stated mission of the Lab is the third key feature influencing the success of the Lab. Its tenets derive from the atmosphere of academic freedom that arises where a campus is decentralized with regard to technology, and where Information Technology has an academic flavor. The primary mission of the IS Lab is to help integrate technology into instruction. A faculty member might still ask for help with printing, but others have asked for help in planning the simultaneous premiere of a new work of classical music on the web from nine locations; in finding the way for a department to rearrange itself into a team in order to publish an online as well as a print version of a scholarly journal; and in rewriting a piece of software so that a professor of communication can create a web course without with maximum opportunities for communication. Beyond this, the Lab constantly conducts its own investigations into new technologies, so as to be prepared with advice when faculty approach us with instructional problems as well as to help drive the evolution of these technologies in the directions we as academics need them to evolve.

Finally, a fourth key feature contributing to success is the use of real-world development methods, always tempered and enriched by the academic viewpoint. Like labs on many other campuses, we have experienced the heady feeling of having the best of two worlds, academia and the commercial "real" world. In the academic tradition we have the freedom to conduct research and the luxury of supporting worthwhile projects. In common with the commercial world we have the realization that we are fortunate to live in a time in which our shared intelligence can find solutions and new directions almost as often as we need them. Developers who are in the forefront of web

design, digital artists, and many of the best instructional design minds all share their insights with us through online conversations and collaboration.

Real-world methods

The most important real-world method in use in the IS Lab is the concept of the multidisciplinary /multimedia web development team. No single person can create any kind of multimedia or web instruction alone if that instruction is to compete visually and professionally with commercial products. It would be impossible for the individual faculty member to simultaneously be a professional in all of the areas needed in development. Thus the faculty member coming into the lab to develop a web supported course becomes one member of a development team, in this case the content expert as well as a project co-manager. A second project manager, equal in authority, represents the Lab. As needed, a graphics expert, a videographer, a programmer, and an instructional designer may be assigned to the project. Each team member is a student, and all bring the latest information from their respective fields. The lab is a crucible in which these students from different disciplines must learn to work together. The graphics designer learns quickly that small file sizes are important to the web designer; the programmer learns to appreciate that it takes as much dedication and as many late-night hours to create visual perfection as it does to create the perfect program. As student team members learn to respect one another they realize the invaluable experience they are gaining: they will be prepared for the development teams that exist in their future places of employment (Crandall & Levich, 1998; Ullman, 1997.) The supervisor becomes the bridge among students from the various disciplines. In all, the Instruction Support Lab has a staff of twelve student workers, from as many of the University's Colleges as possible. While the majority are students in Education, Engineering, Fine Arts, and Architecture, students from all disciplines have something to offer.

A second real-world method is the concept of the "flat" hierarchy. This concept is prevalent in what Pearce (1997) calls "virtual" companies: small, low-overhead companies that can expand and contract as needed. Downes and Mui (1998) report the concept as a successful strategy in development, quoting a CEO as asking, "How do you change a culture from one of hierarchy with the normal pyramid to an open, flat culture where the 25-year-old can say to me, 'You're crazy. That won't work. Where did you get that dumb idea?'" A flat hierarchy does not mean that the CEO is no longer the CEO, but that a system of revolving authority can allow the expert in a field to make the decisions involving that field. The expert must be willing to share information, and the other team members must be willing to learn, so that responsibility for decision-making stays with the expert only so long as the decisions involve the expert's field. In practice, this implies that the supervisor is constantly being taught by the employees, so that the supervisor can participate in decision-making regarding the employees from an informed standpoint; and it gives employees a chance to be committed and to do their best.

A third real-world method is that of allowing staff members to manage their time. Student workers in the IS Lab are told upon being hired that they will be expected to spend approximately half their time on lab tasks shared with other Lab staff: working with drop-in clients, scanning, documenting, even dusting. The other half of their time should be spent in activities which will help them develop skills in their area of studies and interests. There may be times when as much time as possible will be devoted to a project deadline that demands that everyone contribute. However, this will be followed by time for the student to learn a new software program or to work on a project of interest.

Fourth, the Lab uses a system of networking and internships to find qualified/competent student staff. Because our work environment is unique on the ASU campus, the Lab has no trouble attracting applicants, yet we do most of our hiring through networking with former employees often recommending new students. These new students usually apply first as unpaid interns, willing give their time for a chance to learn the skills of working in a multidisciplinary team and creating professional work. Such interns are given the responsibilities of full Lab staff members. Interns are required to keep a journal and to produce, or work as a team member on, one large project that becomes a part of their portfolio and is useful to the lab. In addition to interns, the Lab has a mentoree program, in which young adults who would not otherwise have access to technology are given the status of interns in the lab. Of our four mentorees thus far, one was a learning-disabled young man; two came to us through a technology mentoring program for the formerly homeless; and one is deaf.

Fifth, the Lab relies on collaborative procedures involving electronic and face-to-face meetings, for the iterative nature of the developmental process requires collaboration (Yourdan, 1998). All students are given accounts on the Lab servers; after a recent survey of internal files on our main server it was estimated that almost one quarter were uploaded for collaborative purposes. Students working on a project may not be in the Lab at overlapping times, so collaborate by uploading their work to a shared directory on the server, then notifying the other students via e-mail of the project status. A particularly important collaborative procedure is the "studio model" adopted from the College of Architecture. Under this model, students develop in a lab environment, and a team member is encouraged to request feedback from peers at any time in the development process, even if they are not on the same team. An extension of this is the concept of the small usability study, in which an interface is tested by a group of seven to

thirty users. In addition, we are currently using collaboration software in order to keep documentation and student workload information easily accessible.

Finally, as far as possible, the Lab uses real-world planning and documentation procedures. These can be difficult to implement, as neither professors nor students may see the use. However, the use of a multidisciplinary team that does not always meet face to face requires the use also of planning documents such as timelines and storyboards. Such methods contribute to the success of commercial companies, as they break projects down into smaller tasks and issues (Kristof, 199); thus they can only improve our instruction. While developers agree that a project management tool that meets all needs has not yet appeared (England & Finney, 1999), as better software for project management is developed, documentation will become an expected part of project development for all team members.

Streamlining procedures

Streamlining goes hand in hand with technological sophistication (Porter, 1997) and is necessary if the level of sophistication is to be maintained. One means of allowing the Lab to remain dynamic in the face of changing technologies, numbers of users, and levels of user ability, has been the Lab's relationship to other areas within Instruction Support. Large projects may require support from staff members in production areas. Similarly, Lab staff members initiate, evaluate, and test new ideas in a development environment; successful initiatives and ideas are then moved to a production environment as projects grow. This streamlining procedure ensures that Lab staff are then free to begin new initiatives. With web course development we focus on finding ways to streamline procedures while maintaining high standards in terms of interface design, programming issues, web tenets, instructional design, and learning theory, while allowing maximum individualization for/ input from professors. This balance ensures that we keep current with information and with demand. As far as possible, web course development falls within a set of overarching ideas, philosophical and instructional. This set of standards frees staff developers to experiment and bring in new ideas so long as the ideas remain within this set of guiding parameters. For hyperlinked examples, see the website at <http://is.asu.edu/aect/multi/>. The guidelines are as follows:

1. The professor is an integral part of the design team, not just the subject matter expert.
2. Development should provide for maximum reusability of procedures, templates and tools developed for web courses. Any such products developed for a course should be designed so as to be easily configured for other courses.
3. We attempt to apply principles from communication, learning theory, commercial multimedia/video production, and distance learning.
4. We value content first, using technology only where it is appropriate.
5. We seek to design for all users. We value the accessibility standards developed by the World Wide Web Consortium (1998). The electronic medium can provide disabled students with a chance to use their abilities and creativity (Barnette, 1994) if developers adhere to those standards. Whenever possible, we use multi-platform solutions; we keep file sizes and screen sizes to a level that as many users as possible can view; we use few passwords, preferring to share information when possible; and we attempt to use good HTML so as to be viewable everywhere.
6. Those using the lab resources are asked to give back to the Lab in some way. Often a professor places a graduate assistant or student worker in the lab.
7. Whenever possible, standard multimedia documentation procedures are used. We encourage professors to make plans with us for both formative and summative evaluation.
8. We pay particular attention to visual communication in interface design. This is an aspect of web course development that many course designers have been slow to take into account. This may be because interface design is not seen as being particularly important by professors who are used to considering only content when designing a face-to-face course. Many web courses are consequently still content-only, or use standardized icons for navigation that are the same across courses. It is our belief that visual communication interface design does indeed have a counterpart in the face-to-face world. The classroom itself is, after all, an interface (Jonassen, Davidson, Collins, Campbell & Haag, 1995). Students learn in an environment with which they interface using all senses. One course may take place in a large mediated classroom with projection screens; another may take place in a small room with rows of desks. Ignoring these aspects of the environment produces difficulties for those attempting to learn or teach via the web (Fleming, 1998; Mandel, 1997). Sensory cues are bound up with their learning and help students remember what they have learned.
9. We also pay particular attention to navigation issues. Confusing interfaces slow down the student, who will have to adjust to the interface before learning can begin (Fowler, 1995; Galitz, 1997). Commercial websites and television may be perceived of as noise-free by viewers, since research is used to produce the optimum visual environment. Students have become accustomed to receiving information in a particular format, and information given in another, less professional mode may be difficult to remember. This is not to say that educators need to become entertainers. Educational television uses the design principles of commercial television, and thus successfully transmits content. Web courses need similarly to investigate how information is transmitted in the commercial world, in order to avoid distracting users.

Methods of producing webcourses in Instruction Support

Professors and instructors requesting support with the creation of web courses are offered a choice of two major methods for creating those courses: first, they can choose to use a web course creation software tool, and second, they can choose to become a part of an individualized multimedia team. The two methods can also be combined as desired. The professor who wishes to create a web course is asked to attend an initial meeting with

representatives of the Lab staff. Here, levels of possible development are discussed. The professor may choose (a) to create a basic level web supported course, with syllabus and class schedule; (b) to create an interactive course using a software tool; or (c) to create an interactive course that will be designed from the ground up. If the faculty member wishes to use a software solution, the course is moved to the IS Education area, where training is provided. If the faculty member wishes instead to develop with a multidisciplinary team of Lab staff members, then the faculty member becomes project co-manager and usually provides one or more graduate students for the team. Faculty members may elect to work in both ways; a professor might decide to develop a website in the Lab that ties together and individualizes two courses developed, with a software tool, in the Education area. Should the faculty member decide to develop an interactive course from the ground up, then the multidisciplinary team may include not only IS Lab students, but also IS staff members such as programmers and videographers from production areas.

The multidisciplinary team approach to course development

If development is team-based, the professor is asked to attend at least four meetings, so as to be able to provide direction; this also ensures that communication is efficient. After this, a graduate student provided by the faculty member may attend as co-manager in place of the faculty member. Documentation paperwork, beginning with the first meeting, guides the team through a standard set of planning documents including proposal, content outline, flow chart, and detailed storyboards. An instructional designer from the College of Education is responsible for helping team members create these necessary documents; the documents will save valuable production time later. IS Lab graphics experts work with the instructor to create a series of graphics that communicate visually what the course is designed to do. Typically, a student from Fine Arts or Architecture creates a series of three sketches, and the professor then chooses one line of development. An programmer, usually from Computing Science and Engineering, works with the artist to create the website. Interactive elements are brought in as needed. All graphics must work in harmony; motifs are chosen to reflect the personality of the instructor as well as the nature of the course, for the course is in some sense a creative work, and the professor creating the course stands in the relationship of artist or writer to those who access the course (Maddox, 1996).

We view these initial meetings as an opportunity to learn the answers to questions that we ask in order to improve our work. The early meetings also provide an opportunity to help the professor understand the nature of the procedures used. We take the time to explain professional development methods (such as timelines and storyboards) to the professor. We ask where professors heard about the Lab; this enables us to plan for future information dissemination about Instruction Support. We discuss evaluation procedures, suggest collaboration in research, and explain backup procedures. We also ask the professor for the primary reason for creating a web course or web supported course. The answer to this question helps us direct development and enables us to predict what sorts of courses we need to prepare to develop. For example, a number of faculty members have come to us because they teach very large classes, and feel that they need new means to make information accessible; for this group, we may suggest posting presentation slides, lecture notes, and syllabi. A second group of faculty members may wish to create a course for faculty development or funding reasons. A third group is interested in the concept of web instruction and wishes to try out new ideas; for this group, we can investigate the pros and cons of those ideas and ways of implementing them. Other faculty members have been particularly interested in experimenting with interactivity, so that small groups can collaborate or so that members of a small course can work closely together.

The software method and the multidisciplinary team approach each have strengths and weaknesses that must be taken into account when choosing a method for a particular course. The advantages of a multidisciplinary team are that this method (a) provides for maximum individualization, (b) provides for maximum configurability, (c) can lead to a course that is professionally developed and of the highest quality in every area, (d) consists of well-integrated modules connected via good navigation design, (e) allows easy access to the visually impaired and others who use a text reader and/or speech software, and (e) can contain any element desired, as long as it is possible and there is sufficient time. Disadvantages are that (a) this method is time-consuming for all, including the professor; (b) if the professor is not a committed member of the team, expectations may be unreasonable; (c) if one team member leaves or graduates, it may slow down production, as the replacement will need time to become a member of the team.

The software tool approach to course development

For those who choose the software solution, the Instruction Support Education area currently offers a choice of three tools. We do not believe at this time that it is necessary or wise to offer only one, as any software tool has its advantages and disadvantages. While the standard packages have improved greatly, none really offers all of the features one would desire. An intensive look at the tools and packages being offered reveals that there are a number of considerations when deciding on which tool to use or to test. We have compiled a list of questions that faculty and staff should ask themselves before making this decision.

1. First, was the tool developed originally for the corporate world or the academic world? If for the corporate world, will its use conflict with sound instructional theory? If you are not sure, ask someone in the College of Education who is familiar with computer-based instruction or web-based instruction.
2. Is the interface intuitive and professional for both students and professors? Can you, as instructor, use your own graphics? If not, there is a danger that all courses will look the same from year to year, so that students forget where they learned important content. If possible, ask a graphics design professional to look at the interface and give an opinion on design and usability.
3. Which interactive features does it offer; which do you see a need for? You may want a forum, online quizzes, a chat room. Sometimes the programming that is necessary to build in interactivity slows the speed with which your users can access your course. If you elect to incorporate interactivity, do these features interfere with speed? You may want to ask an expert from Engineering or Computer Science.
4. Does the package provide for data collection and user tracking? Depending on the software tool, you may be able to give quizzes, add quiz scores to a grade book automatically, check on which pages have been accessed by which students, and keep logs of chat room activity. Again, sometimes the programming that is necessary to build in such data collection slows the speed with which your users can access your course. You may want to check with an expert from Engineering or Computer Science to see if these features unacceptably interfere with speed of access.
5. What is the pricing? How does this compare to other packages?
6. Does it offer accessibility for the visually impaired? Graphical interfaces can present difficulties for the visually impaired (Coombs, 1995). If a disabled student is in your course, you will need to offer all information in a manner that the student can access. It is relatively easy to write web pages so that they can be read either by a text reader or built-in speech, but not all web course tools offer this ability.
7. How many users and classes will it support? Software may allow many courses to be created, but break down in actual use if a relatively small number of students attempts to login at once. You may have to test the software on the server you will be using in order to know how many simultaneous logins the software can support.
8. Finally, does it work? If it is buggy, will students believe that they are not being treated fairly? Again, ask an expert from Computer Science to test with you.

To summarize, there are both advantages and disadvantages to the use of web course creation software tools. Advantages are that (a) they are relatively easy to use, as designer does not need to learn HTML but only the program that creates the HTML; (b) they provide interactivity with no extra effort on the part of the instructor; (c) they provide data collection to varying degrees; and (d) built-in password protection allows a sense of protected community. Disadvantages to take into account are that (a) courses developed with such a program tend to look alike, since they use an interface created by the program; (b) courses may look old-fashioned quickly, a problem that could be alleviated if the creators of the software used new templates each year; (c) interactivity and data collection are done via programming that may slow down the speed with which the pages are accessed; (d) if there are software bugs, they may not be easily remedied.

Discussion

During two and one half years of development the road has not always been smooth. We have had to adjust and change policies innumerable times, and from a bird's-eye view of that road we can now offer a number of "lessons learned" that we can share with others. To begin with many difficulties lie in the fact that there is too much information to manage (Stoll, 1995). It has been suggested (Applehans and Laugero, 199) that it is beneficial to think in terms of knowledge management rather than information management, where knowledge refers to documented, interpreted information that, once interpreted, becomes useful. Knowledge management then refers to defining job functions, identifying the knowledge needed for each job, and ensuring that workers receive that knowledge. Applying this idea to the Lab, we see that along with programmers and creative artists, a third important job function is the administrative/clerical area. People who enjoy detail-oriented organizational tasks, and can relate to these tasks in a creative and technological environment, are as necessary to functioning as a lead programmer. We have learned that unless we make the three roles equal in status and responsibility, development will not proceed smoothly.

Documentation and data collection are a high priority when developing in an environment in which team members may be collaborating electronically, when new paradigms are being tested, when pedagogies are being extended to other media, and when students are relying on our expertise to help faculty members offer web courses. While all this adds information to manage, it is important for predicting where we are going and identifying issues that need to be addressed. Giving high priority to the administrative/clerical side of the Lab has helped, as has an increase in supervisory staff. In 1996, the Lab had only one supervisor. This rapidly proved to be a difficult situation as one person cannot efficiently ensure that all policies and procedures are followed, guide the development of all projects, supervise all employees, be a bridge to production areas, and successfully conduct documentation. The addition of an assistant supervisor as well as a graduate student who can act as assistant supervisor has helped immensely. However, ensuring good communication and free information sharing among supervisors becomes of paramount importance so that policies and procedures remain standard.

The Instruction Support lab remains a drop-in lab for faculty requiring immediate help as well as being a development lab for those creating web courses and other projects. This has its advantages and disadvantages: we gather new ideas from all parts of the University by thus keeping our doors open. Moreover, we have a better idea of

the level of familiarity with technology among faculty than we would were we solely a production environment. On the other hand, it can be difficult to meet a deadline for a meeting with a faculty member when team members must take the time to help drop-in clients as well. Having other support areas within Instruction Support that we can call upon if necessary is one way in which we have been able to deal with this problem. A quiet space where students could retreat to work uninterrupted would be helpful also. Further, while keeping our door open to drop-in faculty members helps us judge the level of support needed, it does not help with those faculty members who are afraid to enter the doors. Having the Lab supervisor go directly to a College to support technology integration there has been helpful in bringing to light the technology problems of those who are just beginning to use it.

In a University setting such as ours it is common for some staff to be student workers. We found that while the majority are committed and dedicated, a few cannot handle the freedom of a professional development environment in which they must make many of their own decisions and manage their own time. We have found it useful to place the student under the direct supervision of a student who is doing well; the second student then reports to the supervisor on progress. In this way the student who is having trouble can learn from a student who has adjusted to the professional model. Sometimes a student having difficulty with time management will fail to accomplish tasks; other students will must learn to avoid burning out. Similarly, some students find it difficult to adjust to the idea that they will be working in a team. Here, it is useful to seek and hire students who understand the value of having experience in a multidisciplinary team, and who are eager to learn to work with their peers from other Colleges.

No discussion of lessons learned would be complete without a reminder to back up data. The early status of the Lab as a developmental, experimental venue worked well when faculty members who co-developed were among the early adopters of technology. As the users of Lab services grew in numbers, many were not expert. In time we realized that we would need to treat any project developed for a course as "production" rather than "developmental" since not all faculty would understand the difference. Any course element being developed in the Lab must now be moved onto a production server located in a secure area before being offered to students.

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AUTHOR & KEYWORD INDEX

A

A Vygotskian Perspective	157
Andrew, Richard	359
Andrews, Sandra	275, 565
Aptitude Treatment.....	87
Askun, Cengiz	429
Asynchronous and Synchronous	561

B

Babb, John S.....	275
Backward Navigation	429
Barab, Sasha A.	443
Baylor, Amy L.....	437
Beck, David.....	323
Bender, Carl	537
Bichelmeyer, B.A.	73
Bland, Ray	473
Boling, Elizabeth.....	429
Brown, J.P.	119
Burmeister, Marsha	211
Burton, John K.	101, 465
Byun, Yung Kye.....	165

C

Caffarella, Edward P.	483
Cai, Weijia.....	119
Cavalier, Jamie C.....	63
Cennamo, Katherine S.....	29
Charnitski, Christina Wotell.....	157
Chiero, Robin T.....	377
Cifuentes, Lauren	531
Clariana, Roy B.	87
Cognitive Development.....	45
Cole, Jason	479
Color Coding.....	39
Computer Games	327
Computer-Based Instruction.....	241
Conley, Aaron T.....	111
Contextual Variables	503
Cooperative Learning	63
Cribelli, Susan	81
Cross, Lawrence H.	465

D

Danielson, Jared A.	101
Davis, Michaelleen	553
Designing Instruction	295, 413
DiGangi, Samuel A.....	275, 565
Distance Education.....	465
Distributed Cognition.....	249
Doctoral Dissertation.....	483
Dual Structured Instructional Systems	165
Dwyer, Francis	45
Dwyer, Francis M.....	39

E

Edens, Jim.....	561
Edwards, Craig.....	319
Edwards, Leslie D.....	221
Equivalency Theory	207

F

Faculty Motivation.....	269
Frick, Theodore.....	111, 119, 429

G

Generative Learning.....	333, 443
Gilbert, Linda S.....	249
Giles, Frank.....	119
Gleber, Conrad.....	171
Green, Tim	429
Greene, Barbara	451
Guan, Yi.....	359, 443
Guoping Ma.....	429

H

Harmon, Stephen W.....	423
Harvey, Francis A.	137, 157
Hinn, D. Michelle	233
Holmes, Glen	29
Hsu, Yu-chen	73, 199

I

Instructional Design	215, 349, 479
Instructional Design Models	323
Instructional Designers	7
Instructional Designing.....	391
Instructional Principles	93
Instructional Technology	29
International Team Teaching	531
ITDE Model.....	211

J

Jannasch-Pennell, Angel	275, 565
Januszewski, Alan.....	371
Jones, Marshall G.	327, 423
Jordan, John	81
Julian, Marti F.....	7

K

Keller, John M.	513
Kilic, Gulsen	111

Kim, Jaehyun.....	171
Kim, Young Hwan.....	165
Kincannon, Joyce.....	171
Kinzie, Mable B.	7
Kisling, Eric	119
Klein, James D.	53, 63
Klemm, E. Barbara	561
Knowledge Structures	127
Koroghlanian, Carol M.....	241
Kuiper, Wilmad	403

L

Land, Susan M.....	451
Larsen, Valerie A.....	7
Leader, Lars F.....	413
Learner-Teacher Interaction	259
Learning Structure and Summarization	53
Lee, Jiunde	341
Lee, Mi Jar.....	137
Ley, Kathryn.....	93
Lockard, James	281
Lockee, Barbara B.	461, 465
Luetkehans, Lara M.....	491

M

Magliaro, Susan G.....	349
Mahesh, Veena.....	259
Manternach Wigans, Lynn	537
Marszalek, Christine S.....	281
Maushak, Nancy.....	537
Mazur, Joan M.....	187
McCrary, Nancye.....	187
McIsaac, Marina Stock.....	259
McKay, R. Ian	561
Mental Models.....	473
Metacognitive.....	171
Microworlds	281
Middleton, James A.....	413
Miller, Patty.....	561
Mitchell, Marlon R.....	269
Monson, John A.	111
Moore, D. Michael	461
Moore, David M.....	39
Moore, David R.....	461
Motivation in Distance Education	403
Motivationally-Adaptive CAI.....	513
Multidisciplinary Approaches	565
Murphy, Karen L.	531
Murry, Brandon	81

N

Narrative Simulation	187
Navigation Influences.....	437
Navigation Models	543
Navigational Models	119
Navigational Structure.....	111
Networked Instruction.....	461
New Technologies in Education.....	101

O

Owen, Steve.....	359
------------------	-----

P

Pacheco, Janice.....	81
Park, Su-Hong.....	165
Pearson, Robert.....	371
Persichitte, Kay A.	81
Plomp, Tjeerd	403
Powers, Susan M.	553
Problem Based Learning.....	371
Problem-Based Learning.....	73, 199, 341
Processing Styles	137

R

Rathbun, Gail A.	391
Resource Integration.....	451
Ritchie, Dr. Donn.....	333

S

Schaumburg, Heike.....	429
Schlosser, Charles A.	211
Schuh, Kathy L.	127
Secondary Teachers'	377
Shambaugh, R. Neal	349
Shellnut, Bonnie J.....	503
Sheng Chieh Leh, Amy	385
Sherman, Greg	295, 311
Sherry, Annette C.....	561
Simonson, Michael	207, 215
Smaldino, Sharon.....	215
Song, Sang H.	513
Spaulding, Karen L.	45
Sullivan, Howard J.....	241

T

Tao, Chia-Wen.....	429
Taylor Day, Barbara.....	81
Technology Courses.....	385
Technology, Teaching, and Learning.....	537
Tessmer, Martin.....	473
Torrence, Eileen.....	553

U

Using Groupware.....	491
Using Multimedia	221

V

Virtual Classroom.....	553
Visser, Lya.....	403

Voithofer, Richard J.	543
Volk, Christian	333

W

Wamey, Beatrice	111
Wang, Jianjun.....	359, 443
Web Assisted Learning.....	359
Web-Based Environments	311
Web-Based Instruction	233, 319, 423
Web-Based Learning	275
Web-Based Menus	81
Werner, Jenny Lynn	53
Winograd, David	565

X

Xaver, Richard F.....	111
-----------------------	-----

Y

Young, Dawn B.	93
Young, Michael	359
Young, Michael F.	443
Yu, Alex.....	275
Yu, Byeong Min	119
Yu, Chong-Ho.....	565