44th annual Proceedings

Selected Research and Development Papers - Volume 1
Selected Papers on the Practice of Educational Communications and Technology - Volume 2

Presented Online and On-site during The Annual Convention of the Association for Educational Communications and Technology

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Preface

For the forty fourth time, the Association for Educational Communications and Technology (AECT) is sponsoring the publication of these Proceedings. Papers published in this volume were presented online and onsite during the annual AECT Convention. A limited quantity of these Proceedings were printed and sold in both hardcopy and electronic versions. Volumes 1 and 2 are available through the Educational Resources Clearinghouse (ERIC) System. Proceedings volumes are available to members at AECT.org.

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The Proceedings of AECT's Convention are published in two volumes. Volume #1 contains papers dealing primarily with research and development topics. Papers dealing with the practice of instructional technology including instruction and training issues are contained in Volume #2. This year, both volumes are included in one document.

REFEREEING PROCESS: Papers selected for presentation at the AECT Convention and included in these Proceedings were subjected to a reviewing process. All references to authorship were removed from proposals before they were submitted to referees for review. Approximately sixty 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.

Michael R. Simonson
Deborah J. Seepersaud
Editors

2021 Annual Proceedings – Volumes 1 & 2

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and
Volume 2: Selected Papers
on the
Practice of Educational Communications and Technology

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2021

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Volume 1

Selected Research and Development Papers

Virtually a Sisterhood:
Social Connectedness and Online Collaboration

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Abstract

The purpose of this ethnographic research was to uncover the experiences of culturally diverse women participating in an online business strategy course and to evaluate the impact of virtual collaboration on social connectedness among this group. This study was situated within a national organization for women of color who are entrepreneurs. Data was collected from three members during an eight-week online course that also functioned as a virtual community of practice. Qualitative data was collected in three phases of semi-structured interviews with each participant being interviewed at the beginning, midpoint, and end of the course. Inductive analysis revealed that virtual collaboration positively impacted participants' feelings of social connectedness when activities were supported by use of virtual collaboration tools. The virtual collaboration tools allowed participants to work towards common goals, build a support network, and participate in skill development that contributed towards their career advancement.

Keywords: social connectedness, virtual community of practice, virtual collaboration tools, social capital, and women of color

Virtually a Sisterhood: Social Connectedness and Online Collaboration

Professional women of color often encounter discrimination and marginalization that negatively impacts their careers (Neville et al., 2018; Scott & Hussein, 2019). Additionally, based on their status as double minorities, these women also experience threats of being stereotyped which can leave them feeling isolated (Alfred et al., 2019; Johnson et al., 2017). Among the challenges faced by these individuals is the lack of access to support systems that provide them opportunities for mentorship, networking, and professional development opportunities (Ong et al., 2018; Rice, 2017). Research has shown that when these women have access to resources, networks, and spaces where they feel supported, understood and connected, it has a positive impact on their personal and career success (Kumi-Yeboah et al., 2017; McLoughlin et al., 2018).

The purpose of this study was to evaluate the impact of virtual collaboration on social connectedness among a group of culturally diverse women participating in an online professional development course for entrepreneurs. Social connectedness is identified as a factor in the success of underrepresented populations and past research has expressed a need for more studies centered on the professional experiences of these individuals (Ong et al., 2018). Specifically, the research question that guided this study was how does virtual collaboration impact social connectedness among a group of culturally diverse women participating in an online business strategy course for entrepreneurs.

Conceptual Framework

Social capital theory holds that social constructs impact how one views their role in a group (Bourdieu, 2011). Current research on social capital evolves this theory, identifying social capital as a construct that can be directly aligned to the social and economic well-being of individuals who belong to groups, networks, or communities (Waller et al, 2011; Zhang et al., 2011). Waller et al. (2011) highlighted that the degree of social capital's influence can be connected to an individual's perception of belonging within these groups, and how this perception impacts their connection to other individuals in this group. There is value connected to an individual's sense of belonging and subsequently their social connectedness to a group or network, with these two components often identified as the two major tenets of social capital theory (Waller et al., 2011).

When an individual has a strong sense of belonging it means they feel fully integrated into their environment and as such, can maximize opportunities to benefit from the resources of that environment. An internal form of sense of belonging is social connectedness (Costen et al., 2013). Social connectedness is centered on the opinion of one's self in relation to other people within a group or network and represents the emotional distance between one's self and other people within their network (Paolucci et al., 2021). Social connectedness is also viewed as the strength of the relationships that an individual has with others, and how these relationships influence their interactions with others in a particular network.

Social Connectedness and Underrepresented Populations

As it relates to underrepresented populations, Costen et al. (2013) revealed that social connectedness can be an influencer in an individual's ability to acclimate to an environment. Aligning with this study, Museus and Saelua (2017) highlighted that more culturally engaged climates can positively impact feelings of connectedness and belonging among underrepresented individuals in learning environments. In these environments, individuals from underrepresented populations seek out or build their own support systems (Ong et al., 2018; West, 2017, 2019). Participation in these types of support networks, also known as counterspaces, has been shown to lessen feelings of isolation by helping women form connections with others who may also have had similar challenges with discrimination and marginalization (Johnson et al., 2017; Ong et al., 2018; West, 2017, 2019).

A high degree of social connectedness in learning environments can also have implications for an individual's success (Mishra, 2020; Museus & Saelua, 2017). Factors that positively influence social connectedness in learning environments are those that intentionally embrace diversity and inclusion as well as depth and quality of relationships with peers who share similar ethnic backgrounds (Costen et al., 2013), and support services such as counseling, coaching, or mentorship (Mishra, 2020).

With the advancement of technology, recent research has explored the role technology plays in building social capital in online environments. Much of the research showcases the ways in which individuals engage or leverage technological tools within these environments to engage with others, to find and create communities, and to learn in ways that impact or help individual's form their social identities and acquire social capital (Grottke et al., 2018; Roldan et al., 2017). As such, online interactions have implications on an individual's feelings of connectedness to other individuals in those networks. Additionally, past research on building social capital in an online forum uncovered how the use of technology, namely computer mediated communication tools, both supports and interferes with an individual's feelings of connectedness (Roldan et al., 2017).

In in-person environments an individual's feelings of social connectedness can be assessed through their perceptions of their position or belonging in that group, how they feel they demonstrate the predictable behaviors of that group, and the physical traits of the environment (Callahan et al., 2015; Irgens, 2019). However, in online environments, each of these aspects are more challenging to observe (Slagter van Tryon & Bishop, 2009). Further suggesting that enhanced feelings of social connectedness in online environments are closely tied to activities and behaviors that support collaboration, open communication, and provide opportunities to identify common goals or to share resources (Grottke et al., 2018; Mays, 2016). When these strategies and activities are leveraged in online environments and strong feelings of social connectedness are able to develop, it can be an influencer in career development, persistence, and achievement (Donelan, 2016; Heidari et al., 2020). These opportunities are often presented through the use of online social networking tools, where individuals can build formal or informal networks (Donelan, 2016; Heidari et al., 2020; Roldan et al., 2017). Through these networks, individuals can contribute their own knowledge and at the same time, learn from others, and gain access to career opportunities.

Virtual Communities of Practice & Virtual Collaboration

Lave and Wegner (1991) defines communities of practice as systems or networks where members develop a shared understanding about who they are, what they are doing, and how each of these components apply to them individually as well as within a collective community. Virtual communities of practice (VCoPs) are defined as communities where members build, share, and create knowledge in an online environment and have been heralded as vital to collective learning in a society that is more reliant on technology (Ardichvili et al., 2003; Ardichvili, 2008). Through VCoPs, those individuals who are novices can build knowledge and acquire resources from more experienced individuals (known as experts) participating in that community (Hafeez et al., 2019; Hernández-Sotoa et al., 2021).

Research of Callahan et al. (2015), Liu et al. (2017), and West (2019) suggested to combat underrepresentation and improve the retention of diverse talent in professional industries, activities that enhance social connectedness must be integrated into virtual collaboration strategies which are essential to the success of a VCoP. Although definitions of virtual collaboration are varied, it is most commonly defined as activities or acts in a virtual environment centered around a common goal, purpose, or task (Taras et al., 2013). For purposes of this study, virtual collaboration was defined as a group of individuals working toward common goals in an online professional development environment. These common goals were supported through the use of audio-conferencing, videoconferencing, or computer-mediated technologies also known as virtual collaboration tools (Poppe et al., 2017). Several virtual collaboration strategies have been identified as relevant to knowledge sharing and learning in VCoPs. These strategies stress the importance of creating inclusive environments where all members feel they can actively participate, even though their participation is often framed as voluntary (Ardichvili, 2008; McLoughlin et al., 2018). Porter et al. (2011) identified that VCoPs are more successful in driving participation from members when those who belong to that community have role clarity and defined responsibilities. This can also include opportunities for members who are experts to provide mentorship to others (Hernández-Sotoa et al., 2021) as well as find ways to disperse knowledge creation equally across members (Barnett et al., 2016). In addition, Hernández-Sotoa et al. (2021) holds that members of the community must not only understand what their role is, but also how it aligns with the greater mission, values, and goals of that VCoP.

Methods

Approaching the research through an ethnographic lens, this study was conducted through The Prominence Association for Women (a pseudonym), a national membership organization for professional women. Founded in 2012, The Prominence Association for Women was founded to provide professional coaching, mentorship, and educational resources for women of color who were seeking to grow their career or their business. As a part of their membership in the organization, women benefited from access to a suite of online self-paced courses, one-on-one coaching opportunities with the organization's founders, and invitations to participate in specialized career and professional development programs known as Mastermind Sessions. Mastermind Sessions take place over an eight-week period at least four times per year. Each course is guided by a different theme and are designed to provide members of the organization opportunities to quickly develop and execute specific strategies for their business or to hone a specific set of skills related to growing as professionals. The topic of the Mastermind Session that underpinned this research focused on developing a growth and customer engagement strategy for an online business. The course was conducted entirely online through a mix of weekly one-to-two-hour workshops led by leaders of The Prominence Association for Women or industry experts, and involved developing and presenting a final project or presentation to the leadership team. The five free virtual collaboration tools available for the women to use in completing their final project were Zoom, Facebook Groups, Facebook Messenger, E-mail, and Google Drive. In addition to the weekly workshops, each week participants were assigned an accountability partner, who was one of their peers in the course. The Mastermind Session referenced in this study was viewed as a VCoP because all interactions occurred online and virtual collaboration tools were used to stimulate feelings of social connectedness. Being an entrepreneur and marketing professional of color, the lead researcher of this study served as a board member of The Prominence Association for Women to advance equality for the underrepresented female membership of this organization. The lead researcher also served as a facilitator of other Mastermind Sessions; however, was not the facilitator of the professional development session for this study. While the lead researcher shared similar cultural standpoints, professional predispositions, and personal experiences of this study's participants, their internal positions did not influence the outcomes. The second author, who did not share characteristics of the study's participants, assured that bias or influenced inquiries were removed.

A purposive sampling (Etikan & Bala, 2017) of Mastermind course participants allowed for factors of race/ethnicity, age, educational background, profession, and tenure in the organization to be considered. Members participating in the online business strategy course who were with the Prominence Association for Women for less than a year were excluded from this study. At the beginning of the online business strategy course, an e-mail was sent to the nine potential participants who had enrolled in the professional development course asking for their consent to participate in the study. The three women who responded and provided consent to participate in this study offered culturally diverse backgrounds and had varied levels of experience with technology. Table 1 provides a description of each participant, aligned to their pseudonym, and includes their age, race, tenure of membership, education, geographic location and entrepreneurship business type.

Table 1

Participant Descriptions

Pseudonym (She/Her/Hers)	Age	Race	Tenure of membership	Education	Location	Business
Jordan	30's	Black	3 Years	Master Degree	New Jersey	Real Estate / Travel
Louisa	40's	Hispanic	1.5 Years	Bachelor Degree	New Jersey	Floral Design / Event Planning
Maisie	50's	Hispanic	1 Year	Bachelor Degree	Pennsylvania	Non-Profit Scholarship Fund

Data Collection and Data Analysis

Ethnography, a qualitative research method, was used to deeply understand the social and cultural life of the women in this study (Glesne, 2016). The qualitative data was collected from a three phase semi-structured interview protocol that produced thick written cultural descriptions of the women's experiences throughout the course. Interviews took place at the initiation, midpoint, and at the conclusion of the course, each lasting 30 - 45 minutes in duration. Because participants were geographically dispersed, interviews were conducted via Zoom Meeting with the lead researcher. Methods for rigor and trustworthiness included triangulation, member checking, and weekly peer debriefing with the co-researcher (Mertler, 2017). Member checking was a multistep process that began with gaining participants feedback by providing them a presentation consisting of data collected from interviews, analytical memos, and researcher notes. Next, an individualized report of their specific responses was sent via e-mail to each woman who participated in the study. Finally, a 30-minute member check discussion was scheduled via Zoom Meeting with each participant to review their feedback and ensure their experiences and words were captured correctly. Each of the three participants validated their semi-structured interview transcripts to accurately capture their interaction and offered no feedback that changed the findings of the qualitative analysis.

Utilization of Delve coding software assisted in an inductive analysis of the nine transcribed interviews. Saldaña's (2016) first and second cycle coding techniques (Structural, In Vivo, Process, Value, Pattern, and Focus Coding) resulted in 224 codes, eight categories, three themes and one assertion: Participants perceived technology can support the development of strong intimate relationships when entrepreneurs who are women share similar backgrounds, common goals, and past experiences.

Findings

The findings of this study illustrate that the participants' use of virtual collaboration tools had an impact on their personal growth and skill development throughout the course, the ways in which they interacted with others in the course, as well as the authentic connections and bonds they were able to build as a result of their participation. Participants indicated that skill development and relationship building were enhanced by synchronous one-on-one and group interaction that allowed them to engage in discussion, provide feedback to each other, and offer guidance in real time. Participants expressed those activities that supported these types of interactions also lessened the feelings of isolation they feel as women of color who are pursuing entrepreneurship. Additionally, the activities created a learning environment where they felt supported and resulted in them identifying a positive impact on their personal and career success. These findings led to the assertion that participants perceived the use of technology can support the development of strong intimate relationships between women entrepreneurs who share similar backgrounds, common goals, and past experiences. These findings align with the existing body of research on VCoPs that has revealed technology supported activities are essential to an individual's social connectedness and subsequently their engagement with other members of that community (Ardichvili, 2008; Hafeez et al., 2019; McLoughlin et al., 2018). As well, the findings also align with research on counterspaces and women of color, where social connectedness is identified as an indicator in one's ability to develop relationships, and as such, garner benefits from those relationships that are built with others in that counterspace (Johnson et al., 2017; Ong et al., 2018; West, 2019). Support for the assertion and the existing body of research was illustrated through the three themes that emerged out of the qualitative data collected: (a) Entrepreneurial Progression, (b) Richness of Synchronous Interaction and (c) Interdependence Fosters Authentic Connections.

Theme 1: Entrepreneurial Progression

Entrepreneurial progression centered on how an individual's personal history, background, and experiences as women of color who are professionals affected their participation in the online business strategy course. This included aspects of the course that impacted professional skill development and learning outcomes. Research suggested that entrepreneurs who are women often experience discrimination and marginalization in ways that can leave them feeling isolated or unsupported in their careers (Block et al., 2019; Callahan et al., 2015; Wilkins-Yel et al., 2019). Research has also shown that being provided opportunities to connect with others who share similar background and professional experiences can lessen feelings of isolation (Ong et al., 2018; Vaccaro et al., 2019), and can help them to develop and hone skills necessary to succeed in their careers (Johnson et al., 2017; Ong et al., 2018; West, 2017, 2019). In this study, entrepreneurial progression was categorized by how an individual's identity as a woman of color shaped their views as an entrepreneur, the activities these women felt contributed to their skill development, and the specific outcomes and impacts to their career development they described as a result of their participation.

The three participants in the study - Louisa, Maise, and Jordan - highlighted that they were attracted to becoming members of The Prominence Association for Women because its focus was about women of color who are entrepreneurs. Each of these women shared that they experienced feelings of loneliness, lacked a connection with like-minded female business owners who shared similar backgrounds, and had a desire for the support and encouragement that The Prominence Association for Women offered them. In fact, the desire to connect and to collaborate with other women of color was one of the leading reasons each participant was attracted to this organization. All participants described that as women of color, they had not encountered organizations like The Prominence Association for Women that allowed them to connect with like-minded business owners who share similar backgrounds. For example, Jordan in her initial interview stated, “I hadn't heard of a membership organization that was specifically for entrepreneurs who are women of color...that was founded by a Black woman... and that was really fostering this environment of collaboration and learning and growing together.” This statement was similar to one by Louisa, who highlighted in her final interview that she felt less isolated and alone as a result of taking the course. Louisa said, “Being an entrepreneur is a very lonely journey…but then I was able to find another chick out there that has the same struggle. It doesn't have to be the same business, but she's living her own, same, lonely race.”

While the desire to connect with other women of color who were entrepreneurs and building a support network was one of the main attractors to the organization, participants expressed that they enrolled in the online business strategy course to cultivate skills that they felt would aid them in their future success as entrepreneurs. At the onset of the course, Louisa and Maisie, expressed a lack of self confidence in the skills they felt were essential in their roles as entrepreneurs. These skills included better understanding how to market their businesses, how to communicate with customers, how to gain funding and sponsorships, and how to expand their products or services. However, as time moved forward in the course, each of the three participants expressed feelings of appreciation, confidence, and competence as it related to their skill development. Jordan stated in her final interview, “I had tried using these [content] creation tools on my own. [After the course] I was like, wow, I can’t believe I did that compared to what I was creating before.” By the conclusion of the study, all three participants indicated that they felt they had cultivated skills in social media, marketing and branding, and collaboration to a level where they were able to complete a variety of tasks on their own without assistance. Louisa expressed in her final interview, “Before I was intimidated...now it’s like I can walk on my own, and I am a lot more tech savvy.” For communications skills, specifically, all participants commented that over the duration of the online business strategy course they were able to increase their capability to communicate with their peers and pitch their business to potential investors or donors. For example, Louisa stated in her midpoint interview, “I actually feel like I'm developing better communication skills because before I just didn't have the words [to explain] or I didn't have everything in order in my brain.”

In the final interviews, each of the participants shared that through working alongside and receiving encouragement from the other women enrolled in the course, that they were able to learn how to use social media tools, video conferencing, and web design technologies as well as gain access to professional and financial resources that would benefit their business. Additionally, they discussed creating a stronger network of professionals through the relationships they were able to build with one another. Maisie noted in her final interview that through the help and coaching she received from other members in the course, she was able to learn about the different types of customer relationships she needed for her business to grow.

> Building the relationships that I did with everybody and how we helped each other, there was times that I would feel stuck and didn't know what to do and they really reached out to me and helped me out a lot. Um, that meant a lot. It still means a great deal to me and you know, learning about the different relationships, the customer relationships.

These sentiments supported these findings that when women of color have access to counterspaces, they are able to gain support and mentorship that they may not have in mainstream forums.

Theme 2: Richness of Synchronous Interaction

Throughout the study the participants' experiences were explored based on how interactions occurred within a VCoP (Ardichvili, 2008; Hafeez et al., 2019). Research has shown that in VCoPs, interactions can happen using a multitude of virtual collaboration tools (Mather & Cummings, 2014; McLoughlin et al., 2018). The nature and use of these various technologies can have an impact on the value a member may glean from their participation in the VCoP (Altebarmarkian & Alterman, 2019; Barnett et al., 2012). In this study these tools supported various types of interactions including communication between members, sharing of information, and task completion. Additionally, participants were able to leverage these virtual collaboration tools for both synchronous and asynchronous interactions throughout the study.

Participants engaged in synchronous interaction through the use of technologies such as Zoom, Facebook Messenger, and through text messaging and telephone calls. However, each of these tools served different purposes for participants based on their individual needs at the time. For example, when discussing Zoom, participants highlighted a number of key benefits including the opportunity for face-to-face communication (which participants felt were more personable) as well as capabilities such as screen and desktop sharing which allowed for other participants to provide feedback on their work. Participants also discussed the value of Zoom breakout rooms for engagement in personalized small group discussions and activities. This supports research that using these synchronous tools with a collaborative purpose can often create more value in VCoP (McLoughlin et al., 2018; Wang & Huang, 2018). This value was expressed by Louisa who identified how the breakout rooms offered an opportunity for others to ask her questions or for her to express opinions that she may have felt uncomfortable asking in the larger group. Louisa stated in her midpoint interview,

> Let's say maybe a person who's more of an introvert may feel intimidated because I'm an extrovert and I got all these questions, the breakout room helped.… If I'm by myself with someone who I feel is at a plateau, then I will start asking questions...reiterating things we've learned in the course.

Outside of the weekly workshops facilitated through Zoom, participants used Facebook Messenger, text messaging, and phone calls to communicate with their assigned accountability partners and to get assistance from their peers regarding their businesses. For example, Maisie expressed a point where she was trying to find funding for her business while completing her final presentation and how she was able to leverage text messaging to accomplish this. She stated in her midpoint interview, “I texted my accountability partner to ask her about different funds that I wasn't aware of and she helped me with that...”

In addition to synchronous interactions, virtual collaboration tools can also support asynchronous interactions and have been found helpful in document editing and feedback, formal or informal discussions, or sharing resources (Antoci et al., 2012; Porter et al., 2011). In this study, the asynchronous interaction occurred primarily through Facebook Groups. Aligning with research on computer mediated communication such as discussion boards and information sharing tools (Antoci et al., 2012; Kabilan, 2016), Facebook Groups functioned as a repository of questions and where resources were shared over the duration of the eight-week online business strategy course. Additionally, participants took advantage of Facebook Groups to engage their peers when they needed assistance, to ask questions that they felt would be beneficial to others, to provide encouragement, when they had news or information to share, or to keep up to date on content they may have missed in one of the weekly workshops. For example, Maisie noted in her final interview, “In the Facebook Group itself I would post questions or concerns if there was anything going on that I wasn't too sure of or I would help them out and encourage them.” Similarly, Jordan highlighted that Facebook Groups provided her an opportunity to share resources and information that could benefit her peers. In her final interview she provided an example, “I literally went to a training and then straight from the training...I wanted to share the information with [my classmates] ...so I posted it in the Facebook Group.”

Although other technologies such as E-mail, Instagram, and Canva were mentioned, as it related to asynchronous interaction they were used sparingly. In instances where they were used, they served as a way to share information or to ask a question, however, as already identified Facebook Groups was the preferred method of communication and asynchronous interaction.

Theme 3: Interdependence Fosters Authentic Connections

When an individual has a strong sense of connection to others in a specific organization or group, it can positively impact their personal and professional success (Virick & Greer, 2012; Yoon et al., 2012). During the eight-week online business strategy course used for this research, participants cited many opportunities they were given to build strong and authentic bonds and relationships. Relationships that they believed contributed to their success in the course, but also aided them in furthering their businesses. The theme of Interdependence Fosters Authentic Connections focused on the behaviors and activities that fostered these connections and how those behaviors and activities created feelings of interdependence among the participants. There were multiple occasions where the participants likened the relationships, they were building with their peers to those they had with their family. This aligns with research on social connectedness which asserts that in order for someone to feel like they belong to a group they must feel some type of connectedness, affiliation, and companionship to others (Framke et al., 2019; Irgens, 2019). Each of these feelings were expressed when participants discussed the bonds, they were building with others in their course. These bonds were initially described during the first weeks of the online business strategy course, and were revealed by all participants in both the initial and midpoint interviews. For example, Jordan, in her midpoint interview shared, “We have a sisterhood, an environment, a safe place, for Black and Brown women to come together … where our voices and frustrations can be heard. … We can work together and give each other support through hard times.”

Because women of color who are professionals have experienced discrimination over the course of their academic and professional lives, this also impacts how they acculturate into new VCoPs (Ardichvili, 2008; Barnett et al., 2012). These issues are often marked by feelings of doubt, apprehension and judgement which can prevent them from fully receiving the benefits that participation in such communities provide (Hernández-Sotoa et al., 2021). Throughout this study, all three participants shared challenges they encountered or apprehensions they felt due to age, experience, and undeveloped business acumen and technology skills. For example, Maisie cited several examples where she felt uncomfortable, frustrated, or unprepared based on her lack of knowledge or capability to perform a task or participate in a discussion in comparison to her peers. However, by the end of the study each of the participants noted that being in the course helped them to become less intimidated when using technology, and that they were all able to utilize the other woman as resources. In her midpoint interview, Maisie shared,

> I got really frustrated...and I almost started to cry... because I [didn't] know how to do a website … and I felt alone. So, when [the facilitator] came to me [to describe my website] and I said to her, I can't do this...and I [left] because I was so upset...the next day, Jenny messages me this long message and she just made my day. She's like, I know she says, this is personal for you ... just don't give up. And you know that meant a lot.

Similarly, when asked about her comfort with technology in her final interview Louisa stated, "I don't feel intimidated. I don't know everything. I'm not an expert, but...with the ladies, we can figure it out. We can pull up the YouTube, show me how to do this... but before it would stop me."

Supporting each other and working towards a common goal was another aspect that participants believed had benefited them and their business. In her final interview, Jordan provided specific examples of how this occurred,

> I've learned a lot from the other women...I've learned how to be more of a financial steward and take control of your finances, how to deal with difficult people and how to work on dealing with that difficult customer .. and still providing the utmost customer service...I've learned different technologies.

These outcomes were supported and described by Maisie and Louisa as well, and showcased how through collaborative work and mutual support, each of the participants were able to develop skills and garner resources from their participation in the online business strategy course.

Implications

With opportunities for support networks being scarce, women of color have often been forced to seek out or build their own support systems (Ong et al., 2018; West, 2017, 2019). Participation in these types of support networks, has been shown to lessen feelings of isolation helping these women form connections with others who may also have had similar challenges with discrimination and marginalization (Johnson et al., 2017; Ong et al., 2018; West, 2017, 2019). The findings of this study suggest that virtual collaboration could offer these women more access to spaces that are free of the discrimination, sexism, marginalization, and oppression they face in their day-to-day lives. The findings also infer that when these virtual settings are guided by common goals and collaborative activities and are supported by the right choice of virtual collaboration tools, that women entrepreneurs are able to develop strong feelings of social connectedness. This social connectedness can aid in building authentic, intimate relationships with each other in ways that positively impact their confidence, help to hone and develop skills for their careers, and aid them in building a network of support for their professional success (Mishra, 2020; Museus & Saelua, 2017; Ströbel et al., 2017).

In addition, the findings of this study support past research that integrating virtual collaboration tools into online learning environments can be essential to establish common goals, provide opportunities for synchronous interaction, and embed activities that allow learners to develop their technological aptitude (Mather & Cummings, 2014; Nistor et al., 2012). When learners come from underrepresented backgrounds the presence of these components can allow them to build confidence, and encourage relationship building with their peers (Mishra, 2020; Museus & Saelua, 2017). As with this study, the development of these relationships through virtual collaboration can impact social connectedness, and ultimately provide underrepresented learners who are professionals with resources, education, and the support they need to grow and develop as entrepreneurs. When audio-conferencing, videoconferencing, or computer-mediated technologies are embedded in online professional development courses, social connectedness can be developed and can be an influencer in career development, persistence, and achievement (Donelan, 2016; Heidari et al., 2020).

Compliance with Ethical Standards

Conflict of Interest: The authors declare they have no conflict of interest.

Research Involving Human Participants: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to Participate: Written, informed consent was obtained from individual participants included in this study. No identifying information about these participants is included in this article.

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Benefits of Video Feedback on Low Performing Female Cadets in Physical Education: An Action Research Study

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Abstract

Learning novel physical motor skills can be frustrating for some cadet students in the military movement class at the academy. A lack of clear feedback further exacerbates the problem for students' skill development. This action research study examined the benefits of using video recording as augmented feedback to inform motor skill development in an applied gymnastics course at a service academy. Furthermore, it sought a more efficient method of providing female participants individualized feedback with the goal of decreasing the physical skill gap between the males and females at the academy. The primary aim was to identify the effects of video feedback on the instructor/student process for skill evaluation and skill improvement involving low female performers. The secondary aim was to examine the extent that giving video feedback promoted the ten female students' motivation to learn, use of deliberate practice, autonomy, and competence. Data analysis revealed skill improvement on at least one skill event in the participants. Findings demonstrated that students perceived video feedback as an effective method for enhancing skill improvement in gymnastics class. These findings indicate video feedback can be used to improve motivation, deliberate practice, competence, and autonomy. The ability to visualize performance cues for the students may also result in faster motor skill acquisition. The study suggests video feedback is an effective method of augmented feedback for students struggling with novel physical motor skill progressions.

Keywords: video feedback, augmented feedback, skill acquisition, female cadets, motivation, autonomy, competence

Benefits of Video Feedback on Low Performing Female Cadets in Physical Education: An Action Research Study

Within the Physical Education Department at the academy, instructors are constantly seeking improvements and efficiencies within the curriculum and program of instruction. The core physical education classes are a graduation requirement. This means that every cadet at the academy must pass these classes to obtain a commission as an officer in the United States Army (Gist, 2016). The military movement class is one of the largest hurdles for the female cadets. However, this physically demanding course is a great indicator of future success throughout the physical program at the academy. As leaders, the academy is responsible for giving purpose, direction, and motivation to their students (Baghurst et al., 2015). One of the biggest challenges is motivating lowest performers to effectively use their practice time to improve their physical skills (Ellison & Woods, 2016). One of the greatest limiting factors to skill acquisition for students is the lack of quality feedback provided during instruction (Coelho, 2019; Turner & West, 2013). Performance based feedback is a key part to effective learning. The design of this study added to the existing sports and physical education literature on the benefits of using video feedback to inform motor skill development and improve student motivation (Potdevin et al., 2018).

While female cadets only make up about 24% of the students at the academy (PAO, 2019), females account for about 40% of the low performers and failures in the military movement class. According to the end of year report (Goetz, 2020), there were 68 course failures in the academic year 2019-2020. Goetz found that female students accounted for 27 of the course failures and failed the course at twice the rate of the enrolled males. The lower performing female students struggle to score points on many of the physically demanding tasks in the course. Low performing students lack intrinsic motivation and self-confidence (Erturan & Hulva, 2019) and are therefore less likely to use their free time to work on their skills. Given the minimal time for classroom instruction and modeling (Coelho, 2019), instructors seek ways to boaster student participation and buy-in so that they benefit from the feedback provided by instructors (Chatoupis & Vagenas, 2018).

This action research case study sought a more efficient method of providing female students individualized feedback with the goal of decreasing the physical skill gap between the males and females at the academy. The purpose of this study was to determine how video feedback effects skill performance in physical education classes and the perceived benefits of video feedback for the low performing females in an applied gymnastics class. The research questions guiding this study were:

1. What are female cadets' perceptions of video feedback for skill evaluation and skill improvement?
2. How do female cadets perceive video as an additional method of feedback?
3. How do female cadets perceive video feedback as a method to promote motivation for deliberate practice?
4. How do female cadets' perceptions of their skills change when video is added as an additional method of instructor feedback?

Literature Review

The two largest factors for inability to perform gross motor skills are a lack of physical abilities (Evans, 2013) or the lack of productive feedback (Roure et al., 2019). Research of Vanderhasselt et al. (2018) suggests that gender effects the prevalence of confidence and coping skills. Furthermore, current research suggests female students are less achievement motivated compared to male students in physical education (So-Chen et al., 2016; Ulstad et al., 2019). Consequently, female students may respond by lowering their expectations for success in challenging tasks and avoiding the stressor (Yeung, 2011). Additionally, Yeung found that female students may be inclined to try harder to overcome the difficulties they encounter in the classroom. Outcomes from traditional gender stereotypes have contradictory findings. Berlin and Dargnies (2016) found female students are more apt to cope and avoid in the presence of stressors due to a fear of failure. They reported that female students displayed greater degree of effort in challenging tasks. Vanderhasselt et al. (2018) found that emotional based coping, avoidance of problems brought about by stressful situations, predicted higher levels of anxiety and depression. Research suggests that some females appear more apt to cope and avoid due to a fear of failure.

A limiting factor to skill acquisition for students is the lack of quality feedback during instruction (Turner & West, 2013). Augmented feedback is a vital part to learning (Kangalgil & Özgül, 2018). According to Smith (2011), instructors must present augmented feedback to the learner as often and as soon as possible after an attempt to enhance the evaluation of movement and reinforce the memory representation. Providing clear and concise feedback will help students properly practice and develop the desired physical skills (Hatzipanagos & Warburton, 2009). Efficiency will generate more time to spend on skill mastery (Smith, 2011). So-Chen et al. (2016) concluded instructors need to seek efficient teaching methods to achieve course goals and to provide their students with correct information to enhance learning, behavior, knowledge, and positive student attitudes. Erturan (2014) found the nature of teaching styles, type of feedback, time spent on the task, size of the class, and the nature of learning content are the most crucial factors that are related to teaching effectiveness. In addition, instructors need to foster an effective teacher-student interaction that provides a participatory environment for all students (Griffin et al., 2013). Overall, effective feedback should increase student motivation (Cecchini et al., 2019) while giving positive reinforcement of goals (Baghurst et al., 2015) and showing the correct and incorrect actions in the execution of a skill (Hattie & Timperley, 2007). Instructor feedback enhances student learning (Sharma et.al., 2016) through an evaluation of their contributions, discrepancies, and how to fix their errors (Berlin & Dargnies, 2016).

Physical education teachers are in a unique position to capitalize on the use of video in the classroom (BenitezSantiago & Miltenberger, 2016). Potdevin et al. (2018) found video modeling and video feedback are effective tools to aid trainers. Boyer et al. (2009) examined the use of expert video modeling combined with video feedback of performance execution of three complex gymnastic skills. While the athletes were not able to achieve perfect performance during the study, the gymnasts all demonstrated increases in skill performance and improved skill retention after the intervention. Video analysis gives a degree of freedom and choice for the student's feedback reception (Laughlin et al., 2019). Students can also incorporate select peer feedback to go with the review of video recordings (Potdevin et al., 2018) to review their own trials and self-assess, thus taking charge of their learning process (Laughlin et al., 2019). Video analysis for every lesson and every skill is not practical. However, video analysis can serve as an effective tool for supporting quality instruction and assessment of skills.

Four theoretical frameworks that underpinned this research were (A) social learning theory (Bandura, 1977; Chng & Lund, 2018); (B) self-determination theory (Baghurst et al., 2015; Drost et al., 2018; Ryan & Deci, 2000); (C) motor learning theory (Schmidt, 1975; Sharma et al., 2016); and (D) theory of feminism (Avci, 2016; Corey, 2009).

Methodology

Action research design connects theory to practice and has a connection to school improvement (Mertler, 2017). This study used a mixed-methods approach utilizing data from instructor observations, pre/post-test questionnaires, semi-structured interviews, video recordings, and student self-assessments. Through extreme case sampling, the low performing female students (N=10) within the 8-week gymnastics course were provided video feedback on their graded attempts of three gymnastic skills.

Setting and Participants

The research site was a four-year military service academy. The school enrollment was 4,400 with 20% women (PAO, 2019). The study occurred during the 8-week, 19-lesson military movement course that exposed cadets to a variety of basic movement skills, with 28 physical skills being taught and tested. Each 50-minute session consisted of roughly two skills per lesson with structured time for a master demonstration, teaching the skill progression, free-practice time, and testing (Coelho, 2019). The military movement class is a graduation requirement that all students must complete during their freshman year to obtain a commission in the United States Army.

The student to teacher ratio in the class was 10:1. Each class had between 35-40 students. The average class consisted of about 30 males and 5-10 females. Extreme case sampling was used to select the lowest performing females in the class (those who actively displayed avoidance and poor coping techniques during skill practice time). Ten female students who met this criterion and were currently enrolled in the military movement course volunteered to participate in the study. There was no extra incentive to take part in the study beyond the potential benefits of the intervention. All participants returned signed copies of the informed consent prior to engaging in the study and were assigned unique IDs. The age range of the participants was 18-23 with an average age of 19.30 (SD=1.40). The majority (66.7%) of the participants were Caucasian with the remaining having a diverse mix of ethnicities. No additional demographic information was collected. The participants also described their overall fitness level at a range from *fair* to *excellent* with a median of *fair* and had no limiting physical profiles that inhibited their ability to complete the requirements of the course.

Intervention

The study coincided with an eight-week quarter of the academic year to align with a class in session. The study took place over the course of six weeks during the additional instruction time outside of the regularly schedule class time. The program of instruction for the class included additional instruction periods scheduled throughout the quarter. The purpose of the additional instruction sessions was to provide lower performing students within the gymnastics course an opportunity to practice, review video feedback on their graded attempts of three gymnastic skills to identify performance deficiencies, and retest on their class skills. The procedures for the intervention were divided into three stages: pre-test, test, and post-test.

The pre-test stage included all the activities the participants performed prior to participation in the intervention. The method of skill progression was in accordance with the instructor manual (Coelho, 2019). Participants also completed the pre-test questionnaire. The test stage began once the students had received all the lessons covering the selected skills and covered all the graded attempts during the intervention with the use of video feedback and instructor feedback to influence skill acquisition. The participants learned the performance cues of the selected skills during the class periods. The students were provided a master demonstration followed by progressions of each skill. After each graded attempt, the participants were allowed three minutes of deliberate practice time to work on their deficiencies prior to taking their next graded attempt of the skill. Effective use of practice time during the study was defined as a participant using the practice time to actively work on any of the components of the assigned skill. Verbal cues on the points of performance that the student needed to fix to earn a higher score on the skill were provided by the instructor. The instructor also replayed video of the attempt with the student to identify performance deficiencies. Once the student felt comfortable with the skill, they were able to make one or two graded attempts with instructor feedback on each attempt. Once the attempts are made for all three skills, the final stage of the intervention, the post-test stage, occurred. At this point, the participants completed the post-test questionnaire and individually met with the lead researcher for a semi-structured interview concerning the process and the intervention.

Data Collection

This study used multiple methods of data collection including pre/post-test student questionnaires, instructor observations, semi-structured interviews, video recordings of graded attempts, and student self-assessments. All participants completed three attempts of three separate gymnastics skills: cartwheel, rope climb, and shelf mount.

Pre-Post Test. The study used the earlier work of Standage et al. (2005) and their assessment of self-determination theory in school physical education for the pre/post-test questionnaire measures of autonomy, perceived competence, and motivation. Measures of autonomy included six items that corresponded to the participant's level of familiarity and comfort with the selected skills. During the pre-test stage, prior to each attempt, students provided an estimate of their projected score on the attempt with measures of competence assessed using six items that were modified from the perceived competence subscale of the 18-item Intrinsic Motivation Inventory previously created by McAuley et al. (1989). Measures of motivation to learn were captured using 10 items, four items to assess levels of intrinsic motivation, four items to assess a lack of motivation, and two items to assess levels of extrinsic motivation. The questionnaire used a 5-point Likert scale (1= Strongly disagree to 5 = Strongly agree). Additionally, the distinct types of motivation were assessed using the Perceived Locus of Causality scale developed by Goudas et al. (1994). The nine items were divided into three subscales that examined intrinsic, extrinsic, and a lack of motivation for the military movement class. The scores from these three subscales were used as indicators for motivation. A high score in a subscale reflects a strong indication of agreement with the motivational methods. A low score in a subscale reflects a lack of agreement with the motivational method.

Instructor Observations. Observations of the participant's active use of their deliberate practice time was recorded on a researcher created data sheet. The number of practice attempts that each student took was noted on the same data sheet. Notes on whether the participant spent time viewing their video feedback again during the practice session was also captured on the data sheet.

Semi-Structured Interviews. Semi-structured, one-on-one interviews were conducted with the participants before and after the intervention. Twelve open-ended questions were used to measure the benefits the cadets identified during the intervention. The interviews also assessed how giving video feedback impacted the instructor/cadet process for skill evaluation and improvement.

Video Recordings. The instructor video recorded each graded attempt of the skills using standard video recording settings on the participant's phone to inform the student about their quality of movement during the execution of the physical task. The instructor focused the feedback on the visual depiction of the verbal cues of the skill being tested. The participant then viewed the recording of their attempt with the instructor to identify the key areas for skill improvement. Using the video recording, the instructor visually showed the student what elements of the skill were performed correctly, incorrectly, as well as gave the participant a grade for the attempt.

Assessments. Cadets provided an estimate of the score they felt they would get when they performed the skill for a grade prior to each attempt execution. The students also provided a rating level to address their previous experience and comfort level with each task prior to the first attempt. The experience level was based on a 5-point Likert scale (1= *I have never heard of the exercise* to 5 = *I am an expert*). The attempt score was also collected based on the performance scores of the participants. Data for each participant was collected at the end of each session for performance on the task.

Data Analysis

The quantitative data were collected from the questionnaires and assessments. Quantitative data were analyzed to illustrate the rate of skill acquisition and improvement as well as the level of motivation of participant. The scores were analyzed for each skill using repeated measures ANOVA to investigate changes in the mean over the course of three or more points in time. A Pearson's correlation coefficient was used to measure the statistical relationships. Qualitative data was analyzed for themes through content analysis to reflect participants perceptions, feelings, attitudes, and opinions of the study's intervention.

Results

On the pre-test, measures of autonomy corresponded to the participant's level of familiarity and comfort with the selected skills. The participants indicated a median value of familiarity of slightly familiar with the cartwheel, very familiar with the vertical rope climb, and moderately familiar with the shelf. The participants indicated a median comfort level of neutral with the cartwheel, comfortable with the vertical rope climb, and uncomfortable with the shelf. The participants' self-confidence and competence responses indicate a mixed level amongst the group. Most of the group (90%) felt they would be able to perform the skills well on their third graded attempt. However, the group was split concerning their satisfaction of their performance of the skills. Only 40% of the group agreed they would be satisfied with their performance while 30% disagreed. The participants overwhelming believed the class would boost their confidence. Most of the group (90%) felt they would be confident on the skills after working on the tasks in class. When comparing their performance on the skills with their peers, only 30% of the group felt they would do well compared to their peers. The participants indicated an elevated level of support for intrinsic motivation. Nearly all participants (90%) agreed that they find "pleasure and satisfaction" in learning new things. Most of the group (90%) agreed they go to the class to "prove to themselves" they can complete the class. However, only 30% of the participants agreed that military movement class teaches "things that interest me." The participants also indicated an elevated level of support for extrinsic motivation for the course where 60% of the group agreed the course would help them "better prepare for military career." Additionally, only 40% of the group agreed that success in the class will make them "feel important." The participants also indicated a low level of support for a lack of motivation for attendance and participation in the military movement course. The bulk of the group (80%) felt like they understood the purpose of military movement and why they needed to take the course. Likewise, 70% of the group did not feel like the class was a "waste of time." However, 20% of the group agreed that they did not "understand what they are doing" in the class. Overall, the group indicated an elevated level of motivation to attend the class and saw the value and importance of taking the class.

The participants were asked to predict their attempts just prior to making each of their three video recorded attempts. The predicted scores were based on their previous exposure to the skill during the class instruction and deliberate practice sessions. The mean predicted score for all video recorded attempts of the cartwheel was 2.37 (SD=1.61). The mean predicted score on the vertical rope climb was 3.67 (SD=1.69). The mean predicted score on the shelf was 3.70 (SD=1.90). After the students provided their predicted performance scores, they completed one graded attempt of the skill. The graded attempt was recorded using the student's video recording application on their cell phone. The mean graded score for all video recorded attempts of the cartwheel was 1.47 (SD=1.53). The mean graded score on the vertical rope climb was 3.13 (SD=2.16). The mean graded score on the shelf was 3.33 (SD=2.14).

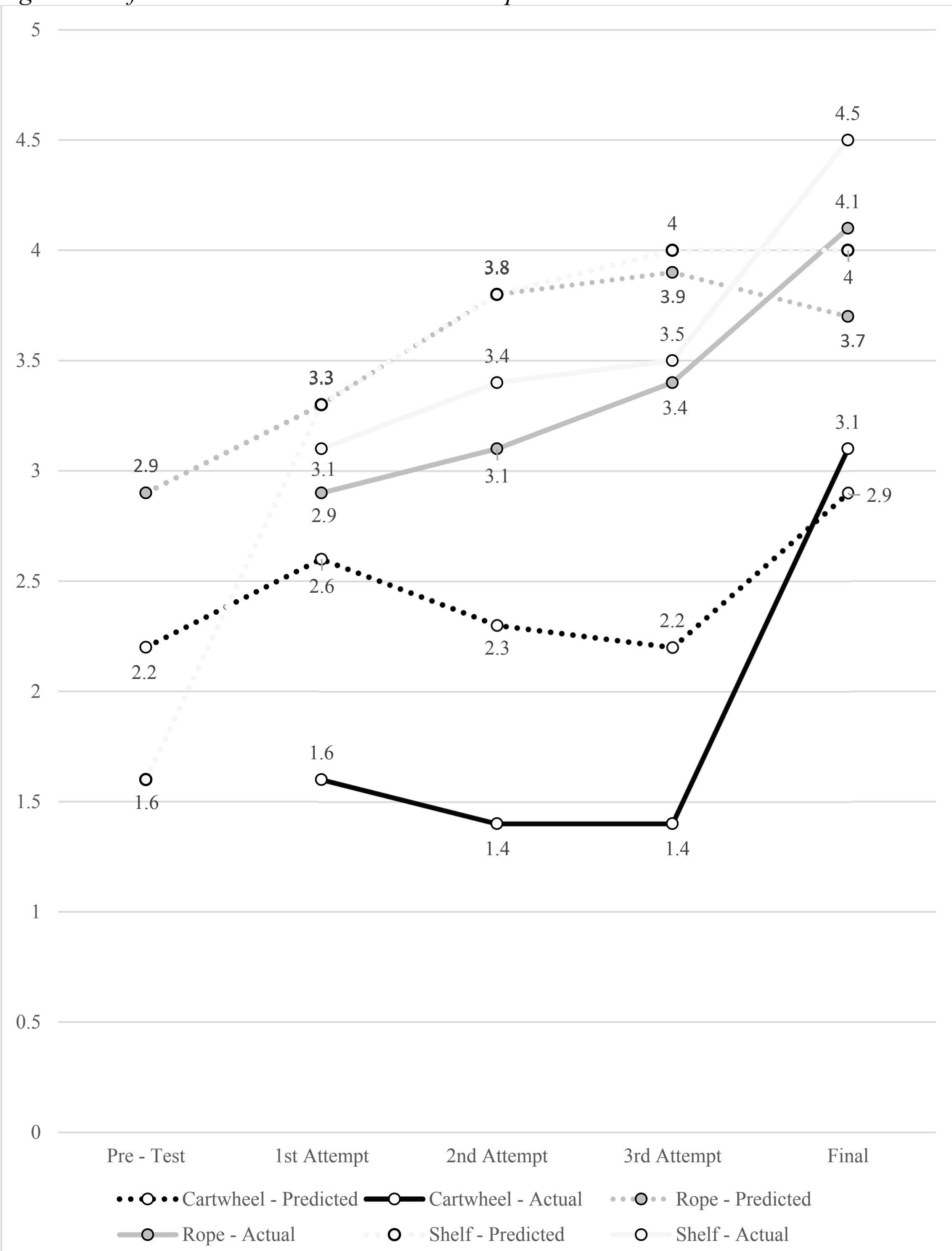
Using a repeated measures ANOVA, the findings indicate there was a statistically significant increases in scores within the group for the cartwheel and the shelf. Video feedback had a statistically significant effect on the performance of the cartwheel, $F(2, 18) = 21.50$, $p < .001$. Additionally, the participants significantly increased their performance on the shelf, $F(2, 18) = 3.58$, $p = .049$. Contrary to the cartwheel and shelf, the participants did not significantly increase their performance on the vertical rope climb, $F(2, 18) = 2.62$, $p = .10$. However, the group did increase their mean score on the vertical rope climb from their first attempt, M= 2.90, to their final attempt, M= 4.10. Moreover, the students made significant adjustments to their predicted scores on the shelf between attempts, $F(3, 27) = 4.23$, $p = .014$. The group did not make significant adjustments to their predicted scores on the cartwheel, $F(3, 27) = 2.57$, $p = .075$, or the rope, $F(3, 27) = 2.28$, $p = .10$. While the changes in the group's predicted outcomes were not statistically different for the cartwheel or rope, the difference between the predicted and actual scores for the individuals within the groups improved significantly for the cartwheel.

The participants overestimated their abilities on the cartwheel by an average of 1.0 point on their first attempt and underestimated themselves by an average of 0.20 points on their final attempt. The improvement in their accuracy of predictions on the cartwheel was significant, $F(2, 18) = 14.48$, $p < .001$. The participants had overestimated their abilities on the vertical rope climb by an average of 0.40 points and underestimated their skills by an average of 0.40 points on their final climb. The group did not significantly improve the accuracy of their predictions on the vertical rope climb, $F(2, 18) = 3.23$, $p = .063$. While the group did make significant changes to their predictions on their performance of the shelf, they did not significantly improve the accuracy of their predictions, $F(2, 18) = 2.16$, $p = .14$. The group went from overestimating their skills on the shelf by an average of 0.20 points to underestimating their scores by 0.50 points.

Overall, the group saw their mean scores improved in each skill. The group had a mean score increase of 1.50 (SD=.71) on the cartwheel. The group had a mean score increase of 1.20 (SD=1.69) on the vertical rope. Additionally, the group had a mean score increase of 1.40 (SD=.97) on the shelf (see Figure 1).

The Pearson's *r* correlation analysis for the cartwheel revealed limited correlation between the number of practices and the final score, $r=0.37$, as well as the relationship between practices and score improvement, $r=0.52$. However, for the vertical rope climb there was a strong positive correlation found between practices and score improvement, $r=0.88$, $p < .001$. There was minimal negative correlation found for the shelf between practices and score improvement, $r=-0.19$, and nearly no correlation between practices and their final score, $r=-.05$.

Figure 1
Average Scores for the Predicted and Actual Attempts



Data analysis revealed skill improvement in the participants. Overall, all the participants improved their task score on at least one event. Furthermore, half of the participants increased their task score on all three events. All the participants identified the video feedback as helpful for improving at least one of their skills. Within the group, 70% of students reported an increase in perceived competence, 90% reported an increase in autonomy, and 80% of the students reported an increase in motivation. Overall, 90% of the participants recommended the future use of the video feedback in the performance of each of the performance skills.

Major themes that emerged during the qualitative data analysis included clarity of the feedback, changes in self-awareness, changes in deliberate practice, and changes in performance. The participants identified many benefits from the use of video feedback to inform their skill development. Video helped provide greater clarity for the knowledge of performance cues for the student as well as a better understanding of their deficient components of the skill. The video feedback was also shown to increase the accuracy of their predicted performance. Another significant finding from the study was the increase in self-regulation and autonomy that also lead to an increase in the use of deliberate practice time. The participants also experienced an increase in their motivation to learn while identifying support for both intrinsic and extrinsic motivational levels for the class. The study also found video feedback was beneficial for the participants' increased self-awareness and the participants preferred video feedback as their method of instructor feedback in physical education classes.

Implications for Practice

This study aimed to improve the feedback process used in the military movement class at the service academy by generating data concerning the efficiencies and effectiveness of video feedback. The findings from this study support video recordings also offer multiple benefits that could assist physical education instructors as well as students seeking a more efficient and effective feedback process. Instructors are encouraged to utilize video feedback throughout the physical education curriculum to enhance instruction for lower performers within the program. The findings of this study also suggest video feedback is an effective method of augmented feedback for students struggling with novel physical motor skill progressions. These findings demonstrated that students perceived video feedback as an effective method for enhancing skill improvement in their gymnastics class. Video feedback helped the study participants provide greater clarity for the knowledge of performance cues as well as providing them a better understanding of their deficient components of the skill. Additionally, these findings indicated video feedback could be used to improve motivation, deliberate practice, competence, and autonomy. The utilization of video feedback was shown to improve participants task scores as well as increase the accuracy of their predicted performances. Finally, the participants found video feedback to be their preferred method of feedback for learning physical skills. They found video feedback to be more beneficial than instructor verbal cues on all performed skills. The augmented feedback provided them a clear understanding of their current ability level as well as an improved understanding of the areas required to improve. Suggesting that the ability to visualize performance cues for the students may also result in faster motor skill acquisition.

Another suggestion for the implementation of video feedback is to incorporate peer feedback into the process. Allowing a partner feedback loop reduces the requirement for the instructor to serve as the lone source of feedback in the learning process. A peer could video record a practice attempt and then review the footage with the student. Reviewing the video should help students gain awareness of the key components of the skill while seeking methods for how to improve upon their deficiencies. In addition to helping reduce the time requirements of reviewing video during the class period, students could have their attempts recorded and then review the footage after class on their own time.

Limitations

The study relied on self-reported ratings for perception of feedback effectiveness. The study also included only the lowest performing female members of the class. Higher performing students may not see as much benefit from video feedback regarding their skill development or as a source of motivation. Another limitation of the study was a small sample size of ten participants which decreased statistical power of the study and is not representative of the student population at large. However, the small sample size was selected due to the population of available participants for the study. Finally, the study examined a unique population and unique set of skills. While the fitness levels of the selected participants may be below average of their peers at the academy, they have an average level of fitness when compared to their peers at other universities. The selected skills are unique to the requirements of the military academy and are not a common skill found in many physical education courses.

Compliance with Ethical Standards

Conflict of Interest: The authors declare they have no conflict of interest.

Research Involving Human Participants: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to Participate: Written, informed consent was obtained from individual participants included in this study. No identifying information about these participants is included in this article.

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Graduate Instructors' Technostress of Engaging in Emergency Online Teaching During the COVID-19 Pandemic

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Graduate Instructors’ Technostress of Engaging in Emergency Online Teaching During the COVID-19 Pandemic

Abstract

This study investigates graduate instructors' technostress before and during the COVID-19 pandemic, and the relationship between instructors’ technostress with their TPACK competencies and institutional-colleague support, respectively. Results show a significant increase in instructors’ technostress level during the COVID-19 online teaching period (t (27) = -5.74, p<.01). Instructors’ TPACK competencies were significantly and negatively correlated with their technostress, while the institutional-colleague support was not significantly associated with their technostress. The findings suggested that institutions may consider providing pedagogy courses, including TPACK competencies, to help graduate instructors decrease technostress.

Keywords: technostress, online teaching, TPACK, higher education

Introduction

In early 2020, most educational institutions in the United States rapidly transitioned from face-to-face instruction to online teaching due to the COVID-19 pandemic. According to Hodges et al. (2020), while this method is currently called “online teaching,” it is not planned online teaching but rather a crisis-promoted emergency remote teaching, which differs from online teaching before the pandemic. This teaching method is new to most instructors, and the use of technology has become a necessity rather than an option (Özgür, 2020; Panisoara et al., 2020), which may have led to stress deriving from technology use during online teaching (Joo et al., 2016). Technostress, first introduced by Brod (1984), is defined as “a modern adaptation disorder resulting from the inability to use current computer technologies effectively” (Özgür, 2020, p. 1). While technostress research has been conducted extensively across different workplace settings, studies investigating educators’ technostress are still rare (Çoklar et al., 2017). Among the few studies, Boyer-Davis (2020) discovered that college faculty suffered significantly more technostress during the pandemic than before the pandemic. Estrada-Muñoz et al. (2020) also found that during the pandemic, instructors’ stress and anxiety associated with the application of educational technology grew exponentially over time. These implied that more studies are needed to understand educators’ technostress to better support them in navigating the emergency online teaching.

Across the different groups of educators, graduate instructors received very little concern in educational research. But in reality, graduate instructors have become a significant teaching force for supporting undergraduate education in the United States (Douglas et al., 2016), and the preparedness of graduate instructors could directly impact the quality of education (Fong et al., 2019). Despite its significance, the support and training provided to them were quite limited (Luft et al., 2004), and few studies have been conducted to evaluate the impact of this support provided (Fong et al., 2019; Wyse, 2010). To better understand graduate instructors’ teaching conditions in the United States, this study investigates their technostress levels before and during the COVID-19 pandemic and examines the factors that led to their technostress and ways to cope with it.

Literature Review

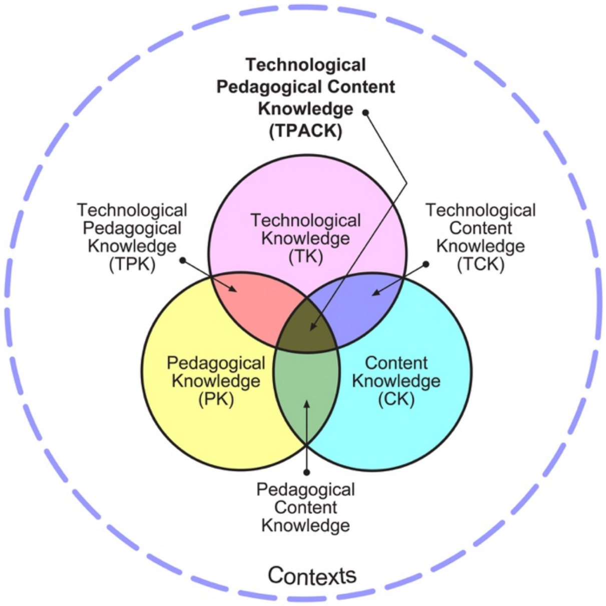
Numerous scholars have investigated factors influencing faculty's technostress in teaching. Previous literature has noted that personal and environmental factors are major ones resulted in instructors' technostress (Matthews et al., 2004; Özgür, 2020).

Personal Factors

In a study, Fuglseth and Sorebo (2014) discovered that the instructors' low-level individual ability (e.g., technological literacy, mental competencies) was an essential reason for their technostress. Some other personal factors, such as instructors' negative beliefs and resistance to applying computer technology into their teaching, were also identified by researchers (Harahap & Effiyanti, 2015). Likewise, a recent study by Zeeshan et al. (2020) examined the technostress of university faculty due to their lack of pandemic preparedness and sudden transition to online teaching during the pandemic in Pakistan. They discovered that in addition to technical issues such as internet connections, power disruptions, camera and voice quality, instructors' personal factors (including fear of using technology in class) were resulted in their technostress during the pandemic. Panisoara et al. (2020) also claimed that instructors' intrinsic motivation could effectively reduce their technostress.

Among a number of personal factors, Joo et al. (2016) proposed that teachers' competencies to teach with technology (developed from the Technological Pedagogical Content Knowledge - TPACK) are highly related to their technostress in teaching. TPACK is a framework that introduces the relationships between three basic components of knowledge (technology, pedagogy, and content) (Koehler & Mishra, 2008, 2006). Meanwhile, at the intersection of the basic knowledge are the four overlapping domains elaborate on integrating the three circles (Mishra & Koehler, 2006). In total, seven components are included in the TPACK framework (see Figure 1). Briefly, Technology Knowledge (TK) refers to the knowledge about various technologies (Schmidt et al., 2009), and Content Knowledge (CK) is the "knowledge about actual subject matter that is to be learned or taught" (Mishra & Koehler, 2006, p.1026). Pedagogical Knowledge (PK) refers to the methods and processes of teaching (Schmidt et al., 2009), and Pedagogical Content Knowledge (PCK) is the content knowledge that deals with the teaching process (Shulman, 1986). Technological Content Knowledge (TCK) is related to the knowledge of how technology can create new representations of specific content (Schmidt et al., 2009), and Technological Pedagogical Knowledge (TPK) refers to the knowledge of how various technologies can be used in teaching. Technological Pedagogical Content Knowledge (TPCK) refers to the knowledge required by teachers for integrating technology into their teaching in any content area (Schmidt et al., 2009). Many studies have been conducted to apply the TPACK framework into understanding teachers' knowledge of integrating technology into teaching (e.g., Archambault & Crippen, 2009; Hughes et al., 2020). However, since our current study focused on understanding the influence of technology-related self-efficacy for online teaching during the pandemic, only TK, TPK, and TCK were used to examine graduate instructors' technostress.

Figure 1.
The Components of the TPACK Framework (graphic from http://tpack.org/)



Environmental Factors

Previous studies (e.g., Fuglseth & Sorebo, 2014; Ragu-Nathan et al., 2008; Salanova et al., 2013) found a lack of environmental support, such as technical support, information- and communication-technology use facilitators, can result in technostress. Additionally, Al-Fudail et al. (2008) noted that the lack of fit between teachers and the technological environment, specifically, the unbalance between demands of the technological environment and teachers' abilities, as well as teachers' needs and supplies, cause instructors' technostress.

Joo et al. (2016) proposed that school support is an external factor, and the external regulation could enhance instructors' stress to a large extent (Panisoara et al., 2020). Panisoara et al. (2020) also emphasized that the school context has a significant impact on teachers' technostress. Vladut and Kallay's (2010) study found that increased school demand for technology use creates technostress among instructors. Dong et al. (2020) also identified administration support that denotes infrastructure and technical assistance and collegial support from colleagues as critical environmental factors related to teachers' use of technology.

In summary, the above research findings suggest that the major reasons for teachers' technostress include teachers' personal and environmental factors. Dong et al. (2020) framed a structural model showing the relationships among teachers' technostress, TPACK, computer self-efficacy, administration support, and collegial support. They found that TPACK can help teachers deal with psychological stress caused by technology use and suggest strengthening teachers' TPACK skills through school support and increasing teachers' computer self-efficacy. Özgür (2020) also noted a negative relationship between teachers' technostress levels and school support and TPACK competencies. TPACK negatively affects teachers' technostress, and teachers' technological integration competencies could significantly decrease teachers' technostress levels caused by ICT use during the education-training process.

Overall, limited studies have been conducted to investigate technostress among graduate instructors, the associations between their personal factors, mainly TPACK competencies and their technostress, and the relationship between the support they have received from institutions and colleagues with their technostress; not to mention their emergency online teaching during the pandemic (Estrada-Muñoz et al., 2020). This study will contribute to the current literature and investigate graduate instructors' technostress during the pandemic.

Method

The Research Questions

1. Is graduate instructors' technostress significantly different before and during the COVID-19 pandemic when emergency online teaching began?
2. Are there any associations between instructors' TPACK competencies and their technostress regarding emergency online teaching?
3. Are there any associations between institutional-colleague support and instructors' technostress regarding emergency online teaching?

Data Collection and Participants

An online survey (see Appendix) with validated instrument items was used to answer the proposed research questions. Participants were asked to rate each item on a five-point Likert scale, ranging from one (strongly disagree) to five (strongly agree). First, participants were asked to rate their stress levels before and after classes were conducted in the online setting. A 7-item scale adopted from Panisoara et al. (2020) was used to measure technostress. An 8-item scale from Chai et al. (2011) was used to measure instructors' TK and TCK, while 4-item scale each from Panisoara et al. (2020) and Valtonen et al. (2017) were used to measure instructors' TPK and TPCK, respectively. Participants' institutional-colleague support was measured by a 6-item scale from Dong et al. (2019). The last section of the survey was about the demographic information of the participants.

The online survey was distributed to graduate instructors in a public university in the U.S. in February 2021, and 31 responses were collected. After excluding the invalid responses, 28 participants were included in this study. Descriptive demographics of the students who completed the survey are demonstrated in Table 1.

Table 1.
Participant Demographics Information

	Value	*n*	%
Demographics			
Gender	Male	8	28.6%
	Female	16	57.1%
	non-binary/not to disclose	4	14.3%
School/Department	College of Education	21	75.0%
	School of Engineering	4	14.3%
	College of Natural Sciences	3	10.7%

Data Analysis

Survey responses were analyzed using R. First, mean (M) and standard deviation (SD) were calculated to get an overall understanding of graduate instructors' technostress levels, their TPACK competencies, and institutional-college support. Then, paired-sample t-tests were used to compare their technostress before and during the pandemic. Pearson's correlation analyses were conducted to investigate relationships between instructors' technostress and their TPACK competencies, and between technostress and their institutional-colleague support.

Results

Instructors' Technostress Levels Before and During the Pandemic（RQ1）

As shown in Table 2, descriptive statistics demonstrate that instructors' technostress levels before COVID-19 pandemic (M = 2.71, SD = 0.81) were lower than when courses were transferred online (M = 3.43, SD = 0.99). The paired samples t-test result indicates that instructors' technostress levels were significantly higher after switching to online teaching (t (27) = -5.74, p < .01). Its effect size is 0.79 (95%CI [0.73, 0.85]), a notably large effect size (Cohen, 1992). This result suggests that graduate instructors felt much more technostress when the courses were transferred from in-person to online format.

Table 2.
Paired Samples t-test of Graduate Instructors' Technostress Before and During the COVID-19 Pandemic (n = 28)

		Mean	SD	t
Pair	Before the pandemic	2.71	0.81	-5.74**
	During the pandemic	3.43	0.99	

** p<.01

The Association Between Instructors' TPACK Competencies and Their Technostress Levels (RQ2)

Descriptive statistics show that instructors had different competency levels in each TPACK dimension (see Table 3), with TPK, TPCK, TK, and TCK in descending order. A Pearson's correlation between instructors' TPACK and their technostress about emergency online teaching (M = 2.75, SD = 0.98) was also conducted. As shown in Table 4, graduate instructors' technostress about emergency online teaching negatively correlated with their TK, TPK, TCK, TPCK. The effect sizes (0.49, 0.37, 0.41, 0.4) indicate that a moderate amount of the variability in instructors' technostress was explained by their TPACK competencies. These findings suggested that when graduate instructors have a higher level of TPACK competency, their technostress could be lower.

Table 3.
Descriptive Statistics of Graduate Instructors' TPACK Competency Level

Dimensions	Mean	SD
Technological Knowledge (TK)	3.90	0.93
Technological Pedagogical Knowledge (TPK)	4.07	0.72
Technological Content Knowledge (TCK)	3.50	0.82
Technological Pedagogical Content Knowledge (TPCK)	3.96	0.81

Table 4.
Pearson's Correlation for Graduate Instructors' TPACK and Technostress

Variable	Technostress
Technological Knowledge (TK)	-0.70**
Technological Pedagogical Knowledge (TPK)	-0.61**
Technological Content Knowledge (TCK)	-0.64**
Technological Pedagogical Content Knowledge (TPCK)	-0.63**

** p<.01

The Associations Between Institutional-colleague Support and Instructors' Technostress (RQ3)

Regarding environmental support, instructors received nearly equal support from institution (M = 3.81 SD = 0.59) and colleagues (M = 3.82, SD = 0.98). 22 (78.6%) participants "agreed" or "strongly agreed" that their college or school provides enough infrastructure and resources for them to do well with online teaching, while 15 (53.6%) participants "agreed" or "strongly agreed" that their college or school provides clear guidelines about online teaching. Regarding support from colleagues, 21 (75.0%) "agreed" or "strongly agreed" that they and colleagues made a connected effort to integrate technology into online teaching; 17 (60.7%) agreed or "strongly agreed" that they received encouragement from colleagues when they encountered difficulties integrating technology into their online teaching.

However, Pearson's correlation analysis indicated that there were no significant correlations between the institutional (r =0.12, p>.05) and colleague support (r =0.253, p>.05) with instructors' technostress about emergency online teaching.

Discussion

Technostress Levels and TPACK Competencies

Our study analyzed graduate instructors' technostress levels before and during the pandemic. It discovered that graduate instructors' technostress levels significantly increased when the courses were transferred from an in-person to an online format during the pandemic. In previous studies, the demand for a technological environment in the teaching context was an important factor that triggered instructors' technostress (AI-Fudail & Mellar, 2008; Panisoara et al., 2020). In this study, the transition from a familiar teaching format (i.e., in-person teaching) to online teaching during the COVID-19 pandemic was an external regulation and requirement for the graduate instructors, and they had little time to prepare themselves for this change in the teaching environment. Hence, it is not surprising that the graduate instructors experienced higher technostress levels after switching to online teaching.

Additionally, their technostress levels were significantly negatively correlated with their TPACK competency levels. As Özgür (2020) pointed out, instructors' technostress levels are determined by their abilities and competencies in using technology, and teachers' TPACK competencies greatly decrease their technostress levels. The significant negative correlations between graduate instructors' technostress levels and their TPACK competency levels found in the current study align with the previous literature showing that teachers' TPACK competencies could contribute to decreasing their technostress levels. This finding indicates that graduate instructors' TPACK competencies play an important role in helping them cope with technostress, a result similar to those in previous studies (e.g., AI-Fudal & Mellar, 2008; Joo et al., 2016). Among the TPACK dimensions, TK was found to be most negatively correlated with graduate instructors' technostress (see Table 4); thus, improving graduate instructors' technological literacy could help decrease their technostress. Also, because TK was not content- or subject-related, a general technology training workshop on integrating technology into teaching could benefit graduate instructors.

Institutional-colleague Support and Instructors' Technostress

Our findings suggested that only half of the graduate instructors agreed or strongly agreed that their college or school provides clear guidelines for online teaching, indicating that they did not get enough support from their institutions. The graduate instructors who participated in our study also pointed out the importance of getting support from peers, suggesting collaborative work among graduate instructors on integrating technology into teaching. However, our findings indicated that the support graduate instructors received from institutions and colleagues did not significantly correlate with their technostress. The significant correlations between graduate instructors' TPACK competencies and their technostress, and no significant correlations between the supports graduate instructors received from the environment and their technostress, suggested that the personal factors played a more influential role in determining graduate instructors' technostress. Thus, a more effective and practical way to reduce graduate instructors' technostress could be to improve their TPACK competencies.

Current literature has suggested that the pedagogy course can consistently increase graduate instructors' confidence and attitudes toward teaching (Fong et al., 2019). The findings of our study could contribute to the current literature and expand their suggestion that the TPACK competencies should be an essential component in the pedagogy course for graduate instructors. Dong et al. (2020) proposed that institutions should create more opportunities for teachers to accumulate hands-on experience and provide timely feedback to improve teachers' perceived knowledge and abilities and reduce their technostress (Xie et al., 2017). They also suggested that mutual collaboration among colleagues effectively enriches instructors' development of TPACK better than providing sufficient infrastructure and technical training. Based on our findings, we also indicated that for the graduate instructors, the collaboration-based learning in a pedagogy course could also benefit them to gain knowledge and reduce technostress.

Conclusion

Graduate instructors provide instruction for many university classes. They have become an increasingly indispensable part of the teaching group; however, the current literature has not thoroughly investigated these young instructors' technostress. Our findings suggest that developing graduate instructors' TPACK competencies is a viable way to reduce technostress caused by the rapid move to online teaching. This study has practical implications for institutions supporting graduate instructors, in particular, providing courses for graduate instructors to improve their teaching ability and TPACK competencies. This study has limitations. Because it is small in scale and the participants were recruited from one university, our conclusions need to be further tested in larger-scale studies and other higher education contexts.

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Appendix

Survey

1. Please rate your <u>stress level</u> before Spring break 2020, when classes were conducted in a face-to-face setting. (Extremely high/High/Medium/Low/Not at all)
2. Please rate your <u>stress level</u> after Spring break 2020, when classes were conducted in an online setting. (Extremely high/High/Medium/Low/Not at all)
3. Please respond to the items below based on <u>your feelings</u> about the emergency online teaching during COVID-19 pandemic. (strongly disagree/disagree/neutral/agree/strongly agree)
   a. I feel stressed while adapting myself to online teaching.
   b. I find it difficult to use digital technology effectively for online teaching due to my limited time availability
   c. I feel stressed by the high technical requirements that are necessary for online teaching.
   d. I find it difficult, with my current skills, to constantly improve the act of online teaching
   e. I feel that online teaching complicates my teaching activity.

f. It is hard for me to concentrate on teaching with the use of different digital tools in the online setting.

g. I hesitate to incorporate other digital tools during online teaching for fear of making mistakes.

h. I am worried that online teaching will compromise student learning quality.

4. Please answer the following questions about your technological knowledge for teaching online.

a. I know how to solve my own technical problems for online teaching.

b. I can learn technology easily to serve the purpose for online teaching.

c. I keep informed about new digital technologies about online teaching.

d. I have the technical skills to use technology effectively for online teaching.

5. Please answer the following questions about your technological pedagogical knowledge for teaching online.

a. I can help my students use online learning environments (e.g., Canvas, Google applications) effectively.

b. I can design lessons/courses that enhance the online teaching approaches.

c. I can use appropriate digital conferencing technologies (e.g., Zoom, Skype, Google Meet, WebEx etc.), which allow me to communicate and interact synchronously with other colleagues or students.

d. I can use online tools to assess students' knowledge.

6. Please answer the following questions about your technological content knowledge for teaching online.

a. I know digital technologies which I can use to illustrate difficult contents in my online course.

b. I know websites with content materials for studying my online course.

c. I know how to decide on the technologies that will enable students to learn the contents of my online course in a meaningful way.

d. I can use the software that are created specifically for my online course. (e.g., e-dictionary/corpus for language; Geometric sketchpad for Math; Data loggers for Science).

7. Please answer the following questions about your technological pedagogical content knowledge for teaching online.

a. In teaching a specific online course, I know how to use digital technology as a tool for students to plan their own learning.

b. In teaching a specific online course, I know how to use digital technology as a tool for students' collaborative learning.

c. In teaching a specific online course, I know how to use digital technology as a tool for students' creative thinking.

d. In teaching a specific online course, I know how to use digital technology as a tool for students' critical thinking.

8. Please answer the following questions about <u>the ways you have been supported</u> for the emergency online teaching during COVID-19 pandemic.

a. My college/school provides clear guidelines about online teaching, so that I know how to guide student learning

b. My college/school provides sufficient training so that I know how to implement online teaching

c. The requirement and timetable for implementing online teaching is reasonable in my college/school so that I can at my own pace

d. My college/school provides enough infrastructure and resources so that I could do well on online teaching

e. I get encouragement from my colleagues when I encountered difficulties in integrating technology in online teaching

f. My colleagues share useful resources with me for online teaching

g. My colleagues share their experience with me about integrating technology into online teaching.

h. My colleagues and I made a concerted effort to integrating technology into online teaching

9. What is your gender?
10. What college/school are you in?
11. How long have you been teaching in higher education?

From Policing to Learner Analysis: Use of ExamSoft Snapshots to Analyze Students' Exam Taking Behaviors in Live and Online Exams

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Abstract

A Doctor of Pharmacy program is using a specialized examination software, ExamSoft® to addesss accreditation requirements. The primary objective of this study was to use ExamSoft snapshots log to provide empirical evidence of exam taking behaviors and the potential impact of the pandemic context on exam taker behaviors across different examination contexts. Significant behavioral differences were found between high and low achieving students as well as between face-to-face and online live monitored exams.

Motivation and Objective of the Study

The use of multiple-choices exams combined with the introduction of computer-testing platforms increased educational researchers' interest in test-taking behaviors, changes in these behaviors, and their relationships with the assessment activities (Olev & Must, 2013; Plake & Wise,1988; Tamowsky, 1977). As interest in test-taking behaviors increased, researchers started to focus on more specific impact areas such as the potential impact of test-taking behaviors on students' cognitive test performance (e.g., Heinonen et al., 2011), the role of self-efficacy in mediating the impact of test-taking behaviors on test performance (e.g., Birenbaum & Alhija, 2013), or the association between test-taking behaviors and test performance for students with special needs (e.g., Pohl et al., 2016).

Pharmacy programs are required by an accreditation agency to provide specific data to support students' progress (ACPE, n.d.). To address these requirements, a PharmD program began using a specialized examination software, ExamSoft®, that allowed instructors to link learning objectives and outcomes to assessment items. ExamSoft was integrated with the learning management system and provided valuable statistical data used to monitor the quality of individual exams items and the whole exam. ExamSoft includes security features such as device lock during the exam, item randomization, and snapshots that record all choices students make during an exam.

The primary objective of this study was to analyze students' snapshots and provide empirical evidence of exam taking behaviors, their potential relationship to the exam performance, and the potential impact of the pandemic context on exam taker behaviors.

Context of the Study

At the beginning of Fall 2020 the university set up pandemic restrictions that allowed both a mixed-attendance and a fully synchronous online attendance option. Both students and the instructor had the option to use either the face-to-face or online format of the course. For live attendance and examination options, the classroom seating capacity was limited and face masks were required.

To address the needs of fully online students, ExamSoft Exam Integrity functionality offered strong security options including offline video, audio recording, and flagging of potential breaches of integrity. For the target pharmaceutical course, in the first half of the semester, when COVID 19 pandemic restrictions were more relaxed the course was live and additional classrooms accommodated a live first exam for the entire class. For the second part of the course, the conditions worsened and the instructor decided to teach and administer the second examination fully online for the entire class. This situation offered a unique opportunity to analyze the exam taking behaviors of the same group of students both in the live and online context and analyze the potential impact of the pandemic-related conditions on the examination process.

Research Focus and Methodology

Research Design

We used a sequential mixed-methods design that built on a qualitative analysis of the raw ExamSoft data to identify significant examination behaviors followed by a comparative qualitative analysis of the identified significant exam-taker behaviors. The dependent variables used in this study were behavioral patterns, assessment item difficulty, and the maximum number of choices an exam taker made for each assessment item throughout the examination period. The independent variables were grade level (high, within top 20% of the exam grades or low, within the bottom 20% of the grades), nature of the exam (face-to-face or online with digital exam monitoring), and the correctness of the final answer (correct or wrong).

Data Collection

ExamSoft records the entire activity of the exam taker during the exam in what is known as "Exam Taker Snapshots". This detailed information was intended to serve as a means to provide support for the instructor when checking and identifying potential attempts of cheating. While this "policing" tool is considered a needed and useful security feature, the Exam Taker Snapshots (or simply ExamSoft snapshots) can also provide support for tracking students' observed exam-taking behaviors (Cernusca & Friesner, 2019). That is, for multiple-choice assessment items ExamSoft snapshots include all choices students made (e.g., view an assessment item, select a specific answer, change a previously selected answer) and the time-stamp associated with each choice.

The ExamSoft snapshot logs are available through the software interface (Figure 1) and allow for basic sorting of the information by assessment item or time stamp. However, the ExamSoft snapshot logs can also be downloaded as an Excel spreadsheet and used for further more detailed analyses.

Figure 1

Sample Snapshot Viewer in ExamSoft

Snapshot Viewer

Previous 1 2 Next   Show: 50 | 250 | 500 | 1000 | 2500

Item #	Snapshot #	Item Type	Time Stamp	Trigger	Response
1	1	Choice	5:05:30 PM	Answered	Choice(s): E
2	1	Choice	5:15:14 PM	Navigation	Choice(s): C
3	1	Choice	5:12:30 PM	Answered	Choice(s): E
4	1	Choice	5:12:16 PM	Answered	
5	1	Choice	5:13:30 PM	Answered	
6	1	Choice	5:04:12 PM	Exam Start	
7	1	Choice	5:24:30 PM	Answered	Choice(s): C
8	1	Choice	5:06:19 PM	Answered	
9	1	Choice	5:22:30 PM	Answered	Choice(s): C
10	1	Choice	5:17:30 PM	Answered	Choice(s): B
11	1	Choice	5:23:30 PM	Answered	
12	1	Choice	5:09:30 PM	Answered	

Question numbering in the snapshot reflected the default organization of the exam even when questions were randomized. The spreadsheet format of the snapshots allowed for the organization of choices by question number and time stamp to reflect the exam taker behaviors for each question. In addition to the snapshot viewer the item analysis output from ExamSoft provided the correct answer and assessment item difficulty (Figure 2)

Figure 2

ExamSoft Item Analysis Output Sample

Exam Takers = 70   KR20 = 0.84   Stdev = 14.93   Mean = 70.11 (77.90%)   Median = 72.00

Question #	Correct Responses			Disc. Index	Point Biserial	Correct Answer	Response Frequenci					
	Diff(p)	Upper	Lower				A	B	C	D	E	
1	0.87	100.00%	66.67%	0.33	0.41	B	1	*61	2	2	4	-
Question ID / Rev: 21562 / 1				-	-	% Selected	1.43	87.14	[illegible]	2.86	5.71	-
-	-	-	-	-		Point Biserial (rpb)	-0.11	0.41	-0.25	-0.29	-0.15	-
-	-	-	-	-	-	Disc. Index	-0.05	0.33	-0.10	-0.10	-0.10	-
-	-	-	-	-	-	Upper 27%	0.00	1.00	0.00	0.00	0.00	-
-	-	-	-	-	-	Lower 27%	0.05	0.67	0.10	0.10	0.10	-

Q: Based on the molecular mechanism of action of tolteridine, which one of the following effects is NOT likely to be caused by the drug?
A: blurred vision
* B: drooling
C: constipation
D: dry eyes
E: urinary retention

Participant Selection

The snapshot of seven high performers that were placed in the first 20% of the class and seven low performers placed in the lower 20% of the class from both live and online exams were selected for this research study.

This number of participants was considered optimal considering that each exam used for this study had between 35 and 50 assessment items and for each assessment item the ExamSoft snapshot log recorded between two and 10 behavioral actions.

Data Analysis

Data analysis involved a qualitative phase that helped identify significant behavioral patterns and a quantitative phase where identified behavioral patterns quantified and used for statistical analysis using SPSS® (https://www.ibm.com/products/spss-statistics) statistical software.

Qualitative Analysis Phase

The structure of the ExamSoft Snapshots allowed for a qualitative analysis of the observed exam taking behaviors followed by grouping of these behaviors into specific behavioral patterns. As a first step in the qualitative analysis the snapshot Excel output was organized by assessment item and then by the choice (recorded exam taker action). The first choice for each assessment item was then color coded and a column with the correct answer for each item was added to help analyze the sequence of the choices made by the exam taker (see Figure 3).

Figure 3
ExamSoft Snapshots Organized by Item and Choice

1	Item#	Snapshot#	Item Type	Time Stamp	Trigger	Response	correct_answer
2	3	1	Choice	4:04:43 PM	Answered		A
3	3	2	Choice	4:14:16 PM	Answered	Choice(s): A	
4	3	3	Choice	4:33:04 PM	Final	Choice(s): A	
5	4	1	Choice	4:09:16 PM	Answered	Choice(s): A	C
6	4	2	Choice	4:33:04 PM	Final	Choice(s): A	
7	5	1	Choice	4:05:11 PM	Answered		A
8	5	2	Choice	4:14:36 PM	Answered	Choice(s): A	
9	5	3	Choice	4:33:04 PM	Final	Choice(s): A	
10	6	1	Choice	4:07:18 PM	Answered	Choice(s): C	C
11	6	2	Choice	4:33:04 PM	Final	Choice(s): C	
12	7	1	Choice	4:11:31 PM	Answered		A
13	7	2	Choice	4:29:29 PM	Answered	Choice(s): D	
14	7	3	Choice	4:33:04 PM	Final	Choice(s): D	
15	8	1	Choice	4:03:43 PM	Answered	Choice(s): A	A
16	8	2	Choice	4:22:48 PM	Answered	Choice(s): B	
17	8	3	Choice	4:33:04 PM	Final	Choice(s): B	
18	9	1	Choice	4:04:22 PM	Answered	Choice(s): D	D
19	9	2	Choice	4:33:04 PM	Final	Choice(s): D	
20	10	1	Choice	4:04:15 PM	Answered	Choice(s): C	C
21	10	2	Choice	4:33:04 PM	Final	Choice(s): C	

This structure of the snapshot log allowed to identify several micro-behaviors: viewing a question without selection, selection of an answer, change of an answer from correct to wrong, or change of a wrong answer to a correct one. These micro-behaviors were then used to defined 10 overall behaviors that reflected potential sequencing across observed exam taker choices for the dataset used in this study. Examples of these behaviors include: correct answer from first choice to the final choice; view without a choice then correct answer to final choice; wrong answer as the first choice then correct answer to final choice; or wrong answer at the first choice, changed to correct answer and then wrong answer to final choice. The identified basic behaviors were mixed into behavioral patterns that included repetitive patterns. For the scope of this study, the behaviors were grouped in four outcomes, two beneficial and two damaging.

The two beneficial behavioral patterns were:

(b1-cc) correct - correct, correct answer from the beginning to the end of the exam

(b2-wc) wrong - correct, wrong answer in the beginning changed into a correct answer by the end of the exam.

The two damaging behavioral patterns were:

(d1-cw) correct - wrong, correct answer in the beginning changed to a wrong answer

(d2-ww) wrong - wrong, wrong answer from the beginning to the end.

Qualitative Analysis Phase

For the quantitative phase of the analysis, two exams in the same course that were administered during the COVID-19 pandemic were considered for this study. The first one was administered during the first stage of the pandemic when the face-to-face attendance was acceptable with distancing and class occupancy and masking requirements were strictly observed. The second exam was administered at the time when the pandemic requirements were tightened and remote instruction was in place. For each of the exams, seven high achieving students placed in both exams within top 20% of the grades as well as seven low achieving students placed within the bottom 20% of the scores were selected for this study. For each exam each student's snapshots were coded at the assessment item level for the four observed behavioral patterns identified in the previous step and then the percentage of each behavior relative to the total number of assessment items was computed.

In the next step, a synthesis Excel spreadsheet was created by recording for each student the percentages for each of the four observed behavioral patterns computed in the previous step, the maximum number of choices, the correct/wrong answer code, the grade level and the exam code (1-live, 2-remote). Figure 4 shows a snapshot of the synthesis Excel spreadsheet generated and used for this phase of the data analysis.

Because of the small number of participants, a non-parametric test, Kruskal-Wallis, was used to compare the considered dependent behavioral variables and number of choices by exam type and respectively achievement/grade level.

Figure 4

Synthesis Spreadsheet for Statistical Data Analysis

1	StudID	ex_id	grade_level	b1_cc	b2_wc	d1_cw	d2_ww	max_choices
2	fs20_413_ex1_live_high_1	1	1	96.43	0.00	0.00	3.57	3
3	fs20_413_ex1_live_high_2	1	1	96.43	0.00	0.00	3.57	3
4	fs20_413_ex1_live_high_3	1	1	96.43	0.00	0.00	3.57	3
5	fs20_413_ex1_live_high_4	1	1	96.43	0.00	0.00	3.57	3
6	fs20_413_ex1_live_high_5	1	1	89.29	3.57	0.00	7.14	4
7	fs20_413_ex1_live_high_6	1	1	100.00	0.00	0.00	0.00	3
8	fs20_413_ex1_live_high_7	1	1	82.14	7.14	0.00	10.71	10
9	fs20_413_ex1_live_low_1	1	2	46.43	14.29	3.57	35.71	4
10	fs20_413_ex1_live_low_2	1	2	32.14	21.43	28.57	17.86	4
11	fs20_413_ex1_live_low_3	1	2	64.29	0.00	0.00	35.71	3
12	fs20_413_ex1_live_low_4	1	2	50.00	7.14	7.14	35.71	5
13	fs20_413_ex1_live_low_5	1	2	46.43	7.14	7.14	39.29	5
14	fs20_413_ex1_live_low_6	1	2	53.57	3.57	7.14	35.71	5
15	fs20_413_ex1_live_low_7	1	2	60.71	0.00	3.57	35.71	4
16	fs20_413_ex2_rem_high_1	2	1	89.66	6.90	0.00	3.45	7
17	fs20_413_ex2_rem_high_2	2	1	68.97	31.03	0.00	0.00	10

Findings

When the observed beneficial behavioral patterns were analyzed by the student achievement levels, a Kruskal-Wallis test indicated that high achieving students ranked statistically significant higher in beneficial correct-correct behavioral pattern (21.5) than low achieving students (7.5), H (1) = 20.37, p <0.001. However, the two groups ranked about the same in beneficial wrong-correct behavioral pattern (p=.0.083).

For the damaging behavioral patterns, the Kruskal-Wallis test indicated the same type of differences between low and high achieving students:

- for damaging correct-wrong behavioral pattern the low achieving students ranked statistically significant higher (20) than high performing students (9), H (1) = 16.16, p <0.001;

- for damaging wrong-wrong behavioral pattern, the low achieving students ranked statistically significant higher (21.5) than high performing students (7.5), H (1) = 20.59, p <0.001;

When only the high achieving students were considered for the analysis, a Kruskal-Wallis test indicated a statistically significant higher ranking only for damaging wrong-wrong behavioral pattern during the live exam (10.1) when compared to the remote exam (8.9), H (1) = 6.04, p<0.05. No statistically significant differences were found for the two positive behavioral patterns and second damaging behavioral pattern (correct-wrong).

However, when only the low achieving group was considered for the analysis, the Kruskal-Wallis test indicated:

- a statistically significant lower ranking for correct-correct beneficial behavioral pattern for the remote exam (4.4) when compared to the live exam (10.6), H (1) = 7.65, $p<0.01$, and respectively

- a statistically significant higher ranking for wrong-wrong detrimental behavioral pattern for the remote exam (11) when compared to the live exam (4), H (1) = 10.27, $p<0.01$. No statistically significant differences for the beneficial wrong-correct and detrimental correct-wrong behavioral patterns between the two types of exams.

Finally, when the maximum choices by question were analyzed across the two types of exams (live and remote), the Kruskal-Wallis test indicated a statistically significant ranking for the remote exam when compared to the live exam for both the high achieving group ($p<0.05$) and the low achieving group ($p<0.01$).

Discussions

By expanding the use of ExamSoft snapshots from exam security purpose to the analysis of exam taker behaviors we were able to identify behavioral patterns and their variation across student achievement levels and across different examination contexts. The findings from this study indicated that, as expected, high achieving students made better answer choices and these choices were reflected in more beneficial outcomes while the low achieving students had behaviors that resulted in an increased level of damaging outcomes.

When students were placed in an online exam format due to the COVID 19 pandemic-related constraints, students in low achieving group were more likely to exhibit behaviors that decreased the beneficial outcomes and increased the damaging ones. Finally, we found that during the online examination students in both achievement groups made more maximum choices by exam questions which can be explained through a combination of a potential increase in the level of anxiety and less distractions during the exam compared to the face-to-face context. However, additional research is needed to analyze the factors that impact, positively or negatively, assessment in a remote testing format.

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A Restorative Leadership Training Model Isn't Just for Mock Trial Training.

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Abstract

A mixed-methods collective case study was conducted to assess how training and accompanying instruments impact teams' implementation of Restorative Leadership skills in competitive and noncompetitive settings. Using a parallel mixed methods hybrid design where focus groups, mixed-methods surveys, observer checklists, one-on-one interviews, quizzes, and self-assessment checklists were used to address five research questions. Nine noncompetitive teams in two honors classes, a mock trial team, and an assistant mock trial team coach from a medium Southeastern university participated in this study. The nine noncompetitive teams were assigned to watch instructional videos about Restorative Leadership touchstones and were required to complete a 10-question quiz, followed by a voluntary Qualtrics mixed survey to get feedback on two restorative skills checklists. A leaderboard (dashboard) was implemented in the competitive mock trial team setting with two teams (Gold Team, Green Team). The purpose of this study was to determine if current Restorative Leadership instruction and accompanying tools can successfully aid both competitive teams and noncompetitive teams to implement Restorative Leadership skills in various activities. The results indicated positive support for the checklists to assess the application of Restorative Leadership skills for noncompetitive teams and mixed results for the impact of a leaderboard on individual and team performance for competitive teams.

1. Introduction:

What would it be like to create a model of leadership that could improve communication, accountability, and team relationships in a post-pandemic workplace? Where would we begin? Law schools across the country have primarily used the Case Method since 1890 to train teams for competitions (Chisholm, 1911). However, team cohesion, a key component in the success of team competition, has been undermined in traditional team training (Salas et al., 2015). Studies have shown that training focused on restorative leadership training improved participants' communication, accountability, and relationship with other team members (Blankenship, Mwenja, Dolowitz & Wech, 2021; Pointer, 2019). Currently, the definition of restorative leadership is a work in progress that centers around four core tenets: working together to achieve invitation over coercion, radical inclusion, equitable communities, and working together to achieve objectives

(Blankenship, et al., 2021). The heart of restorative leadership is the push to help teams address challenges that naturally occur within a team over time. Yet the problem is how to offer restorative leadership training effectively. A recent study by Vegt, Visch, Vermeeren, and Ridder (2018) showed that gamification with team performance components was associated with increasing team cohesion.

In this study, we introduced a new restorative leadership training model in several courses and examined its effectiveness on participants' performance. This model was featured with gamified team strategy and restorative leadership training. The research questions were:

1. How effective was the restorative leadership training in helping participants apply the skills in application exercises?
2. How did the use of the gamified team strategy impact participants' individual performance?
3. How did the use of the gamified team strategy impact team performance?
4. How did the use of gamified team strategy influence participants' preparedness for class?
5. How did the dual assessments impact participants' performance?

2. Research Design

This was a parallel mixed method collective case study. For the qualitative analysis, we examined four different cases simultaneously. We examined how teams implemented the Restorative Leadership model in team activities through self-assessments, observation of other teams, focus group interviews, and surveys. We used the quantitative analysis to examine the impact of the Restorative Leadership training model on participants' performance, looking at the certificate completion, the self-assessment checklist, and individual quiz results. Qualitative results from the focus groups were used to supplement the results of quantitative analysis.

2.1 Participants. Forty-seven undergraduate students in nine noncompetitive teams (23 in an honor's college honor's course with four teams, and 25 in a business honor's course with five teams) and 30 participants, of which 17 were active on two competitive teams according to the final leaderboard, at a midsized Southeastern University in the U.S. participated in this study. The students were primarily juniors and seniors. Participants in the focus groups were from these samples. The Gold Team focus group had three participants, the Green Team had four participants, and the honor's college course focus group ended up being an individual interview. One individual interview was conducted with the Gold Team's assistant coach, a former Gold Team member.

2.2 Intervention. Participants who were from the honors courses received the Restorative Leadership training. Students from the mock trial teams were divided into two teams: Gold and Green teams. The Gold Team were students who received the gamified team strategy and participated in mock trial as an extracurricular activity. The Green Team included students who only received the gamified team strategy in training, where participation on the mock trial team was part of their grade for their course.

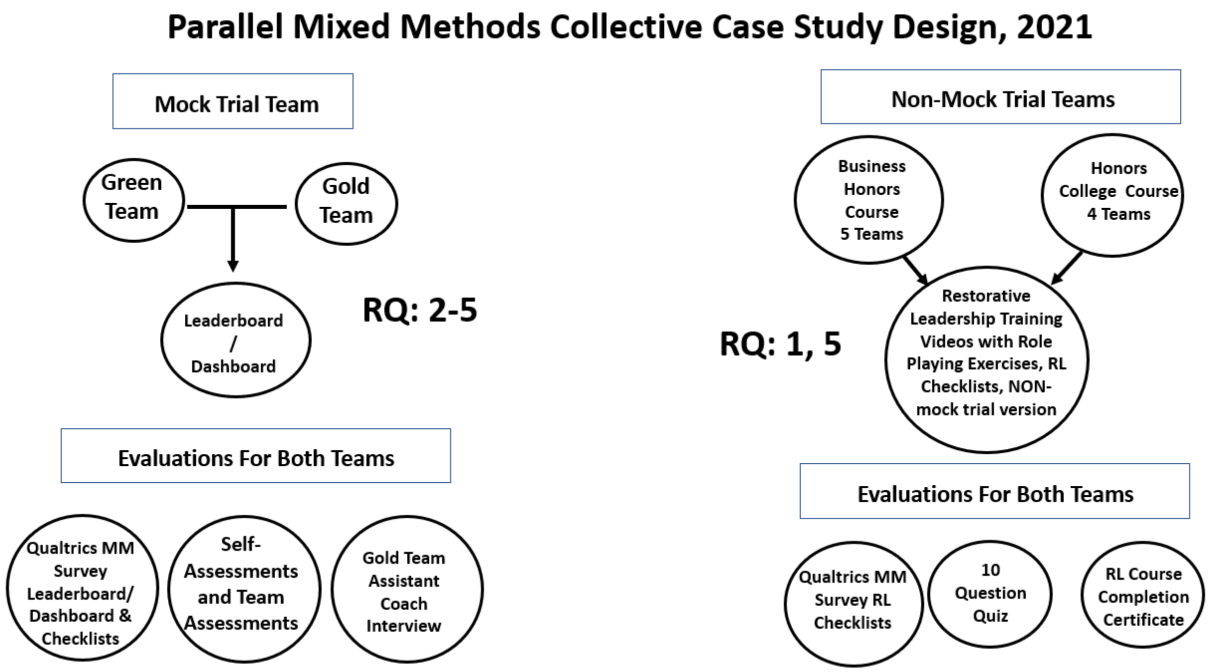
Participants from the honors courses were to watch four Restorative Leadership instructional videos. Each video defined, described, and created a common language for each of the four tenents mentioned above. After watching the video, students engaged in roleplays during the class, where there are at least one to two observers on pre-established teams (in some cases, the whole team). After the roleplay, everyone was to complete either the self-assessment checklist on a Google Form or the Observer's Checklist on a Google Form. Then a debrief was conducted regarding the participants' experiences. This cycle occurred at least once more, where students who roleplayed now become observers and vice-versa.

A leaderboard (dashboard) was created for the mock trial team for both Gold and Green team participants to see their standing as individuals and as teams. These dashboards were used to form the team that competed in collegiate competitions. The seven top performers, according to the dashboard, were selected. Points were earned based on individual performance in various roles during mock trial practices, learning materials, and appropriate application of the mock trial rules. Individuals and teams also earned points for demonstrating Restorative Leadership skills during mock trial training drills and practices.

2.3 Data Collection. The American Mock Trial Association judging form (AMTA, 2019) was adapted into a Restorative Leadership assessment tool. This tool is developed into both a self-assessment checklist and an observer checklist. The self-assessment checklist included 14 behavior questions with a scale ranging from 0 (“Fails to Practice Skill”) to 8 (“Practices Skill and Encourages Others to”). During the semester, as part of the assigned course work, both honor’s courses completed the Restorative Leadership training videos, were required to provide a certificate of completion, and took a 10-question quiz about the materials. In addition to this, each participant was asked to complete a self-assessment checklist to assess their performance of the Restorative Leadership skills after engaging in a roleplay activity. The observer checklist included 14 questions with the same scales, and after roleplays where the participants were observers, they were asked to complete the observer checklist. Two focus groups were conducted with the mock trial’s Green and Gold Team members. The focus groups were designed to ask participants’ experiences and reflections on the use of gamified team strategy.

3. Results.

Figure 1
Design Model



Research Question 1. *How effective was the restorative leadership training in helping participants apply the skills in application exercises?* This question was to assess participants performance applying restorative leadership skills after receiving restorative leadership training. The noncompetitive teams, 47 of the 48 participants completed the individual quiz. The range was 5-10, the average was 7.85, and the standard deviation was 1.54. Over 76% scored above a seven, and about 30% scored nine or higher on this quiz. These results indicate that students could recall 50% or more of the key concepts from the Restorative Leadership videos. Of the 48 students required to complete the training, 47 students participated in all or most of the activities, 23 were required to submit a certificate of completion as part of the module requirements (honor's college course). This certificate was only obtained after they completed quizzes built into the training. 19 of these 23 submitted a certificate. In the business honor's course, 24 of the 25 who participated earned the certificate. To receive a certificate, participants had to score higher than 80%.

Research questions 2-4 were specific to the competitive teams because they addressed the influence of the gamified team strategy, a leaderboard/dashboard, on participants' performance and preparedness both individually and as a team. Quantitatively this was to be assessed by the mock trial restorative checklists and an anonymous mixed-methods Qualtrics survey. These Quantitative results were to be augmented with two focus groups, one with each team. However, only ten mock trial members completed the survey, four Gold Team and six Green Team members. Because this was anonymous, it is also possible that some of these participants also participated in the focus groups.

Research Questions 2. *How did the use of the gamified team strategy impact participants' individual performance*? This question was specific to the competitive teams to see how the gamified strategy impacted their individual performances. Though there were only ten members, the results showed that 90% paid some attention to the dashboard (yes, somewhat, no), and only one member did not Mean = 4.70, *SD* = .64. On a 5-point scale (strongly agree to strongly disagree), 70% of the participants felt that the dashboard somewhat too strongly influenced their individual performance, Mean = 2.30, *SD* = .78. When exploring how the dashboard influenced their individual preparedness, the participants reported the dashboard somewhat to strongly influenced their preparedness, Mean = 2.20, *SD* = .76.

Research Question 3. *How did the use of the gamified team strategy impact team performance?* This question was specific to the competitive teams to see how the gamified strategy impacted their team's performances**.** When asked to assess the influence of the leaderboard on team performance, there was more of a divide. 40% somewhat agreed, 20% remained neutral, and 40% somewhat disagreed, Mean = 3.00, *SD* = .89. The results for how the leaderboard influenced the team's preparedness were varied, 40% strongly or somewhat agreed, where 40% somewhat or strongly disagreed again 20% remained neutral, Mean = 3.00, *SD* = 1.18.

Research Question 4. *How did the use of gamified team strategy influence participants' preparedness for class?* This question was specific to the competitive teams to see how the gamified strategy impacted their individual preparedness for class. When exploring how the dashboard influenced their individual preparedness, the participants reported the dashboard somewhat to strongly influenced their preparedness, Mean = 2.20, *SD* = .76.

Research Question 5. *How did the dual assessments impact participants' performance?* This question was to assess participants perceptions and use of the restorative leadership checklists. At least 38 participants responded to portions of both checklists. The responses were not identical for both the self-assessment checklist and the observer checklist. Of the 38 participants who completed the self-assessment checklist, 37, or over 97%, stated they understood what was being asked of them, 20, and understood their response options, 17. For the observer checklist, 21 of the participants, just over 55%, said they understood what they were being asked, 15, over 39% said they understood their response options, one participant, 2.6%, said they did not know what they were being asked. One participant marked other, 2.6%. When examining the checklists, there is a difference between the self-assessments and the observation checklists. See Figure 2 for a comparison between two checklists.

Qualitative Results for Research Question 5. The decision not to run any statistical tests was made because of the qualitative feedback from the mixed methods Qualtrics survey. A common theme that emerged from participants regarding the self-assessment was changing the formatting, reordering the questions, putting an N/A option, or including open-ended questions. However, just as many responses stated that no changes were needed, it was clear and concise. When asked what reason participants would recommend, or not, recommend the self-assessment for assessing leadership skills, the predominant theme was that participants would recommend this assessment because it helped participants reflect on their actions, "I would recommend the self-assessment because it allows one to reflect and become aware of one's past actions in order to make improvements."

Another theme that emerged was how this tool provided a way for participants to be a better leader, as noted by the following two quotes. “I think the self-assessment overall is a good tool because not only does it remind you of the leadership skills, but it also provides a checklist of actions that you can evaluate yourself on and maybe encourage you to do better in the future." And “I would recommend simply because I have learned so much from it of how to be a better leader, get out of my comfort zone when it came to talking about personal problems from the past, and just be more supportive others throughout this process.”

The Observer Checklist had contradictory themes and seemed to cause participants confusion. Based on responses, it appeared that instructions were not clear on how to use the Observer Checklist. Participants were not sure if they were to focus on each individual in the role play or the overall efforts or objectives of the exercise. Some participants felt that the identified skills did not go with the activity they were observing, “I felt like some of the questions did not apply to the situation, so I was confused on how to respond. Also, clearer instructions would have helped to know how to answer the question." Of the 21 responses to what participants would change, 13 stated "NA," which indicated that they had read the question and had no comments about changes. One participant recommended that we have a comments section about what observers enjoyed about the activity they were observing.

When the participants were asked if they would or would not recommend the Observers’ Checklist, like the self-assessment, the common theme was yes. Participants felt that this assessment enabled them to “properly” assess the players in the role play. Others found it to be helpful in a social learning context, “I would recommend this survey because by reflecting on what others did well and what they could have improved upon, you can improve your own approach. You may see some similarities between yourself and others and decide that didn't work out for them, so I'm not going to do it either." Of the 21 responses, two participants stated "NA," again indicating they had read the question, one person said, “I did not use it but they people on my team that did helped us see what we did not,” and one person said they were not sure if they would recommend it because they feel an open-ended assessment would be more “valuable way of reflecting.”

Figure 2

Noncompetitive Team Restorative Leadership Checklists Comparisons

Restorative Leadership Skill		0 Fails to practice	2 Attempts/ Fails	4 Attempts/ Occasional Succeeds	6 Usually Practices/But Occasionally Stops	8 Practices Skill and Encourages Others To
Invite others to participate	Self			3	18	20
	Observer		1	2	10	24
Affirm others	Self		1	4	12	24
	Observer			5	14	18
Respectfully listened to other’s	Self			1	11	39
	Observer			2	7	28
Encouraged others	Self		2	7	17	15
	Observer		1	3	14	19
No gloat when I win	Self	1		5	9	26
	Observer			3	8	26
Recognize others’ efforts	Self		1	3	16	21
	Observer			2	7	23
Provided others with support	Self		2	6	13	20
	Observer			7	11	19
Demonstrated courage by not giving up	Self	1		6	15	19
	Observer			3	14	20
Summarized others' point of view	Self	1	3	5	15	17
	Observer		1	6	11	19
Restored relationship after conflict	Self		4	4	14	19
	Observer		3	6	11	17
Used "yes and" statements in my responses	Self		3	10	6	16
	Observer		2	12	10	13
Critically assessed the weaknesses of arguments	Self		1	8	15	17
	Observer			8	15	13
Critically assessed the strengths of arguments	Self		2	3	20	16
	Observer	1		4	12	20
Critiqued authority	Self		2	12	15	11
	Observer	1	2	5	16	13

Note. The cells are split for ease of comparisons between self-assessments on the Restorative Leadership skills and observers' assessments of applied Restorative Leadership skills during roleplays. The number reflects the number of participants that marked those specific ratings.

Qualitative Results, Focus Groups. Though a focus group for the noncompetitive team did not occur, the individual interview supported the theme of confusion regarding instructions. The participant did make it clear that she enjoyed learning about Restorative Leadership. However, when asked if her team was using restorative skills, she stated that the team was not using them in their interactions. Then later, she stated that the restorative leadership training was helping the team understand the different ways they communicated.

A major issue was discovered too late in the study. The program director and coach of the Green Team did not administer the Mock Trial Restorative Checklists as the teams' dual assessments. He created his own assessment. Based on the low number of participants and the feedback from the focus groups, these assessments were found to be confusing as time went on during the semester, and members from each focus group stated that they were confusing and did not help performance or preparation. The following two quotes exemplify what was reported in both the survey and the focus groups: “I don't think that I saw any changes after the implementation of the assessments. I think most of the team side as a chore and they were confused 90% of the time that they were filling it out, and the only feedback I could give reach out to the Professor [blank]or try your best because,” and “I don't know if they necessarily help because, like a lot of us just ended up working with people that we already kind of knew how they worked in a sense, and so like. It was definitely a….. I guess a little weird like kind of going in and like sometimes I felt like seeing the assessment question did like apply, but also didn't apply and so.”

These quantitative findings are supported by what was discussed in both focus groups. The results were mixed. However, there was a definite difference between the Gold Team and Green Team themes. The Gold Team's introduction to the leaderboard caused the team confusion, but they also felt it was mismanaged and not transparent. It caused them to focus on their individual performance at the cost of team cohesion. Two participants stated, "I was worried that they would then come in and take a spot, and then they would take away the team chemistry and it wouldn't work as well, and not - not even mentioned the fact they would also have to learn the material and a much more quick rate and may not be able to catch up as fast.” And, “You know, but instead we were kind of focused on kind of our own individual things that we had to do so that we could just get on the team to begin with, with you know what felt like kind of an arbitrary leaderboard system. So, it definitely kind of forced us to working on our own when we should have been working together.” The Gold Team’s coach’s comments also indicated this dual result, “the gamification piece was helpful in the in the way that it incentivizes them to work harder. And it pushed them it basically gave them a reason to kind of go further than what they go beyond what they use what.”

When asked what surprised the Gold Team participants the most, one of the focus group participants stated, “What surprised me most was how much better prepared, we were this year for the competition, we were last year um it was it seemed like we were much more. We had a much better grasp of the material; we knew what we were doing a lot more.” Overall, the themes for both the assistant coach and Gold Team members reflect how the leaderboard did impact their individual performance and helped their preparedness. However, initially, it was at the cost of the team cohesion, or what this focus group called team "dynamics."

On the other hand, the Green Team felt that the leaderboard helped provide them feedback on their performance and what they needed to earn points and be better prepared. They also mentioned how Canvas impacted their preparation. This latter theme was labeled under "other" in the Tools to Impact Performance theme. This is because a key difference between the Gold and Green teams' is that the Gold Team is voluntary, and the Green Team comes from a mock trial course that students are getting course credit for.

The results from both the quantitative portion of this study and the qualitative indicate that the Restorative Leadership training helped help participants recall and apply restorative skills during their quizzes for the certificate and the 10-question quiz given in the class as part of their Restorative Leadership Module. In addition to the quizzes, the mixed methods survey regarding the checklists overwhelmingly said these checklists helped evaluate and apply their skills, despite some confusion regarding labeling of skills and instructions for the observer checklists.
The quantitative and the qualitative data indicate that the leaderboard did influence both performance and preparedness, individually more than the team. It appears that the Green Team benefited positively from having the leaderboard, both as feedback on their performance and as guidance on what to do. For the Gold Team, they felt that the leaderboard harmed their team dynamics initially. As time went on, they felt that it could be a good tool, with more transparency and better management. See Figure 3 for a summary of the outcomes for the research questions.

Figure 3
Research Question-by-Outcome Joint Display

Research Question	**Quantitative Outcome**	**Qualitative Outcome**	**Differences/ Similarity**	**Integrated Statement**
RQ 1 & 5	The numbers seem to support that the training did help the noncompetitive participants apply the restorative leadership skills, as seen with the quiz results, the certificate completion, and the	The qualitative data supports that the checklists help participants recognize and engage in restorative leadership skills. However, there were possible formatting issues on the self-assessment, and the directions and identified skills were confusing on the observation checklist. The majority of the	The differences were that though the checklists and quiz questions may have caused some confusion, participants still felt the checklists helped with applying the Restorative Leadership Skills. The quiz results indicate that the participants understood the	There results from both the quantitative portion of this study and the qualitative indicate that the Restorative Leadership training was supportive in helping participants apply restorative skills. The results, especially the qualitative, indicate a need to address the instructions for the checklists, specifically the Observers Checklist,

	checklist results.	responses recommended no changes or recommended both checklists.	main concepts from the videos.	and how to use the checklists during activities. These results also indicate a need to revise the Observers Checklist for clarity and ensure that these identify skills are observable and measurable.
RQ 2, 3, & 4	The results are mixed on whether the leaderboard impacted individual and team performance and preparedness. It appears that the leaderboard had more influence on individual performance and preparedness than on team performance and preparedness.	Participants' comments in the focus groups, the coach's interview, and the open-ended survey questions also support the mixed results. The main themes here were that participants felt others did not pay attention to the leaderboard, or they only paid some attention to it. While others said it did impact them individually, however many reported as a team, and they felt it did not impact them. Nevertheless, at least one participant said it did help knowing team status as well as individual.	The focus groups had the biggest differences. It was clear that the Gold Team felt that the leaderboard could be effective if it were managed well and how points were earned was more transparent. However, they felt that other things could determine a successful team, such as observing the dynamics of individuals and just plain time and practice, as echoed by the coach. For the Green Team, overall, they found the leaderboard helpful and the points motivation. They also mentioned other factors in their	Based on the overall results, it is clear that there is a need to be clearer on the purpose of the leaderboard, better management and that the leaderboard alone does not help with team preparedness or performance but appears to impact individual preparedness and performance more. There appear to be two emergent themes that should be examined further, the role of motivation and experience on performance and preparedness.

			preparedness, such as Canvas and having the materials to prepare from.	
Emerging themes or ideas for continued research	Use a motivation skill Evaluate experience level with mock trial Be sure to have competitive teams use the checklist Be sure to have trained observers use checklists for both competitive and noncompetitive teams	Address self-assessment about motivation. Run focus groups for noncompetitive teams Determine if identified themes should be used as a priori themes for the next study	NA	It would be good to revise the observer checklist and continue to test both of the checklists as assessments. See how best to begin collecting data for inferential statistics.

4. Discussion. Several issues emerged when recruiting participants for the focus groups, for both the competitive teams and noncompetitive teams. It was clear that the primary researcher needed to be the one who sent all communications to the participants, such as making the requests to participate in the focus groups, completing the Restorative Leadership Checklist assessments, having the Gold Team review the Restorative Leadership instructional videos, and ensuring that the competitive team participants received invites and follow-ups to complete the Qualtrics survey. By not having the primary researcher in charge of the above processes, valuable input was lost from having neutral outside observers use these checklists to evaluate the competitive teams' mock trial skirmishes or competition. This insight would have given the study more data about how to revise the Restorative Leadership Checklists for clarity as well as helping determine how the current revised checklists' reliability and dependability were viewed by an individual who is unbiased and knowledgeable about mock trial processes.

Three interesting themes emerged during the focus groups: the role of motivation, experience vs. nonexperience, and how the Gold Team felt that the dashboard did little to improve the Green Team's performance as the semester wore on. The program director has begun redesigning the team so that motivation and experience levels might be offset because a mock trial class will no longer be offered. He is determining what the prerequisites will be for joining the mock trial team. He is determined to keep the leaderboard, and hopefully, the results from this study will help him create more clear guidelines and management with the leaderboard.

The significance of this study is that once these instruments prove to be valid and reliable in settings beyond a mock trial course, they can be used to help train a workforce in Restorative Leadership and ensure that employees are transferring the skills to their workplace. The results of this study are promising about the possibility of interdisciplinary application of the Restorative Leadership instructional videos, Restorative Leadership application exercises, the Restorative Leadership checklists as assessments of applied skills, and does warrant more in-depth studying.

4. Limitations and Future Directions

There were many limitations to this study. One major limitation was that convenience sampling was used, which meant that one of the noncompetitive teams was co-taught by the primary researcher, the program director from the mock trial team, and another professor. This could have produced response bias, researcher bias, and some threats to internal validity, such as timing or maturation. Not only is this study subject to these biases and threats, but the sampling process, which was a combination of convenience and purposive, also makes generalizing our results difficult. Because there were unplanned changes to the design that impacted research questions one and five, not to mention the low number of participants for research questions two, three, and four.

These limitations, however, guide numerous directions for future research. After revising the observer checklist, it will be good to test the instructions and ensure that the identified skills are observable. Next, the videos should be evaluated using Kirkpatrick's four levels of evaluation (Kirkpatrick, 2006). The researcher will want to evaluate the reaction and learning levels. A mixed-methods survey could help assess if and how the videos helped apply restorative leadership skills. Finally, another area to explore more is how participants are motivated and how they view either the leaderboard and/or the Restorative Leadership training.4. Significance of Research

The significance of this study is that once these instruments prove to be valid and reliable in settings beyond a mock trial course, they can be used to help train a workforce in Restorative Leadership and ensure that employees are transferring the skills to their workplace. The results of this study are promising about the possibility of interdisciplinary application of the Restorative Leadership instructional videos, Restorative Leadership application exercises, the Restorative Leadership checklists as assessments of applied skills, and does warrant more in-depth studying.

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How Department Culture Influences Innovation in Online Teaching for "Pandemic Laggards"

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Introduction

Institutions of Higher Education (IHEs) are focusing on online programs as a way to innovate (Magda & Buban, 2018), but faculty buy-in is a major barrier (Walker et al., 2018). Due to the COVID-19 pandemic in Spring 2020, many higher education faculty were forced to teach online for the first time (Means & Neisler, 2020). Rogers' (2003) Diffusion of Innovations (DOI) theory suggests that the adoption of an innovation, such as online teaching, takes place over time, and the last group to adopt are known as laggards. They adopt an innovation often when there is no other choice. In this study, the term "pandemic laggards" will be used to describe faculty who started online teaching due to the pandemic.

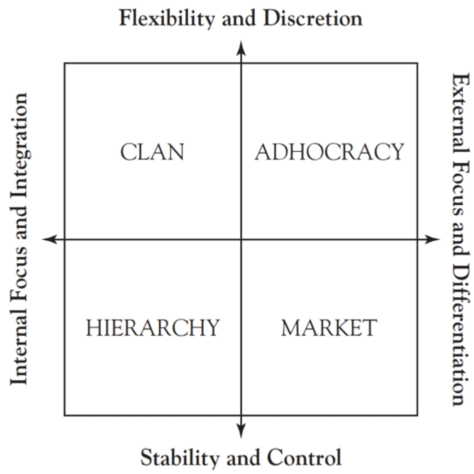
Individuals undergo a process in deciding to adopt (or not adopt) an innovation, which is influenced by multiple factors (Rogers, 2003). However, two factors are particularly relevant to this study. The first, "re-invention" is changing or modifying an innovation in the process of implementing it (Rogers, 2003). Higher degrees of reinvention tend to speed adoption and lead to longer use (Rogers, 2003). The second factor is organizational culture (OC) or the "system of beliefs, values, and behavioral norms that come to be taken for granted" (Schein & Schein, 2016, p. 6). With regard to technology use, aspects of OC have been shown to be influential among faculty (Boichuk & Fast, 2017; Reid, 2017) and in implementing online (Zhu, 2015; Zhu & Engels, 2014) and blended learning (Porter & Graham, 2016).

The pandemic provided an opportunity to explore the relationship between OC and online teaching adoption among a unique group of faculty adopters. The purpose of this sequential explanatory mixed methods study was to explore how pandemic laggards' willingness to adopt new online teaching strategies were related to their views of their departmental culture.

Conceptual Framework

The conceptual framework for this study combined Rogers' (2003) DOI to categorize faculty adopters, and Cameron and Quinn's (2006) Competing Values Framework (CVF) to describe OC. The CVF and its diagnostic component, the Organizational Culture Assessment Instrument (OCAI), was designed to capture participants' views of their current and desired culture into one of four culture orientations (Figure 1): clan, adhocracy, market and hierarchy (Cameron & Quinn, 2006). The OCAI is organized in six dimensions: Dominant Characteristics, Organizational Leadership, Management of Employees, Organizational Glue, Strategic Emphases and Criteria for Success.

Figure 1
Competing Values Framework



Note. Reprinted from *Diagnosing and Changing Organizational Culture* (p. 35), by K. Cameron and R. Quinn, 2006. Jossey-Bass. 2006 by John Wiley & Sons, Inc.

Clan organizations engender loyalty through shared values, consensus decision making, and practices that empower employees (Cameron & Quinn, 2006). Hierarchy organizations foster stability and efficiency and value clear lines of leadership, standardization of processes, and employee accountability (Cameron & Quinn, 2006). Organizations with a Market culture focus on the external environment, with the constant goal of gaining a competitive advantage (Cameron & Quinn, 2006). Adhocracy organizations have a decentralized structure that values individuality, experimentation and future-oriented thinking (Cameron & Quinn, 2006).

Context & Design

This study took place in Spring 2021 at a flagship campus of a large public research university, which typically offers approximately 500 courses via distance education per semester. In Spring 2020 prior to the pandemic, about 15% of courses were taught via distance. In Fall 2020, 81.6% of courses were taught online, 12.9% were hybrid (combination of in-person and online) and just 5.5% were face-to-face (Bruno, 2020).

Email surveys were sent in February 2021 to faculty who taught online that semester (n=1281), which asked about participants' online teaching background and departmental culture based on the OCAI. Of the 184 usable responses, 61% of faculty (n=113) reported being new to teaching online due to the pandemic.

Additional data were collected via seven follow-up interviews with selected survey respondents who identified themselves as new to teaching online due to the pandemic, and who characterized their department with varying OC orientations. Interviews were analyzed using thematic coding (Ary et al., 2019) to obtain codes, categories, and final themes.

Results

Quantitative

The quantitative portion of this study sought to answer, what is the relationship between pandemic laggards' current and desired OC and their plan to teach online once the pandemic is over?

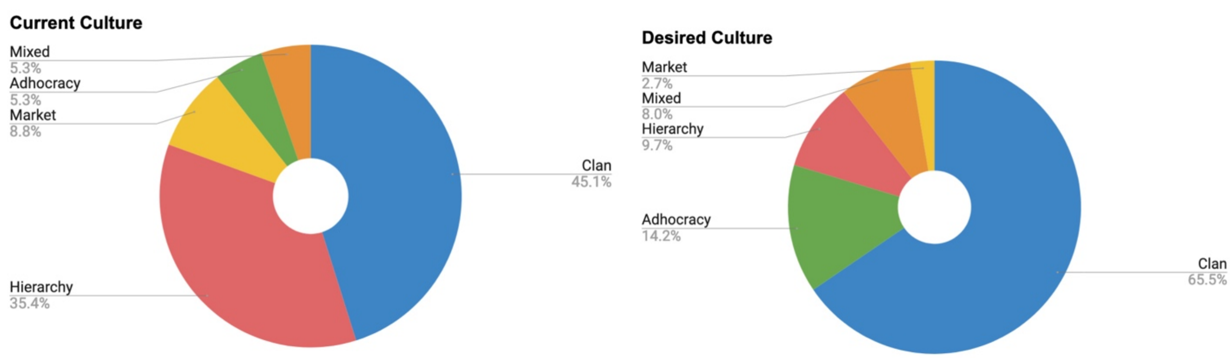
Current & Desired Cultures

Of the 113 self-identified pandemic laggards, 45% (n=51) described their current departmental culture as a Clan type, 35% (n=40) as Hierarchy, 9% (n=10) as Market type and 5% (n=6) as an Adhocracy. In addition, 5% (n=6) described their culture as a mixture of multiple types with four of those describing their OC as a mixture of Clan and Hierarchy.

As for participants' desired culture, 66% (n=74) desired a Clan culture, 14% (n=16) an Adhocracy, 10% (n=11) a hierarchy, and 3% (n=3) a market culture (Figure 2). Seven percent (n=9) desired a mixed culture, with eight preferring a mixture that included the clan culture and six including the hierarchy culture.

Figure 2

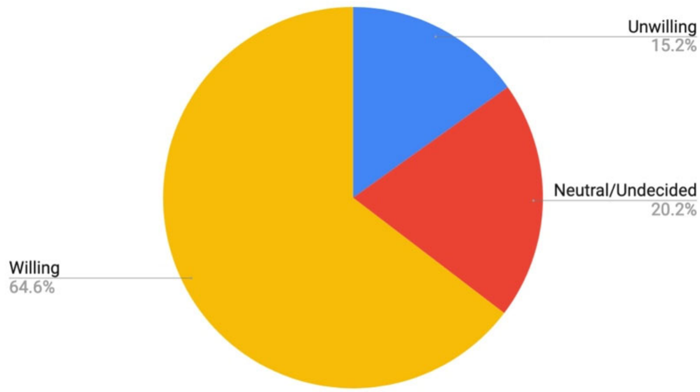
Pandemic Laggards' Current and Desired Cultures



Post-pandemic teaching plans

Of the 104 participants who responded to this question, sixty-two percent were willing to teach online after the pandemic was over (n=64), while 19% (n=20) were undecided or neutral, and 19% (n=20) were unwilling to teach online (Figure 3).

Figure 3
Plans to teach online post-pandemic



No significant relationships were found between participants' current and desired cultures and their plans to teach online post-pandemic. A chi-square test found no significant association between current culture and pandemic online teaching plans X^2 (8, N = 104) = 9.91, p = .271 ando no significant association between desired culture and pandemic online teaching plans X^2 (8, N = 104) = 8.80, p = .360.

Qualitative

The qualitative portion of this study explored how pandemic laggards described the influence their OC had on their willingness to adopt new online teaching strategies and their plans to teach online after the pandemic. Pseudonyms are used for interviewees.

Willingness to adopt new online teaching strategies

There were generally two levels of faculty willingness to adopt new online teaching strategies, 1) transformational and 2) minor modifications. Four interviewees made transformational changes, taking advantage of a number of online tools and/or strategies. Examples of these changes include opting for an asynchronous delivery mode, and creating an online set of modules to accompany a course. Three interviewees only made minor modifications, delivering their courses largely lecture-based using web conferencing tools such as Zoom. These faculty made only minor modifications to how they teach in person. The OCAI's six dimensions were used to organize the emergent themes.

Dominant Characteristics. Dominant characteristics describe the overall characteristics of an organization's culture. The interviewees described their department cultures in different ways, see Table 1. One important theme that emerged was individualistic, as the faculty interviewed were primarily from departments in which collaboration around teaching and research was not the norm. Participants were split when describing their departments with three describing their department's culture in mostly positive terms, and four describing their culture in critical terms or as less than ideal. For the three who were generally positive, they used terms like collegial, supportive and personal. Two out of three were from clan cultures, and all three chose clan as their desired culture. For the four who were critical, they used terms like inefficient, dysfunctional or transitional, and three out of four desired cultures that were different from their current culture.

Table 1
Interviewees' cultures

Interviewee	Positive or Critical	Current Culture	Desired Culture	Descriptors of Culture
Beau	Positive	Hierarchy	Clan	Individual with shared decision making
Nathan	Positive	Clan	Clan	Performance focus, mixed personal connection
Cory	Positive	Clan	Clan	Collegial and supportive
Patricia	Critical	Market	Clan	Supportive leadership, but stressful due to many changes
Fiona	Critical	Hierarchy	Adhocracy	Dysfunctional, conflicting personalities and values
Ethan	Critical	Clan	Adhocracy	Inefficient, Culture of Poverty
Martin	Critical	Hierarchy	Hierarchy	Highly individual, divided by personal agendas

Leadership Style. Leadership style is the approach to leadership within the department. In this area, two themes emerged. The first theme was that of responsive leadership, particularly in regard to instructional issues. Examples of positive or responsive leadership included providing teaching and learning assistants to help faculty with the increased workload, advocating to unit or campus-level administration about instructional needs, emotional support when faculty came to them with issues, and providing online teaching resources such as training or materials. Examples of negative leadership included being too closely aligned with administration-level politics or being too focused on short-term financial gain versus capacity building, both seen as detrimental to an increase in online teaching with one interviewee stating, "Well, I mean given that there's really... a culture of not having any extra resources or ability or investment in pedagogy, that doesn't really make me want to try out a lot of stuff."

Another theme that emerged was faculty autonomy. Most interviewees described their department's leadership as fairly hands off in terms of how faculty taught their courses. According to a number of interviewees, a high degree of faculty autonomy contributed to their willingness to try new online teaching strategies, as they felt free to make changes according to their preferences or student needs. One interviewee mentioned that prior to the pandemic her course enrollments were closely scrutinized and her courses often closed due to low student numbers. During the pandemic, she noticed less oversight, which contributed to her feeling more freedom to implement new online teaching strategies. Some interviewees mentioned that because of a high degree of autonomy, they did not think culture impacted their willingness to adopt new online teaching strategies.

Management of Faculty and Staff. This dimension encompasses how employees are treated and looks at the working environment. In this dimension, two themes emerged. The first is efficient administrative support. Several interviewees expressed being stretched thin during the pandemic, impacted by both a pandemic hiring freeze and increased demands of pivoting to online learning. One faculty member mentioned that it took weeks to handle simple purchasing with grant funds, inefficiencies that took up time that could have been spent on teaching practices.

The second theme was targeted instructional support. Several interviewees mentioned utilizing campus or unit-level support in their transition to online teaching. However, existing services did not meet all interviewees' needs. One interviewee desired personal support saying, "I didn't have the time or the energy to explore all the technical possibilities and exchange five letters with ITS [campus IT services]. If there was somebody here... it would help." In addition, there were particular issues faced by interviewees who taught large classes, such as giving exams, grading and preventing cheating. Two interviewees mentioned the importance of discipline-specific online teaching support. Beyond technical or instructional support, two interviewees mentioned other practical needs. One lacked a proper space at home to conduct Zoom sessions, and another interviewee was not able to be reimbursed for teaching software due to campus rules on reimbursements.

Organizational Glue. Organizational glue is what bonds an organization together. In this area, three themes emerged. The first was students, as stated by one interviewee, "Organizational glue that binds our department together, really that's our students because everyone cares about our students quite a lot." All interviewees talked about how students' feedback and course outcomes influenced their practices.

The second theme was peer support. Two interviewees spoke about influential peers in their departments who served as a hub for online teaching and resources or helped other faculty. Another interviewee shared that she herself provided peer support, giving demos on using Zoom and sharing with her colleagues a list of online teaching resources she had collected. She desired for peer support to become an established norm, stating, "I think, ideally, it would be nice...if we need something from each other, I feel comfortable picking up the phone or shooting you an email, you should feel the same way."

The third theme was collaboration. As mentioned, the interviewees primarily came from individualistic departments, but faculty described ways collaboration could influence their online teaching practices. Several interviewees pointed out that they felt more disconnected from fellow faculty due to social distancing. Co-teaching was a potential form of collaboration mentioned with excitement by one interviewee who stated, "That could work if we have somebody that's taught the course once and then they're bringing on additional people to help bring them up to speed using tools, but then also to bring in new ideas." Collaboration also had the potential to negatively impact efficiency according to one interviewee who stated, "It makes no sense to coordinate with anybody else, that's only extra work in terms of the teaching."

Strategic Emphasis. Strategic emphases are areas of emphasis that direct the department's strategy. In this area, one major theme emerged, the alignment to shared values and goals. One important shared value among all of the interviewees was student success. Other shared values and goals discussed were that of staying accredited, serving students in a culturally appropriate manner, reaching underserved communities and raising funds. Some interviewees discussed that an important shared value was to do what is best for the group or department over the individual. One interviewee mentioned that during the pandemic, he had been willing to take on additional class sections to benefit the department.

Criteria of Success. Criteria of success is how success is defined and what gets rewarded and celebrated in the department. Two themes emerged in this area. The first was research, and the fact that it often is considered more important than teaching in faculty evaluation processes. Research was also discussed in terms of the amount of time it takes to apply for grants, publish in journals and supervise graduate students.

The next theme was departmental survival. Some interviewees described their departments as struggling due to financial strains or external pressures. In light of these issues, anything that promoted departmental survival was to be celebrated. One interviewee said, "Definitely student retention gets rewarded, and really anything positive that can put a positive light on our department."

Post-pandemic plans to teach online

Regarding plans to teach online post-pandemic, there were two main themes.

Face-to-face is primary. First was that face-to-face teaching should remain the primary delivery mode, but could include online elements. All interviewees wanted to move back to face-to-face teaching, however, six out of seven wanted to retain some online elements. Interviewees felt their asynchronous teaching materials such as online learning modules and discussion boards offered greater efficiency and could be reused in their courses post-pandemic. Three interviewees mentioned wanting to teach in the future using hybrid delivery methods, with a mixture of online and face-to-face sessions, or "Here-or-there" sessions in which students have the option to attend face-to-face or online. Two interviewees were strongly considering keeping some of their courses online, despite wanting to move back to face-to-face delivery. Having gone through the experience of teaching online due to a crisis, all faculty expressed willingness to teach online again if absolutely necessary.

While there was openness to hybrid online delivery among the faculty, most of the departments represented in this study did not have plans in place to offer new online courses or programs long term. One interviewee shared that his department was open to online courses and programs as a way to support more students, but the department needed help with developing guidelines, expectations and procedures. One interviewee shared that once his department decided to move to all online classes, faculty worked independently thereafter and never reconvened to discuss strategies or outcomes.

Lessons learned. The second theme was lessons learned. Some of the interviewees were surprised by the effectiveness of online teaching. One interviewee remarked that in his asynchronous class discussions, he saw a greater depth of discussion than in any of his classes prior. Another interviewee experienced remarkable improvement in her students using the flipped classroom model, "My students are speaking, they're speaking the target language, like it's phenomenal...I have not seen this kind of progress."

Many of these "pandemic laggards" were also feeling more confident in their online teaching. One interviewee described it this way, "...having spent the time learning more about this in a crisis situation, you know, now I know a lot more...I could apply that in a much more intentional way." Interviewees described multiple strategies they had used to address online teaching obstacles. For example, one interviewee shared that to address challenges of time management and increased enrollments, he implemented a series of short papers throughout the semester as opposed to one large term paper he previously assigned. Others focused on student differentiation strategies that could be employed online to address differing student needs, for example, employing Universal Design for Learning principles. Faculty also learned overall lessons about teaching that can apply in all situations. One interviewee described it this way, "...I've again, taught for 15 years, and I've learned more about teaching in this past year, then maybe most of the years prior."

Discussion

This study explored pandemic laggards' adoption of online teaching at one institution through the lens of OC. The majority of respondents described their departments as a clan culture and many also preferred this culture. This is consistent with findings from other higher education institutions (Obendhain & Johnson, 2004) which also tended toward clan culture. Perception of culture (culture orientations) did not have a statistically significant relationship to willingness to teach online post-pandemic. Due to social distancing related to COVID-19, faculty expressed feeling more disconnected from their peers and not aware of what each other were doing. Because OC is a shared phenomenon (Groysberg et al., 2018), it may have had less influence due to the effects of the pandemic.

Among the seven interviewees' culture orientations, there did not appear to be a clear relationship between current and desired cultures and levels of re-invention or modification of courses. Two interviewees believed their culture did not influence their online teaching practices due to the autonomy faculty have in their departments. This may suggest that in terms of online teaching adoption in higher education, that individual differences are more influential than departmental culture. This would align with the finding that individual innovativeness, or the desire to try new things, has been shown to be related to acceptance of instructional technology (Akgün, 2017). Some transformational faculty, those who made major modifications to their courses, were indeed more willing to try new things in terms of their teaching. Another individual difference possibly influencing the results is help seeking, particularly the willingness to engage in professional development activities such as training or peer support. Daumiller et al. (2021) found that faculty who were motivated by gaining personal competence, had a more positive attitude to the shift to pandemic-related online teaching.

The qualitative data, however, showed that aspects of culture also influenced willingness to adopt new online teaching strategies and willingness to teach online post-pandemic. While faculty were typically autonomous in how and what they taught, there were cultural factors of departments that influenced their teaching practices. Faculty were extremely busy during the pandemic (Giovannella & Passarelli, 2020), and factors that promoted efficiencies such as responsive leadership, and administrative, technical and peer support had an impact. Faculty also cared deeply about their students' success and were willing to integrate new strategies that supported student success. Because a primary evaluation criteria for many of the faculty in this study was research, the time and resources they were able to devote to teaching was limited. These findings highlight a critical discrepancy between faculty evaluation criteria and institutional goals to grow online offerings and support instructional approaches that increase student success. Reid (2014) also identified rewards and incentives as a barrier to faculty adoption of instructional technologies. Addressing this discrepancy may be key to long term adoption of online teaching. Faculty are often willing to start new initiatives, but IHEs cannot sustain the effort without aligning the desired activity to reward systems (Farmer, 1999).

Hodges et. al, (2020) assert that in Spring 2020 when the pandemic began, faculty were engaged in "emergency remote teaching," characterized by less time for planning and quality assurance, and teaching with a one-size-fits-all approach. Means and Neisler (2020) projected by Fall 2020, with the proper supports in place, faculty would move toward optimal online teaching, which is characterized by effective planning, use of a developed instructional design process, integration of community and engagement, more time and support for quality assurance, and ensuring equity and personalization. This study found that some faculty new to teaching online have begun to make the transition to optimal online teaching. While many felt stressed during the onset of the pandemic, several have integrated community, engagement and personalization and look forward to more time for planning. Continuous innovation, or the process of re-invention (Rogers, 2003), did in fact take place for nearly all faculty in this study. Faculty made various levels of modifications in their online courses in response to student needs, and many learned valuable lessons through the process.

While nearly all interviewees wanted to keep teaching online or use elements of online delivery, they were excited to go back to face-to-face teaching. Faculty in a 2019 study expressed similar preferences, with only 9% preferring fully online teaching, and 51% favoring hybrid approaches (Galanek & Gierdowski, 2019). Now that many more faculty have been forced to teach online, these numbers are likely higher. Trialability, or the ability to try a new innovation, is a factor that impacts the rate of adoption (Rogers, 2003).

It is important to note that all the interviewees were willing to teach online if needed, although it was not their preferred mode. The pandemic appears to have taught faculty that despite previous experience, they are capable of teaching online, and could do it again. Because of the experience of teaching online in response to a crisis, faculty appear to feel a sense of duty toward teaching online. This could be a fruitful area of future research. IHEs may experience more faculty buy-in if online teaching supported growth or survival, such as raising funding or increasing student access. Another potential area of future research could focus on the impact of departmental culture on the offering of online programs, versus faculty's individual adoption of online teaching. Interviewees mentioned that within their departments online programs had been discussed but not implemented due in part to cultural influences such as conflicting values between administrators and faculty. Students want to keep taking fully online and hybrid courses post-pandemic (McKenzie, 2021). Now that faculty are open to teaching online or hybrid, it behooves departments to design course offerings that align with student preferences.

Limitations

This study was conducted during the COVID-19 pandemic, therefore results may not be generalizable to other periods. While OC has been shown to have a positive relationship to technology-enhanced and online learning, factors outside of OC frameworks could influence the results (Zhu & Engels, 2014). Also limiting generalizability is that adoption research is often based on self-reporting and reliant on participants' memories (Rogers, 2003). In addition, because this research took place at one institution in a unique geographic and cultural context, results may not be transferable. The researcher is an employee at the institution under study and thus may also be prone to bias.

Conclusion

Higher education innovation experts assert that the lessons learned during the pandemic may lead long term to increased adoption, lowered costs and improvements in online teaching quality (Arum & Stevens, 2020). To take advantage of this transition, Fox et al., (2020) recommends IHEs, "use the momentum of this watershed moment to elevate your approach to online and hybrid instruction" (p. 4). This study has shown that faculty worked hard to transform their online instruction and look forward to making continuous improvements. It also revealed how aspects of OC, a key driver of innovation, can support this process now and into the future.

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Culturally and situationally-appropriate professional development design for principals of ethnic elementary schools in Yunnan Province, PRC

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This paper is part of a set of three papers that together consider a complex learning design case emerging in the People's Republic of China. The physical setting for this endeavor is the province of Yunnan in southwestern China, a province of some 48 million persons (Yunnan Government, 2019). Yunnan has the largest and most diverse concentration of ethnic groups in the nation.

We have been engaged in determining a suitable learning design for culturally and situationally-appropriate professional development for principals of elementary schools in Yunnan Province – including incorporating attention to the needs of ethnic minority students. Professional development of these principals is undertaken by Yunnan Normal University – the higher education institution in the Province of Yunnan charged with the task of preparing future teachers and administrators for schools and also for their ongoing professional development. Sitting principals are or will be undergoing a systematic program of professional development in light of recent changes to compulsory education. This program will take about six years to complete across the entire cohort of eligible administrative participants. Our work is intended to influence the topics and approaches of some of this professional development for these practicing elementary principals as well as adaptations for the programs preparing future elementary school administrators and teachers.

A majority (the exact number is presently unknown) of the 10,688 elementary schools in Yunnan are small, rural, ethnic minority-majority schools with 100 or fewer pupils of varying ethnicities and ages (Yunnan Provincial Education Department, 2021). These schools are spread across a geographic area roughly the size of California, two-thirds of which is mountainous and the other third of which lies 1000 feet or more above sea level in high plains and river valleys. Principals of these schools face new and unprecedented challenges requiring rethinking approaches to professional development and support both for themselves and the teachers they lead (Dai and Cheek, 2021).

A New Cultural Analysis Framework

Due to a series of interlocking, complex issues that form the context in which professional development of elementary school principals in the province must occur, we have pioneered application of a new cultural analysis framework we have created tailored to this particular learning design challenge. The starting point for the framework was inspired by the work of the French *Annales* School of historiography in its attempts to write *histoire totale* – a term that suggests that understanding the human past and present requires tools, techniques, and perspectives that go well beyond the usual historical considerations of people, places, and sociopolitical events placed within a fairly narrow compass of time. Our cultural analysis framework utilizes the following five key components we created inspired by the *Annales* approach: 1) geography & climate factors, 2) history & anthropology factors, 3) economy & society factors, 4) politics & education administration factors, and 5) management styles & learning factors (Dai and Cheek, in press). We believe, as this framework suggests, that the business of teaching and learning is always functioning within much wider contexts of politics, management, economics, society (both anthropologically and sociologically), climate, and geography. Some of these factors change rapidly, while others change quite slowly and almost imperceptibly within normal human perspectives. Yet all of these many factors influence what happens today and what will happen in future days.

Space considerations make it impossible to overview all of these cultural analysis components in this brief paper. Therefore, we have split the discussion of the factors across three papers with factors 1 and 2 discussed mainly in Dai and Cheek (in press), factors 3 and 4 discussed in Dai and Cheek (2021), and factors 4 and 5 discussed here – with factor 4 in this paper adding material not found in the prior papers. We anticipate writing a longer, more comprehensive article, combining substantial attention to all five factors of our cultural analysis framework at a future date when the whole picture is considerably clearer than it is at present.

One important component of our framework is politics and educational administration matters. Here we focus on national education law, the ways in which primary and secondary education is organized in China, and the implications these matters have for the many roles played by principals of elementary schools in Yunnan.

The Organization of Schools in China

China's public education system has been influenced by four factors: 1) ancient cultural heritage and learning traditions (especially Confucian thought), 2) leadership literature from the West, 3) school management theory and practices from the former Soviet Union, and 4) "leadership tenets and principles of the Communist Party of China" (Feng, 2020, p. 3) A four-tiered system of educational administration was enacted by the Education Law of the PRC originally promulgated in 1995 and whose structural features (detailed in Articles 14 and 15) were left unchanged in its 2009 and 2015 revisions. At the top is the national Ministry of Education (MOE) in Beijing. Below the MOE are the 31 Provincial Education Departments (PEDs), or sometimes called Commissions. Below them are the 334 Prefecture-Level-City Education Bureaus (PLCEDs). (A prefecture in China is an administrative unit containing several counties; the large cities within them have their own educational bureaus.) Finally, underneath them are the 2,850 County Education Bureaus or CEBs (Feng, 2020; cf. OECD, 2016).

The MOE sets all national education policies. The PEDs can establish provincial education policies for local variable conditions but they must be congruent with the national education laws and policies. The PLCEDs promote and supervise implementation of the provincial education policies. Finally, the CEBs handle the day-to-day operational aspects of local primary and lower secondary education. They have the most impact at local levels because they control the funds for the nine years of compulsory education and are also where the 253,736 or so primary and secondary schools get their support, supervision, and evaluation (Feng, 2020). It is important to note that these 250,000+ schools are not the only public schools in China. OECD (2016) reported about 514,000 schools below the university level across China including those in autonomous regions, special administrative regions, and those under other lines of authority within education; attendance in these schools, outside of the first nine years of schooling, are noncompulsory, i.e., the higher grade levels up through the end of high school or vocational school are not required under compulsory education law.

Schools throughout China have similar organizational structures which are standardized by national education law. Leadership within an individual school resides in four key sets of leaders: 1) the School Leadership Team (or School Affairs Committee) – comprised of the Principal (and VPs if applicable), the Party Secretary (and associate secretary if applicable), and the Chairperson of the School Trade Union; 2) Middle Managers are the Directors of the Office of Moral Education, Office for Curriculum and Instruction, and the Office for Scientific Research & Teacher Development as well as Ancillary Services; 3) Lower Managers are the Heads of Grade Units, Heads for Teaching-Study Groups, and Heads of Lesson Preparation Groups; and 4) the Communist Party at the School which is responsible for the work of the School Trade Union, Women's Federation, Communist Youth League (if a secondary school) or the Young Pioneers (if a primary school). Since 2016, the Party representative also leads the moral education of the school and works closely with the school's Director of the Office of Moral Education to ensure that the Party's views are consistently promoted to all people within the school community (Feng, 2020).

These various designated leadership roles are, of course, difficult to both fill and fulfill in small rural schools – a problem not unlike those faced by rural schools around the world (e.g., Kinkley, 2019, for US issues and examples). Too few people wearing too many hats for long periods of time can be a recipe for declining morale and professional burnout. Many supportive resources that are needed in these isolated rural settings are simply not available or if they are made available are difficult to access due to the inevitable constraints of time, technology, lack of knowledge or skills, or competing demands. Rural schools worldwide pose considerable challenges for those responsible for ensuring that education in these schools is consistently of good quality and accessible to all who need it (Kong, Hannum, and Postiglione, 2021). Similar to many other nations with large numbers of very diverse schools, Chinese education policymakers have innovated in a continuing manner to try to address the many challenges faced by school leaders. We now describe a number of recent innovations in approaches to educational administration within the schools of China.

The Principal Responsibility System

A new Principal Responsibility System (PRS) was initially created as part of the 1985 education reforms. For the first time, the principal was made responsible for school development planning. Given its complexities and the need to prepare principals for this extraordinary expansion in their responsibilities, the PRS was phased in over many years as part of a wider overall approach by the government to improve the nation's schools (Feng, 2020). The PRS is comprised of several pillars. First there is the local education authority (county or district education board) who supervises the principal. The principal is responsible for leadership of local schools, is the legal representative of the school, and under Article 30 of the Education Law is "held responsible for teaching and learning activities and administration" (Feng, 2020, p. 27). (It is for this reason that we are concentrating our efforts on elementary principals as instructional leaders.) Finally, the School Leadership Team chaired by the Principal, is responsible for a wide range of activities including various plans, appointments and removals, annual budget, plans for large expenditures, appraisal of staff, graduation and enrollment policies, major infrastructure projects, etc. A recent change in Party organization at the school level, instituted in 2016, now allows the Principal (if a Party member) to simultaneously hold the positions of both Principal and Party Secretary; a situation which makes the principal the "paramount leader in his/her school." While all of this may sound very "top down" to those unfamiliar with the education system of China, it needs to be noted that across a variety of measures, Chinese schools have been viewed as roughly equally autonomous as local publicly-administered schools in Germany, England, and France (Feng. 2018, 2020).

Since 2001, primary and secondary schools in many regions have successively established school-based management systems that combine government coordination, social participation, and independent school management. During this time period, the Ministry of Education sought to move all schools away from a knowledge transmission model of learning to increased attention on student problem solving, lifelong learning, cooperative learning, and making the curriculum more relevant for local situations and contexts. It also incentivized teachers to move and remain in poor rural areas through special teacher allowances and subsidies for both primary (elementary) and secondary teachers (Kong et al., 2021). These developments have prompted changes in the preparation of principals to be instructional leaders as reflected in both textbooks for aspiring school administrators in China as well as increased research on the roles and responsibilities of principals in serving as instructional leaders (e.g., Wu & Zhou, 2008; Chen, 2010; Walker et al., 2012; and Walker & Qian, 2020).

In order to increase accessibility to education, a key component of China's economic development policies, a 2006 revision of China's compulsory education law (part of Article 2) states that "no tuition of miscellaneous fee may be charged in the implementation of compulsory education." Article 6 further clarified that ". . . the State Council and the local people's governments at the county level and above shall reasonably allocate the educational resources, promote balanced development of compulsory education, improve the conditions of weak schools, take measures to ensure implementation of the compulsory education policy in rural areas and areas inhabited by ethnic minority groups, and guarantee that school-aged children and adolescents from families with financial difficulties and disabled school-aged children and adolescents receive compulsory education." Article 44 further required in the event of family financial inadequacies that ". . . the people's governments at all levels shall provide them with gratis textbooks and give living cost subsidies to boarding students" (Kong, et al.,2021, p. xix).

While these provisions now clearly establish the government's priorities, there are clearly still many barriers that must be overcome throughout the more rural areas of China and elsewhere. One continuing problem, for example, is that children who drop out of compulsory education generally are not pursued in any systematic and continuous manner by the educational system to return to school and to complete their studies (Wang, Y., 2014; Bilige & Fan, 2020). It is important to acknowledge that dropout problems are in no way unique to China but are a feature of educational systems worldwide (cf. OECD, 2021 for OECD countries and Irwin et al., 2021 for the US). As a consequence, many indicator systems (e.g., OECD) consider schools *fully* enrolled when only 90% or more of the eligible pupils are "enrolled."

Since 2001, Chinese primary and secondary schools have tried many largely ineffective changes in the process of encouraging further development of their schools and deepening their impacts. The main reason for these failures is the lack of systematic thinking among school leaders, especially school principals; e.g., they have faced an ever-increasing set of leadership responsibilities over the past three decades and they may lack ability to think conceptually about the many complex problems that now confront them (Liu, 2013). We suspect that there are a multitude of reasons beyond just the lack of systematic thinking among school leaders, especially in semi-isolated and geographically challenging areas of China such as Yunnan (cf. Wu, 2020).

Five years ago, in an attempt to deepen reforms and improve results of primary and secondary schooling across China, the Organization Department of the CCCPC and the Ministry of Education (2017) promulgated new provisional "measures for the management of leaders of primary and secondary schools." It complemented and further clarified some earlier guidance issued by the Ministry of Education (2013). The provisional measures deal with a series of matters including: 1) entry requirements and professional qualifications for principals and other administrators, 2) rules and procedures for selection, appointment, and service term setting (e.g., serving a maximum of 12 years as a principal in the same school), 3) accountability and performance appraisal, 4) establishment of a career path and motivation system, 5) supervision and restraint mechanisms (to appropriately limit principal's powers), and 6) termination or dismissal mechanisms for school leaders. The promulgation of these rules simultaneously established the primacy of principals and also delineated for the first times the limits of their authority and powers.

Educational Administration Challenges in Yunnan

About eighty percent of Yunnan elementary schools are found in rural areas where 25 formally-recognized ethnic groups are heavily concentrated. These groups move freely across large areas, including both adjacent countries and other regions of China. Schools in these regions are often ethnic minority-majority with 14+ indigenous languages spoken by children and their parents, in addition to parents and children speaking, reading, and writing Mandarin with varying degrees of fluency and proficiency (Chinese Rural Education Development Research Institute, 2017; Dai & Cheek, 2021). Most schools are small (about 100 students) as we have noted, and many are residential Monday-Friday due to sparse and widely dispersed populations across these mountainous regions (Lei & Zhang, 2014). The number of boarding schools is slowly but steadily increasing as authorities continue to systematically decrease the number of total schools due to overall declining numbers and the provision of subsidies for families to board their children at the schools. China's efforts on consolidations appear to be decreasing the dropout rate as well; perhaps larger numbers both increase school activities and provide more opportunities for students to form friendships and inhibit their dropping out (Yu, 2013).Another new phenomenon are children who remain at school through the weekends and thus board there throughout the school year. Often these are students whose parents are away working in the cities with no local relatives to care for them (Wang, Dong & Mao, 2017). Student populations in the vast rurality of Yunnan tend to vary across the year due to poverty, isolation, hazardous journeys to school, annual migratory patterns, parental need for their free labor, and health (Dai & Cheek, 2021).

The majority of teachers and administrators in these ethnic minority-majority schools are part of the ninety-two percent *Han* culture of the PRC; a group which generally agrees with the view frequently expressed that literacy in China refers to competencies in Mandarin, not in other dialects or languages (Yamada, 2021).There has been mixed success in China with approaches to fully bilingual or trilingual approaches to language learning and use (Tsung, 2009, 2014; Zhang, Y. J., 2013). Valuable programs include plenty of opportunities for immersion in a language, extensive discourse in the language that is related to the school's regular curriculum and highlighting practical uses and applications for the language in question. Many successful programs can be found in cities but in rural areas the many challenges that must be overcome often overwhelm well-intentioned efforts (Tsung, 2009, Sude and Dervin, 2020).

Recent national pronouncements and actions regarding unrest in the borderlands of China will undoubtedly result in changes to government policies regarding local ethnic language learning within the school curriculum and change how schools approach issues of citizenship development and holistic development of children (e.g., Xi, 2014, 2017). The exact nature of these changes is currently unknown.

The need for adaptive leadership has perhaps never been greater. Principals need to be instructional and institutional leaders who can engage in critical thinking about the socio-technical system called formal public education as it faces accelerated change and increasing demands (Blasé et al., 2010; Kinkley, 2019). Principals need to become more culturally attuned to the needs of their teachers, pupils, and communities in areas of the country where the school is vital to community-wide continuity, cohesion, and continuing social and economic development (Cherng et al., 2019; cf. Pasanchay, 2019). Principals need time and opportunity to identify, explore, and question their own beliefs and understandings about the children and families of local ethnic groups. This includes viewing the sociocultural dimensions of students as a resource strength for students' ongoing cognitive, social, emotional, and citizenship development within a holistic frame of reference (cf. Yang et al., 2021). At the same time, principals are responsible within their schools for achieving the government's priority for Mandarin to be the common language ("Putonghua") of the nation (Yamada, 2021).

There is much about our engagement we do not presently know (e.g., Amzat, 2019). Relevant research is meager regarding many relevant issues (Su et al., 2019). There are, however, interesting pointers from ongoing educational and psychological research across an array of fronts including: reducing socioeconomic disparities (Destin, 2020), honing reasoning ability (Bunge & Leib, 2020), improving children's multiple language skills (Hulme et al., 2020), the physical context of child development (Evans, 2021), taking social, emotional, and behavioral skills seriously (Soto et al., 2021), promoting student self-regulation and transfer (McDaniel & Einstein, 2020), addressing discrimination (e.g., Bettache, 2020), understanding neurodevelopmental effects of childhood adversity (Smith and Pollak, 2021), and providing supportive environments that enhance teachers' self-efficacy (Lackey, 2019).

In addition to socio-technical systems thinking about the educational system as a whole (McWalters & Cheek, 2000), principals also need a formal, flexible, and relationship-focused way to apprehend the need for changes and ways to work through the worldviews, means, methods, and processes that will position their teachers, schools, and communities to successfully respond to emerging challenges. We suspect that Soft Systems Methodology (SSM) will be a useful tool to employ with principals as part of their own professional development and to develop comfort and skills using SSM with teachers and community leaders within their own respective school service areas (Jackson, 2019).

Conclusion

The challenge is to create a working model of how to integrate various factors into a flexible approach that will place principals at the center of a systematic learning and action research program that will produce culturally and situationally appropriate and educationally effective changes to learning on the part of both rural children and the adults who work with them. Success at such a venture will greatly affect the future of these rural children as citizens of the People's Republic of China.

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American Teenagers' Use of Social Media to Learn about College: A Literature Review

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Social media can serve as useful learning tools for teenagers. The term social media first emerged in tandem with Tim O'Reilly's declaration of Web 2.0 as a participatory web (Hogan & Melville, 2015). Now, a wide range of online activities with multiple contributors are considered as social media, ranging "from collaborative encyclopedias such as Wikipedia, to social network sites (SNSs) Facebook and Twitter, photo-sharing sites Instagram, and social news site Reddit" (Hogan & Melville, 2015, p. 421). As social media is pervasive in today's teenage life, there are concerns regarding the harmful impacts of social media on teens. However, we, educational technologists, need to proactively find ways to use social media to improve learning and prevent any possible side effects. To fully utilize the new educational opportunities afforded by social media, we should examine the roles of social media in education, as well as the benefits and challenges it presents (Greenhow et al., 2019a, b).

Recent studies found that one of the most common informal learning behaviors among teens on social media is future/college planning (Bagdy et al., 2018; Rutledge et al., 2019). The researchers found that teens use social media to seek out college information by following the institutional accounts of potential colleges as well as by connecting with college students. Given the lack of research on adolescent learning with social media (Greenhow & Lewin, 2016), it is important to synthesize the research to date and figure out the path for the future study.

Thus, this review aims to (a) synthesize the literature on teenagers' use of social media to learn about college and (b) to offer educational practitioners and researchers suggestions for supporting college-bound teenagers. The research questions of the study include:

1. What are some features of previous literature exploring the topic?
2. What social media affordances do teens use to learn about college?
3. What are some obstacles teenagers face while learning about college on social media?

Method

Search and Selection Procedures

I searched the databases ERIC ProQuest, ScienceDirect, and Education Full Text from August 27th to October 7th in 2020 to find the literature. The second search was conducted on August 6th in 2021 to ensure that the recently published studies are included. I consulted with a school librarian to find databases and search terms. The search terms used were (teen OR adolescent OR youth OR "high school student") AND ("college access") AND (online OR internet OR "social media" OR "social network"). I limited the results to be peer reviewed scholarly journals and be written in English. I did not use any specific limit in publication year, considering that social media is a relatively recent phenomenon.

The search yielded a total of 641 articles from the databases. After removing 12 duplicates, I first reviewed the articles' titles based on the inclusion and exclusion criteria, resulting in 386 articles for further review. The abstract review yielded a total of 96 articles. After reviewing the full text of the articles, I found five that were eligible. Additionally, I looked through the reference lists in the selected articles to find relevant literature. I also utilized Google Scholar's "relevant articles" and "cited by" features to find more recent relevant publications. These searches yielded three more articles, bringing the total to eight.

Selection Criteria

I included the literature examining both teenagers and their learning about college through social media. Only empirical studies published in peer-reviewed journals written in English were considered as eligible literature. I excluded the literature on the use of information and communication technologies in general without providing any data regarding social media. In addition, I excluded the research on college students' social media use for college adjustment. I also excluded studies whose participants' demographic information was not provided in detail. As a result, a total of eight articles met the criteria for inclusion in the literature review.

Results

RQ 1: Study Characteristics

For the eight reviewed studies, I identified some of their key features, including participants, theoretical framework, social media sites examined, and data collected (Table 1).

Table 1

Features of the Literature Reviewed

Study	Framework	Methods, Data Collection, and Sample	Social Media Sites
Brown et al. (2016)	Information literacy	Qualitative Interviews Students from six high schools in Michigan (N = 68)	Not specified; Online in general
Ellison et al., (2014)	Social capital	Qualitative Interviews Students from three high schools in Michigan (N = 43)	Not specified
Marciano (2015)	New media literacy	Qualitative Interviews, focus groups Black and Latina first-gen college applicants from a single high school in New York (N = 10)	Facebook
Marciano (2017)	New media literacy	Qualitative Interviews, focus groups 12th grade Black and Latina first-gen college applicants from a single high school in New York (N = 10)	Not specified
Greenhow & Burton (2011)	Social capital	Mixed methods	Not specified

		Survey: Students from low-income families who were recruited from three urban high schools in the upper Midwest (N = 607) Interviews: Participants selected from those surveyed (N = 11)	
Greenhow & Robelia (2009)	New literacies	Qualitative Interviews, talk-alouds, content analysis of MySpace profiles High school students from low-income families in the upper Midwest (N = 11)	MySpace
Wohn et al. (2013)	Social capital	Quantitative Survey High school students (N = 789) Compared first-gen and non first-gen students	Facebook
Rutledge et al. (2019)	Not specified	Qualitative Survey and activities: High school students from a single high school in Florida (N = 48) Interviews: High school students from the same school (N = 37), Administrators and teachers from the same school (N = 18)	Not specified

Note. First-gen = First-generation

Participants of the Studies

All eight studies reviewed used a sample consisting of high school students. Five studies considered participants' first-generation status by purposefully including them in the samples (Brown et al., 2016; Ellison et al., 2014; Marciano, 2015, 2017; Wohn et al. 2013). Notably, Wohn et al. (2013) compared first-generation students and non first-generation students in terms of social capital and college aspirations. All of the studies except for Rutledge et al. (2019) stated that they included students from low-income households. Regarding the locations of the participating schools, four of the studies sampled participants only from urban high schools (Marciano, 2015, 2017; Greenhow & Burton, 2011; Greenhow & Robelia, 2009); other three studies had participants both from urban and rural areas (Brown et al., 2016; Ellison et al., 2014; Wohn et al., 2013). Marciano (2015, 2017) and Rutledge et al. (2019) recruited students from a single high school in New York and a single high school in Florida, respectively.

Theoretical Frameworks

Three of the reviewed studies adopted the social capital framework to situate their research. Social capital refers to the ability of individuals to access and deploy resources in their social network (Wohn et al., 2013). Ellison et al. (2014) examined teens' online and offline experiences associated with two different forms of social capital: bridging and bonding. They discussed how teens' experiences related to these two types of social capital reshaped their future aspirations. Greenhow and Burton (2011) emphasized the significant role of social capital in education and psychological well-being. They examined how social media use of high school students from low-income families related to their social capital. Wohn et al. (2013) examined how social capital accrued through parents, peers, and Facebook Friends can affect teens' college application efficacy and expectation of college success.

Four of the reviewed studies adopted the literacy perspective. While they used different terms like information literacy, new literacy, and new media literacy, they all focused on teens' communication practices on social media. Brown et al. (2016) investigated teens' college information seeking practices online to understand what skills and strategies they use to access information about college and how they analyze and evaluate the information found online. Greenhow and Robelia (2009) emphasized the importance of online communication, especially for low-income students, because it allows them to interact with peers based on their specific interests rather than geography. They looked at how teens from low-income families use MySpace from the perspective of new literacy. Marciano (2015, 2017) explored the new media literacy practices of Black and Latina/o youth attending urban public high school.

Research Designs

One study used only quantitative data. Wohn et al. (2013) used questionnaires to inquire about their college aspirations and different types of social capital they had (i.e., demographic, structural, immediate network, extended network). They conducted hierarchical linear regression analyses to identify the added variance due to the inclusion of the four social capital factors.

Six research only relied on qualitative data. Brown et al. (2016) conducted in-depth interviews to examine teens' online practices to learn about college. Ellison et al. (2014) also employed in-depth interviews to investigate how teens' online and offline experiences shaped their understandings of possible life paths. Marciano (2015, 2017) used interviews and focus-group interviews. They adopted a social participatory youth co-researcher approach, in which the researcher recruited focal participants, and the focal participants invited peer participants to the study and performed interviews as coresearchers. Greenhow and Robelia (2009) conducted qualitative case studies to explore teens' novel practices on MySpace by using interviews, talk-alouds, and content analysis of MySpace profiles. Rutledge et al. (2019) used a multilevel exploratory case study. They taught social media lessons to 48 high school students in the first study year and 37 students in the second. Data were collected through survey, audio-records of the lessons, field notes, activity worksheets, and interviews. They also interviewed 17 faculty members and administrators.

One study used both quantitative and qualitative data. Greenhow and Burton (2011) first conducted a survey with high school students from low-income families and used multiple regression analyses to see how intensity of their use of social media could predict their social capital. They selected 11 participants from those surveyed and carried out semi-structured interviews in order to complement the survey data.

Social Media Sites

Two of the studies indicated their focus on teens' use of Facebook (Marciano, 2015; Wohn et al., 2013), and one on MySpace (Greenhow & Robelia, 2009). The other five studies looked at teens' overall use of social media rather than specific social media platforms. Several sites, including Twitter, Xbox, and YouTube, were mentioned by the research participants and were covered in those publications.

RQ 2: Social Media Affordances to Learn About College

The reviewed studies show that teens use social media in various ways to learn about college. I identified the five social media affordances teens use: vicarious experience, information seeking, identity development, emotional sharing, and schoolwork support.

Vicarious Experience

Many of the reviewed literature suggest the promising role of social media in exposing teens to a broader range of people. For instance, Brown et al. (2016) found that teens were monitoring social media profiles of college students at their "dream schools," which informed them about college life and functioned as a motivator. Furthermore, they revealed that teens on social media would inadvertently encounter college-related information from their peers and family members in college. Seeing their college lives shared on social media helped teens make school decisions and inspired them to research more about college.

Information Seeking

Wohn et al. (2013) revealed that having Facebook friends who could give college information and advice was a positive predictor for the first-generation students' expectations about college success. Ellison et al. (2014) reported that a teen who was a member of a special interest Facebook group discussed attending college out of state with the group members. Greenhow and Burton (2011) described a teen encountering a college student going to her interested school on MySpace. The teen exploited the opportunity by inquiring how to get into the school and their personal opinions about the school. Rutledge et al. (2019) also noted that teens networked with college students they encountered on the college's Facebook page and messaged them to ask about school information. Greenhow and Robelia (2009) suggested that first-generation students got advice on their college application by contacting their former classmates. Similarly, Brown et al. (2016) reported that teens used social media to ask college-related questions to their peers and cousins with college experience.

The advanced technological features facilitated disadvantaged teens' information seeking. For example, Marciano (2015) described a teen from an immigrant household who could not afford college tours. Thanks to a friend's suggestion, the teen was able to take a virtual tour through YouTube videos and Facebook pages, which the teen found very beneficial. Moreover, Rutledge et al. (2019) reported that teens were following the colleges' official Instagram, Facebook, and Twitter accounts, where they read the posts and comments and interact with college students. The reviewed studies have also reported teens using the tag and hashtag features to learn about college (Brown et al., 2016; Marciano, 2015). Brown et al. (2016), for example, found that teens utilize hashtags to locate the social media posts about a university's marching band and Historically Black Colleges and Universities.

Identity Development

Some of the reviewed studies show that teens used social media to share their college aspirations and achievements. According to Brown et al. (2016), some teens updated their Facebook status to share their college plans. Friends and family members showed interest in their college application process and gave them encouragement to keep going. Some students posted their admission letters on social media. Similarly, Greenhow and Burton (2011) reported that teens shared their educational plans on MySpace profiles. Sharing their college aspirations and attainment on social media enabled teens to build and maintain college-going identities and recognize peers who had similar plans. The social support they received reinforced such identity.

Emotional Sharing

Social media became a place where teens vented their stress about college planning. Greenhow and Robelia (2009) found that when teens expressed their concerns about college planning, their former classmates, now in college, gave emotional support by leaving supportive comments on their MySpace accounts.

Schoolwork Support

Marciano (2015, 2017) highlight how teens utilize social media to help one another meet academic requirements for college readiness. They found that teens discussed schoolwork through text messages and Facebook posts. Greenhow and Robelia (2009) and Rutledge et al. (2019) also suggest how teens use social media to support schoolwork, by asking questions about deadlines, organizing study groups, exchanging educational materials, and collaborating on homework. Furthermore, Marciano (2015) described that a teen posted her poem on Facebook that could be possibly used for her college application essay. She tagged a well-known literacy organization in her post, and one of the organization's mentors gave critical feedback on her writing. The teen purposely utilized the tag function to attract the organization's attention and was successful in gaining comments to improve her work.

RQ 3: Obstacles Teens Face While Learning About College on Social Media

Despite the advantages of social media identified above, the reviewed studies have also noted some obstacles that teenagers could face while using social media to learn about college. In this section, four major challenges will be discussed.

Difficulties with Applying Broad Information to Their Specific Contexts

Brown et al. (2016) revealed that while teens reported being able to identify and access college information online, they struggled to evaluate and apply the information to their specific needs. The participants described a large amount of information on the web as overwhelming due to its lack of meaningful context. The researchers thus emphasize the importance of knowledgeable translators who can help them understand the information found online. The term "knowledgeable translator" is defined as "social contacts that students access(ed), via online and offline channels, in order to make sense of generic information and apply it to their specific informational need" (Brown et al., 2016, p.110). The researchers also discovered that a few participants considered social media as an unreliable source of information and preferred authoritative sources such as guidance counselors. However, at the same time, social media may help teens make sense of complex information. For instance, some participants described how a guidance counselor at their school curated information for a Facebook group by filtering information relevant to students. The counselor also answered students' questions about online information and directed them to additional resources. Teens also reached out to peers and family members who were current undergraduates or college graduates, to contextualize information about college. In sum, while teens may have difficulty interpreting information obtained on social media, it could also be a place for them to find knowledgeable translators.

Potential Negative Influences of Social Media

Wohn et al. (2013) revealed in their quantitative research that teens' frequent use of Facebook was negatively related to their expectations of college success. This result implies that not all activities on social media might be beneficial for teens' college aspirations. Moreover, Wohn et al.'s (2013) found that for non-first generation students, the number of Facebook friends were negatively related to their college application efficacy. For first-generation students, the emotional support from Facebook friends was a negative predictor for their college application efficacy. Though the study does not provide further evidence to clarify such relationships, the findings indicate that Facebook friends and their emotional support might have negative impact on college application efficacy.

The Nature of Social Media Platforms That May Limit Network Expansions

Social media platform's distinctive features could affect teens' learning about college. For instance, Ellison et al. (2014) found that on Facebook, teens tend to friend their schoolmates and family members rather than reshaping their networks. The participants mentioned the "normative pressure to indiscriminately friend schoolmates" (p. 526) on Facebook. Such a norm had teens have little control over their friending decisions and thus kept them from being exposed to various worldviews or novel information.

However, the same culture on Facebook where teens network with their existing relationships appears to be beneficial in terms of getting social help. Specifically, Marciano (2015, 2017) found that when teens post questions about school assignments on Facebook, they were able to get quick, multiple answers from their peers enrolled in the same classes. Greenhow and Robelia (2009) and Greenhow and Burton (2011) also found similar results on MySpace, where teens asked for help with their school tasks and received needed help.

Discussion

RQ 1: Study Characteristics and Suggestions for Future Research

All the reviewed studies recruited high school students as participants, and the majority of them considered the participants' socioeconomic backgrounds. They used literacy and social capital as their primary frameworks to explore the topic. Empirical studies based on a broader range of theoretical frameworks may help us to see teens' social media use from diverse angles and thus enrich the research conversation on this topic. Potential frameworks that could be employed include communities of practice, self-efficacy, affinity spaces, cultural historical activity theory, and self-regulated learning theory (Greenhow et al., 2019b). In terms of research methods, one study only used quantitative data to identify the connections between variables, whilst six only used qualitative data. One study employed both quantitative and qualitative data. Recent social media research has begun to be more methodologically varied, by adopting, for example, big data techniques and social network analysis (Greenhow et al., 2019b). Future researchers could investigate such opportunities and utilize different methods to achieve their research goals. When it comes to social media sites, three studies were primarily focused on Facebook and MySpace while others did not identify any specific platforms and instead looked at teens' social media use in general. Though either approach could be used depending on research goals, focusing on specific tools may allow us a more nuanced understanding of different tools (Orben, 2020).

RQ 2: Suggestions for Leveraging Social Media Affordances

The current review identified five social media affordances that can be used to learn about college, indicating that we can use them to better help college-bound teenagers. First, we can support students' technical access to social media by reducing the regulation on the use of phones and social media during the school day. Blocking social media sites at school may separate teens from potentially valuable college information (Brown et al., 2016; Marciano, 2015). According to Enriquez (2011), undocumented immigrant Latinx students found weak ties with other undocumented students to be more useful than teachers, counselors, and school officers in meeting their unique information needs. Teens can possibly use social media to connect with potential weak ties who may provide information tailored to their own situations that they may not be able to obtain at school.

Second, we could integrate social media into curricular activities to benefit from its learning affordances (as suggested by Marciano, 2015). Previous scholars have emphasized the importance and benefits of bridging formal and informal learning contexts with the use of social media attributes (Greenhow & Askari, 2017; Greenhow & Lewin, 2016). For example, we could encourage students to share classroom artifacts via social media by tagging experts and peers to receive help with their work. This way, we can utilize the social media affordances to support schoolwork and have our students associate social media as a learning tool.

Third, we should also help teens improve new media literacy skills to fully exploit the benefits of social media (Brown et al., 2016; Marciano, 2015). New media literacies include traditional literacy such as reading and writing, research skills, technical skills, critical analysis skills, but more importantly, "social skills developed through collaboration and networking" (Jenkins et al., 2009, p. 29). The new media literacy will be crucial in finding credible online resources and making more informed college-related decisions.

Fourth, we could design and develop an intervention for teens' college preparation by using social media affordances. Though many teens use social media on a daily basis, they might not be fully aware of its affordances to help their college-going process. We could let them know the availability of institutions' social media accounts and potential uses of social media to reach out to people attending their dream schools. We could also teach skills to find specific information about colleges using their appropriate hashtags. Such endeavors may involve design-based research aimed at developing an intervention to improve teens' informal learning about college using social media (Greenhow et al., 2019b).

RQ 3: Suggestions for Overcoming Potential Obstacles

Despite all the merits of social media mentioned earlier, this review also highlighted some obstacles teens experience while learning about college through social media. Based on them, I give specific suggestions for practitioners and future researchers. First, educators should provide teens with knowledgeable translators who can help teens make sense of information found online and apply it to their specific needs. Educators themselves could serve as translators for teens at school or district levels. In addition to face-to-face assistance, we could also consider utilizing social media. For instance, school guidance counselors could create a Facebook group page or an Instagram account where they provide college-related information tailored to their students as suggested by Brown et al. (2016). Considering that disadvantaged students are less likely to seek help from guidance counselors (Holland, 2015), using social media as a means to communicate college information could be a possible strategy for making college information more accessible to a larger student population.

Second, researchers should examine how specific social media activities have different impacts on teens' college aspirations. Wohn et al. (2013) found a negative association between teens' frequent use of Facebook and their college aspirations. The frequency indicator may not be sufficient to draw upon to explore how social media usage impacts teens. It is important to stop using the blanket term "social media use" and instead focus on specific social media practices. Future studies should examine what types of social media activities are associated with teens' college aspirations and with their actual college access.

Third, future studies could investigate the impacts of social media friends. The reviewed studies suggested mixed results regarding how social media friends and their emotional support affect teens' college aspirations, which implies the complicated nature of peer influence. Other previous studies have examined how peers on social media can possibly affect teenagers through fear of missing out (Marengo et al., 2021), peer comparison (Chua & Chang, 2016), and drama (Dennen et al., 2018; Rutledge et al., 2019). Such complex phenomena could complicate how social media friends influence teens in terms of their college aspirations.

Fourth, researchers should examine different social media platforms' distinctive features and their impacts on teens' learning about college. This review suggests that a social media norm could be a double-edged sword depending on how teens use it. Future research might look into teens' learning practices on various social media sites, as well as their potential advantages and drawbacks. For instance, Dennen et al. (2020) explored the role of six prominent social sites in a high school environment (i.e., Instagram, Snapchat, Facebook, Twitter, YouTube, and Pinterest). Alhabash and Ma (2017) investigated college students' use of different platforms and nine distinct motivations. Similar to them, we could examine how teens learn about college through various social media platforms and further explore best practices for each platform.

Conclusions

This study reviewed the eight literature investigating teens' use of social media to learn about college. Theoretically, current studies on this topic have been primarily situated in literacy theory and social capital theory. Methodologically, the current studies leaned more toward the qualitative approach. The review suggests five social media affordances in learning about college: vicarious experience, information seeking, identity development, emotional sharing, and schoolwork support. On the other hand, there were some potential barriers teens may encounter when learning about college on social media. First, they were having difficulty understanding generic information obtained online. Second, some social media activities may be detrimental to teens' college aspirations. Third, the norms of social media sites may impede teens from learning about college. This research has implications for how to use social media affordances to better help college-bound teens in their college learning.

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Evaluation of a Sequential Feedback System to Promote Nudge Among Learners and Support Learning Strategies

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Abstract

Note-taking is an effective learning strategy for SRL development. However, due to the lack of opportunities to learn note-taking, learners cannot write complete notes. Therefore, from the perspective of co-regulated learning (Co-RL), we proposed that learners learn note-taking from each other. This study aimed to evaluate NoTAS, a note-taking support system using tablet devices. We asked 33 participants in the experiment to evaluate whether NoTAS promotes Co-RL and note-taking. The questionnaire results showed that the learners using NoTAS can learn and take notes through interaction with others. However, there were some cases where NoTAS prevented learners from note-taking, suggesting the need for improvement.

Keywords: Note-taking, Co-RL, Nudge theory, CSCL, Learning visualization

1. Introduction

1.1. Self-Regulated Learning

OECD (2018) indicated that learners need to develop self-regulated learning (SRL) competencies in the Learning Compass, a vision for the future of education. SRL is the ability to cycle through forethought, performance, and reflection on their own to learn effectively (Usher and Schunk, 2018). In the field of educational technology, much of the research on SRL development has focused on outside class learning support, such as encouraging reflection and learning management using assignments, portfolios, and learning management systems. However, outside class learning support can be burdensome in terms of preparations by teachers and activities by learners. On the other hand, Nilson (2013) proposed note-taking as one of the effective learning strategies for SRL development for in-class learning support.

1.2. Note-Taking and Support Methods

Note-taking has two types of features: encoding and storage functions (DiVesta and Gray, 1972). The encoding function facilitates recognition processing by combining the learning contents with the learner's prior knowledge through writing notes. The storage function enables effective review by reading notes. Morehead et al. (2019) suggest that many learners take notes in class but cannot write complete notes because they have few opportunities to learn note-taking strategies. One of the ways to support note-taking is to distribute class material. Class material clarifies the main points of the lesson (Kiewra, 1989). Furthermore, writing directly on the class material facilitates understanding of the class (Avval et al., 2013). However, only a few learners take organized notes on the teacher’s explanations. Therefore, Lannoe and Miller (2019) suggest that more support is needed to encourage more learners to take notes.

Another practical support strategy is to provide feedback on note-taking. For example, Beaudoin and Winne (2009) developed the “nStudy system,” which allows teachers and other learners to provide comments and detailed feedback on learners’ essays. While “nStudy” can provide detailed feedback, it is difficult for instructors to provide note-taking instruction constantly, and we do not have enough time to share and discuss notes in the class (Nilson, 2013).

1.3. Who Provides Feedback on Note-Taking?

Hadwin et al. (2017) proposed Co-Regulated Learning (Co-RL) as a recent trend in research on regulated learning. Co-RL is a learning to regulate one's learning through interaction with others. Therefore, we suggest that note-taking feedback among learners is possible by applying the Co-RL theory.

In Japan, the Ministry of Education, Culture, Sports, Science, and Technology (MEXT, 2020) has promoted a policy to allow all learners to own devices to develop networks. Thus, many countries witnessed the growing trend of teachers and learners using Information Technology (IT) in classes in recent years. An example of such a feedback system is the “Metaboard,” a learning analytics dashboard that supports learners’ metacognition and SRL by visualizing their learning behavior (Chen et al., 2020). Furthermore, learners can take notes using a pen and tablet in class without any stress (Özçakmak and Sarigöz, 2019). Therefore, learners can use tablets for longhand note-taking instead of paper and keyboard. However, there is little study on supporting longhand note-taking with tablet devices applying Co-RL theory.

We hypothesize that learners who cannot take notes would be aided by assuming that the notes that many learners were taking were correct and providing them with feedback using tablets. Thus, to promote interaction among learners, we focus on "Nudge theory," which has been studied extensively in the field of behavioral economics in recent years (e.g., Thaler and Sunstein, 2009).

1.4. Nudge Theory in Education

Thaler and Sunstein define the nudge as any element of choice behavior that changes people's behavior predictably without narrowing the choice or significantly changing the economic stimulus (Thaler and Sunstein, 2009). Research on nudge has also been applied to educational studies (Weijers et al., 2020). However, most research is confined to nudging on teaching policies, with little research on nudging the learning strategies among learners in class. Here, we define the educational nudge as improving one's note-taking by referring to the colors and positions of others' note-taking. In this research, we aim to learn each others' learning strategies, such as note-taking in the class.

2. Purpose

In this study, we evaluated NoTAS developed by Kondo et al. (2021) that uses nudge to provide feedback on note-taking among learners in class. We applied NoTAS to subjects and evaluated its effectiveness by using questionnaires. There are two perspectives for the evaluation.

1. NoTAS promotes interaction with other learners (Co-RL) in the class.
2. NoTAS promotes note-taking based on the others' note-taking.

3. Methods

3.1. System Overview

Nudge for Note Taking Assist System (NoTAS) is a note-taking feedback system that can be accessed by up to 45 people at a time, excluding teachers (Kondo et al., 2021). NoTAS is available on web browsers such as Safari and Google Chrome. NoTAS has three functions: note-taking function, learning log function, and visualization function. Learners can use the note-taking function to write notes and highlights text directly on class material displayed on their tablet using their tablet pen. Two types of markers are available for learners to highlight the important parts and the unclear parts. The learning log function has two types: log collection and log confirmation. The log collection allows learners to save their note-taking sequentially as they write and erase notes and highlights in class material. Teachers can view the log of the learners' note-taking processes by specifying the learner (User ID) and the material (Class ID) using the log confirmation. Furthermore, the learning log function uses BASIC authentication so that only certain learners and teachers can access the system. The visualization function is the main of NoTAS. When a learner writes notes and highlights on the class material with visualization function, the approximate location of the notes and highlights written by others on the class material is visualized on the same material in almost real-time.

The interface of NoTAS consists of four layers: note-taking layer, learning log layer, learning visualization layer, and class material layer. On NoTAS, the learner directly writes on the material that has been distributed via the tablet device. The note-taking layer and learning log layer correspond to the note-taking function. Then, to improve note-taking among learners, NoTAS collects and visualizes information, such as the place and time of writing of all learners, which facilitates learning. The learning visualization layer shows the position and timing of other learners' note-taking. Since this layer overlaps with the number of learners in class, the more learners fill in the same part, the darker the color becomes. As a result, the areas written by more learners are emphasized. Figure1 shows an example of the visualization function of NoTAS. Each color has the following meanings.

- The red areas mean that other learners wrote notes.
- The yellow areas mean that other learners highlighted important parts.
- The blue areas mean that other learners highlighted unclear parts.

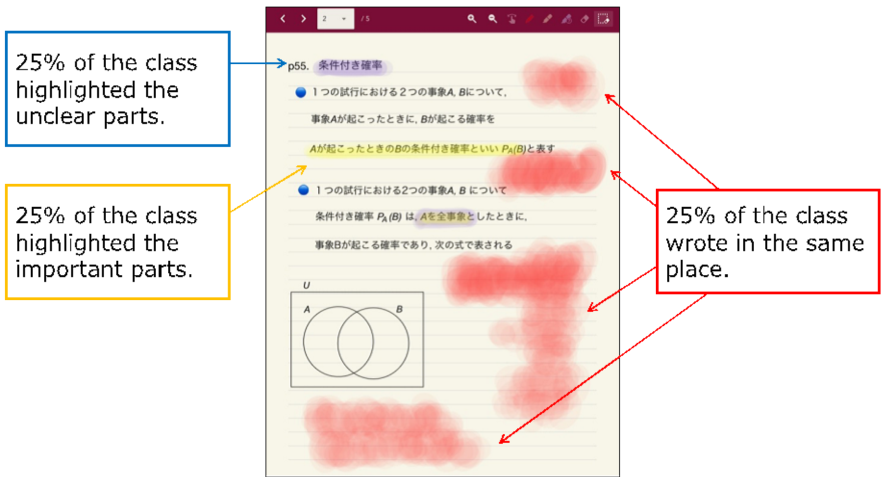

Figure 1. Visualization interface

3.2. Procedure of Research

We recruited university students to evaluate the NoTAS. The participants in this research were 33 students (males: 22, females: 11). The average age of the participants was 22.7 years old. We distributed a tablet (iPad 6th) and a tablet pen to the participants. Before the class, the participants had an opportunity to practice the operation of NoTAS. The experimental group (n = 15) took the class using the visualization function of NoTAS. On the other hand, the control group (n = 18) took the class without using the visualization function of NoTAS. The class content was four instructional design theories, and the participants watched the class video using a projector. Figure 2 shows the procedure of research.

In addition to the participants, five collaborators wrote the contents set by the first author on the class material at a set time. This operation was conducted to verify the effect of the visualization function. We asked the participants on the face sheet, "If they had ever taken a class using a tablet and tablet pen," and found no significant difference between the two groups, $\chi^2(1) = 0.02$, $p = .88$, $\phi = .03$.

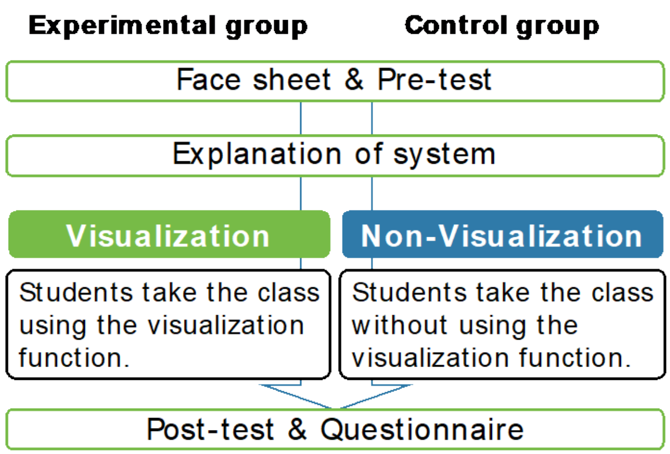

Figure 2. Procedure of research

3.3. Questionnaire

In this research, we surveyed questionnaires from three perspectives as follows:

Community Awareness

We quoted 15 items related to community awareness for Classroom Community Scale (Rovai, 2002). We have partially rewritten the text to be more consistent with the purpose of this study. Moreover, we created and added 3 original items about others' note-taking. We asked all items using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

Social Presence

We adopted 3 items proposed by Short et al. (1976) to measure social presence: sociable – unsociable, personal – impersonal, and warm – cold. It employed a semantic differential method with a bipolar 7-point scale.

Note-taking Factor

We created 6 items related to whether learners referred to the others' writing in their note-taking. Moreover, we only asked the visual group 3 items regarding their feeling about using the visualization function of NoTAS. All items used a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

3.4. Guidelines for Analysis

We compared the results of the two groups' community awareness and social presence to investigate purpose 1, "Does NoTAS promote interaction with others?" We used these items as a measure to evaluate the promotion of Co-RL.

We compared the note-taking factor between the two groups to investigate purpose 2, "Does NoTAS promote note-taking based on the others' note-taking?" Moreover, we focused on the visualization group results and compared them with the median of 3.00. The note-taking factor was used as an index to evaluate the nudge.

4. Results

In total, 33 participants answered the three questionnaires. The result of the questionnaires to evaluate Community Awareness, Social Presence", and Note-taking Factors in the class are presented below.

4.1. Community Awareness

Table 1 shows the results of Mann-Whitney U test for the scores of community awareness. The index was reliable (Cronbach's ± = .88). The class in which learners used the visualization function of NoTAS is called "Visual," while the class in which learners did not use it is called "Non-visual." Twelve items found significant difference and marginally significant, visual was higher in all items. However, there were ceiling effects and floor effects except for No. 7. Therefore, the learners felt that they were receiving real-time feedback on their note-taking by using NoTAS.

Table 1. Comparison of community awareness

	Visual		Non-visual		M_1-M_2	U		r
	M_1	SD_1	M_2	SD_2				
1. I felt that learners in this class cared about each other.	2.60	1.35	1.89	1.28	0.71	90.50	†	0.33
2. I felt that I was encouraged to ask questions.	2.53	1.19	2.22	1.00	0.31	114.00		0.16
3. I felt uneasy exposing gaps in my understanding.	3.93	1.49	3.50	1.43	0.43	112.00		0.17
4. I felt connected to others in this class. (R)	4.00	1.13	1.11	0.32	2.89	2.00	***	0.99
5. I did not feel a spirit of community. (R)	3.53	1.36	1.61	0.78	1.92	34.00	***	0.75
6. I felt that this class resulted in only modest learning because of using NoTAS. (R)	3.73	1.34	3.11	1.37	0.62	99.50		0.26
7. I felt that I received timely feedback on my notes and highlights in this class.	3.53	1.13	2.00	0.84	1.53	41.50	***	0.69
8. I trusted others in this class.	2.93	1.49	2.67	1.14	0.26	122.50		0.09
9. I felt isolated in this class. (R)	4.27	1.10	2.94	1.16	1.33	56.00	**	0.59
10. I felt that I could rely on others in this class.	3.33	1.29	1.44	0.71	1.89	34.00	***	0.75
11. I felt that other learners did not help me learn in this class. (R)	4.13	0.92	2.72	1.23	1.41	49.50	**	0.63
12. I felt that members of this class depended on me.	1.60	0.74	1.22	0.55	0.38	95.00	†	0.30

13. I could feel how the other learners were listening to the teacher's explanation in this class.	4.20	1.27	2.50	1.30	1.70	46.00	***	0.66
14. I felt uncertain about others in this class. (R)	3.53	1.25	2.78	1.40	0.75	94.00		0.30
15. I found that the other learners were taking notes very hard.	4.53	0.64	3.67	1.03	0.86	68.50	*	0.49
16. I felt confident that others would support me.	3.00	1.20	1.61	0.85	1.39	49.50	***	0.63
17. I felt that I had enough opportunity to learn how to take notes in this class.	3.27	1.39	3.06	1.16	0.21	118.00		0.13
18. I was curious about others' note-taking behavior.	4.00	1.46	2.83	1.43	1.17	61.50	**	0.54

Visual: $n = 15$, Non-visual: $n = 18$ $^{\dagger}p < .100$, $^{*}p < .050$, $^{**}p < .010$, $^{***}p < .001$
(R): Reverse score, 5-point Likert scale

4.2. Social Presence

The social presence score was the average value of the three social presence items. The result of Shapiro-Wilk test showed that this score was normally distributed. Moreover, the result of Levene's test showed that this score was equality of variance. Table 2 shows the results of Student's t-test for the social presence score. The index was reliable (Cronbach's ± = .88).

Table 2. Comparison of social presence

	Visual		Non-Visal		M_1-M_2	t		r
	M_1	SD_1	M_2	SD_2				
Social presence score	4.89	1.12	3.46	0.79	1.43	4.28	***	0.81

Visual: $n = 15$, Non-visual: $n = 18$, Semantic differential method $^{***}p < .001$

As a result, the visual's score was significantly higher than the non-visual' score. Therefore, learners can feel a higher social presence of others by using visualization of NoTAS.

4.3. Note-taking Factor

We compared the six note-taking factors (No. 1 to 6) between the visual and non-visual groups. All items were significantly higher in the visual group. However, we found a floor effect for all items in the non-visual group for the note-taking factor. We expected this result because the learners who did not use the visualization function of NoTAS could not watch the others' note-taking.

Then, we compared the values for the visual group with a median of 3.00. Table 3 shows the results of One-Sample Signed Rank Test for the value of note-taking factors. The index was reliable (Cronbach's ± = .83). We asked only the visual group about No. 7 to 9.

Table 3. Note-taking factors

	M	*SD*	*M*-3.00	*W*		*r*
1. I wrote the "teacher's writing" based on the notes and highlights of other learners.	3.47	1.51	0.47	71.00		0.18
2. I wrote the " teacher's oral explanation" based on the notes and highlights of other learners.	2.80	1.47	-0.20	39.50		0.34
3. I highlighted "the important points" based on the notes and highlights of other learners.	3.33	1.45	0.33	58.00		0.03
4. I highlighted "the points I did not understand" based on the notes and highlights of other learners.	2.40	1.06	-0.60	6.00	†	0.90
5. I wrote "symbols" based on the notes and highlights of other learners.	2.80	1.42	-0.20	26.00		0.57
6. I wrote in "diagrams and tables" based on the notes and highlights of other learners.	2.67	1.35	-0.33	26.00		0.57
7. The visualization prevented me from writing my notes. (R)	2.13	1.13	-0.87	17.00	**	0.72
8. The visualization prevented me from writing my highlights. (R)	2.87	1.60	-0.13	57.00		0.05
9. I enjoyed note-taking with the visualization function of NoTAS.	3.07	1.62	0.07	50.50		0.16

n = 15, (R): Reverse score, 5-point Likert scale — $^{\dagger}p$ <.100, $^{**}p$ < .010

As a result, learners tended not to refer to others' highlights when they highligted parts they did not understand, W = 6.00, p < .100, r = 0.90. Furthermore, the visualization of NoTAS interfered with the learners' note-taking, W = 17.00, p < .010, r = 0.72.

5. Discussion

5.1. NoTAS Promotes Interaction Among Others

The results of community awareness suggest that the learners felt the interaction with other learners by using the visualization function of NoTAS. For example, they felt connected to others and felt that other learners helped them learn and note-taking. Furthermore, the learners felt that they were receiving sequential feedback on their note-taking using the visualization function. On the other hand, learners did not feel that they had enough opportunities to learn note-taking even though they used the visualization function of NoTAS. We suppose that this is because this study was a short-term experiment. This result suggests that learners learn more about note-taking by using the visualization function of NoTAS in the long term.

The social presence score suggests that the visualization function of NoTAS makes learners feel more social presence. Moreover, the visualization function helps learners recognize others' presence and promotes interaction among learners.

Therefore, we found that NoTAS promote Co-RL.

5.2. NoTAS Promotes Note-taking Based on the Others' Note-taking

From the results of the note-taking factor, we found that learners who used the visualization function wrote their notes based on others' writing more than the others who did not use this function. The visualization function of NoTAS automatically shares with learners the color and location information of others' notes and highlights. These results suggest that learners write notes and highlights using this visual information.

However, the mean scores of the visualization group were below 3.00 for many items. These results suggest that the visualization feature of NoTAS did not contribute much to the learners' note-taking. Furthermore, we found that the visualization might interfere with note-taking. There are two possible reasons as follow:

- ❿ The learners are not familiar with NoTAS
- ❿ The density of the visualization layer is set too high

As a future task, we need to have learners use NoTAS for a long time and evaluate their note-taking. Furthermore, the density of the visualization needs to be reduced.

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Knowledge Convergence in Collaborative Concept Mapping

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ABSTRACT

This study investigates how collaborative concept mapping tasks affect the knowledge convergence of learners. Participants are divided into two groups by different group contingency, independent and interdependent, and we analyzed their discourses. We observed that agency could strongly affect their collaboration, but verbatim recitation was not a strong indicator of knowledge convergence in this context where learners had created an individual map before collaboration, and they used it as a reference. Though we also found the process of knowledge convergence, that did not strongly indicate that learners build knowledge together in both groups. Their actual collaborative map with an informational text was not considered as the knowledge convergence outcome.

INTRODUCTION

Online discussion, either asynchronous or synchronous, has been emphasized since social interaction was one of the critical capabilities for this new normal era, according to OECD (2019). However, efforts devoted to the study of group achievement and understanding have been significantly lacking, considering the new understandings built through dynamic interaction (Fisher & Mandl, 2005). This paper extends the investigation of in-depth learning, focusing on collaborative achievement, particularly knowledge convergence, while constructing a collaborative concept map. In this study, we engaged Information Science and Technology undergraduates in collaborative concept mapping to do the summary activity of a chapter, and we analyzed learners' knowledge convergence by different group contingency from their discourse. The finding from this study can inform the development of practical instructional support within the context of learning linearly arranged information.

THEORETICAL RATIONALE

Dillenbourg (1999) defined collaborative learning as two or more people's attempts to learn something together compared to cooperation. Team members individually solve sub-tasks after splitting the work and assemble the individual's results for the outcome in cooperation, whereas individuals share and negotiate for the outcome in collaboration. Roschelle & Teasley (1995) also defined collaboration as a coordinated and synchronous group activity as a result of individual learners' consistent effort to construct and develop a shared conception of a problem. Concept mapping is a visualizing technique to organize and represent the relationships among nodes(concepts) by edges (connecting nodes) representing relationships among the concepts as a network of ideas as a part of qualitative methods (Novak & Gowin 1984; Novak & Canas, 2008). Concept mapping tasks are generally regarded as cognitively demanding tasks given complex procedures such as identifying the main concepts and finding relationships among nodes by focusing on the organizational structure of the text, simultaneously screening the learning materials (Jonassen 1997; Hay, Kinchin, & Lygo- Baker 2008). These tasks generally improve verbatim knowledge and comprehension, and inferential skills for the contents (Novak & Gowin 1984). Thus, as a learning strategy for knowledge construction, collaborative concept mapping can certainly enhance conceptual understanding (Stoyanova & Kommers 2002; Farrokhnia et al., 2019). Collaborative concept mapping tasks are essential strategies to integrate individual learning with various group learning skills, such as creating a shared meaning of the task, concepts, procedures, and strategies for knowledge construction (Van Boxtel et al., 2002). Bereiter and Scaldamalia (2003), who appear as the pioneers in the field of knowledge construction, insist the creation of knowledge only occurs in collective processes, and Jeong and Chi (2007) indicated that in-depth learning only occurs after the group members integrate reasoning into personal understanding with the shared meaning. Knowledge convergence, essential to evaluate the depth of understanding of learners, mainly focuses on mutual influence through social interaction; as such, it is a process where two or more people exchange and converge their knowledge of the problem. Through mutual understanding, the knowledge finally becomes similar, which can be called 'shared understanding' of the content (Hutchins, 1991; Rogoff, 1998; Jeong & Chi, 2007; Roschelle 1992).

Processes and outcomes are often used to explain knowledge convergence (Roschelle 1992; Jeong&Chi 2007; Fischer&Mandl 2005). The process of convergence is conceptualized in various ways. One approach is based on knowledge contribution, which emphasizes that learners should contribute the ideas to varying or similar extents by counting the number of turns in discussion (Cohen 1994). This process can include grounding (Clark & Brennan, 1991), where both parties believe both understood and contributed to the discussion. The grounding process is the bottom layer of negotiation (Dillenbourg et al., 1996) and an essential part of achieving convergence. Shared knowledge, group mind, community memory, and team mental model are often viewed in the process of knowledge convergence as contributions of mutual knowledge. However, grounding may only capture the local convergence, not lead to a global convergence in terms of both mental models (Chi et al., 2004). Roschelle (1992) indicated that conversational analysis (CA) and pragmatics are critical in knowledge convergence research as interaction provides a means to construct abstract concepts collaboratively through the gradual refinement of ambiguous meaning. In addition to knowledge convergence processes, the other aspect to explain this phenomenon is resulting outcomes or mutual understanding. The outcomes can be defined in one way as "increased similarity in the cognitive representations of the group members" (Jeong & Chi, 2007, p 288) as their knowledge will be incrementally elaborated. That is, learners mutually influence the knowledge outcomes of the group members; common knowledge or common ground are examples of outcomes of this mutual influence (Roschelle 1992; Teasley 1997; Jeong & Chi 2007; Mercier 2017). In Roschelle (1992)'s study, the outcomes of two learners were gradually similar, indicating that the similar representation as an outcome after collaboration is convergence. For example, each learner interprets a situation, adjusts their understandings, and collaborates to solve problems; this process leads to the outcome of convergence. Jeong and Chi (2007) assessed knowledge convergence quantitively by conducting pre and post-knowledge tests to see the increase in common knowledge within the group; they defined knowledge convergence as an increase in common knowledge within a group. The results of pre and post-test performance revealed that learners shared more knowledge pieces and mental models after collaboration, though the association between the amount of interaction and the increase in common knowledge was not statistically significant. The study design considered the influences of learning artifacts (e.g., concept map) besides collaborative dialogues. Another study using pre and post test measures to quantify the knowledge convergence outcome differences when students had different goal assignments (either a learning goal or a performance goal); was conducted (Mercier, 2017). Though the results did not represent the differences in having learning goals or performance outcomes, there was a difference in knowledge convergence; groups with learning goals showed more knowledge convergence than groups with performance goals, suggesting that creating achievement goals for collaboration can influence interaction behaviors.

Peterson & Roseth (2016) developed four CSCL (Computer Supported Cooperative Learning) strategies to increase students' cooperative perceptions based on the social interdependence theory: social interdependence, summarizing, scripts, and synchronicity. We particularly apply three relevant strategies to examine this small-scale research. Social interdependence (Johnson & Johnson, 1989, 2005) describes how students perceive their success as being affected by others' works, so hypothetically, the interdependent group has a more positive perception of their collaboration than the independent group. Additionally, requiring students to work on a collaborative summary should enhance collaborative perceptions because the shared goal involves active collaboration to create a group product (Ortiz, Johnson, & Johnson, 1996). Summarizing enhances achievement encouraging students to focus on the most relevant material and integrate it with existing knowledge (Hidi & Anderson,1986; Wittrock & Alesandrini, 1990), and using concept maps for summarization can even double the effects on text comprehension (Chang, Sung & Chen, 2002). In short, the greater positive goal interdependence by adding summarizing tasks with concept maps could enhance the benefit of collaboration, increasing the group productivity. Another essential part of this research is synchronicity. A synchronous video conferencing tool can enhance their collaboration by allowing them to convey social cues negotiating to construct knowledge in real-time, and researchers to analyze the processes of constructing a concept map during collaborative works. Therefore, it is critical to study knowledge convergence using a concept map with the concept of social interdependence in synchronous discussion in computer-supported learning to understand their deeper learning. This research investigates whether participants interact to share their individual knowledge and improve their conceptual understanding. Additionally, we explore their term usages to understand which terms are more frequently used together and how the terms in the interdependent group differ from the independent group.

METHOD

It occurred within the Information Sciences and Technology introductory course of 80 students at a Northeastern American university.   For this particular paper, we randomly selected one independent and interdependent group to compare and analyze their discourses to understand how the collaborative concept maps are constructed differently by the group contingency to find evidence of deeper learning.

Procedure

Each group comprised three students, and they were randomly assigned to either an independent or interdependent group. The independent group students read one chapter about "system design and development" and constructed an individual concept map using the given tool, whereas the interdependent group students read one-third of the chapter and constructed an individual concept map using the same tool. After this preassigned task, both groups synchronously met and collaborated to create one map for the group. During the collaboration, students were required to create at least 20 nodes with edges but were not asked to consider the directionality of the nodes. Students were told their options not to be included in the research without any negative influences at the end. There was no time limit, and participants could look at other team members' maps. A tutorial of a tool, Cmap (Novak & Canas, 2008), was provided to instruct how to place words(nodes) with links (edges), including the directionality in advance.

RESULTS

Lexical network analysis

Based on the content-related term frequency in two transcripts, we created their lexical networks in different group contingencies and compared them to understand the difference by the group. We picked 40 relevant terms from the most frequently used terms, and networks joined in pairs by edges were generated. Modularity, based on the eigenvectors of a characteristic matrix for the network, is a highly effective measurement technique in network analysis to detect delineated clusters (Newman 2006). With this definition, we found four different term clusters with 17 nodes and 51 edges in group 1(independent) and seven clusters with 22 nodes and 114 edges in group 2(interdependent). Simply describing, there are more nodes so as more clusters and the terms in each cluster were different in groups. Though each cluster includes identical terms, slightly different terms in clusters were found by the groups—also, the average degree and average weighted degree of the interdependent group was 5.182 and 9.090, which is relatively higher than the independent group of 3 and 6.647. The graph density of both groups is low and cannot be compared because of the different numbers of nodes(Table 1).

	Independent	Interdependent
Average degree	3	5.182
Avg.Weighted Degree	6.647	9.091
Network Diameter	5	4
Graph Density	0.188	0.247
Modularity	0.303	0.204

Table 1 Lexical difference in groups

Discourse Analysis

Roschelle (1992) indicated that conversational analysis (CA) and pragmatics are critical in knowledge convergence research as interaction provides a means to construct scientific concepts collaboratively through the gradual refinement of ambiguous meaning. In his case study, the dialogues of a pair of high school students were analyzed when they collaborate to learn the concepts in physics within the concepts of conversational action, conceptual change, and shared knowledge.

Craig, Rick, and Julien (Group 1) and Malissa, Josh, and Bryce (Group 2) are undergraduates taking an introductory course in information science. The main difference in the tasks between the two groups is the content they read. The members of group 1 were assigned to read a whole chapter, while the members of group 2 were required to read one-third of the chapter. After that, group 1 individually constructed a whole map of a chapter, while group 2 members created only one-third of the map before their collaborative work. The evidence of social outcome is shared knowledge as a process for knowledge convergence. During the collaboration, ideally, learners interpret a situation, coordinate their understandings, and come up with a solution to a problem together, and this process leads to the outcome of convergence. Here we focus on knowledge convergence in socially shared meaning, and we found knowledge convergence in both groups but could not conclude their collaborative map is their knowledge convergence outcome.

Agency by grouping

"Agency refers to the capacity of an individual or group to affect change on some entity, person, experience, state… and it is also connected with the notions of power and control (Strauss and Feiz, 2014, p.293)." Two groups were required to construct a collaborative map after different task requirements: group 1 members were asked to read a whole chapter, while group 2 members were to allocate their reading by one-third of the chapter per individual for the knowledge dependency. We expected group 2 to be socially dependent on their achievement as the outcome is more likely to be affected by other members' commitment and knowledge.

Group 1, whose task was to read a whole chapter individually, caused to rise of a dominant leader. Grammatical and conceptual connotations of his utterance with controlling attitudes signified the role in the group. In their previous conversation, Craig asked what other nodes connected with the node of programming languages, and Rick suggested having programming as a node and branch off to higher-level language and lower-level language. In the excerpt below, Craig uses imperatives to provide direction, and the rest of the members agree and follow. When Rick suggests branching macro language off languages, Craig says, "that's what I will do." This sentence represents his way of agreement. Also, asking an obvious question is often used as a means of control.

Group 1- Independent
Craig – OK so then we're over here. I'll connect those in a second, just give me a sec. We'll put high level languages over here, and then while I'm connecting that you guys, uh, work on high level languages. We don't need a ton, I mean as long as we get some. Julian – Yeah, um… low level…assembly…machine…low level…high level… [reading out of book to himself] Craig – OK, uh…high level languages…[mumbling a little] algorithm. Oh OK, Ricky. I got you. I see what you're doing. OK, so high level languages… is that like basic and C and C++?

Rick – Yeah.
Julian – Yes.
Rick – You could also branch, uh, macro languages off of languages.
Craig - OK, that's what I'll do. Now do we have to cover the whole chapter?

Group 1- Independent
Julian - Did it – did it go across? It doesn't matter about that.
Craig – OK. Um, if you wanna move – Julius, if you wanna move Java up to the high level languages up there and I already got C++, so if you wanna move FORTRAN and- and Java up there, go ahead. OK Ricky, for macro you just had 4th generation and 5th generation?

This excerpt above is a dialogue between Julian and Craig. While Julian was constructing a part of the map individually, his link(edge) crossed the part Craig was working on. He overly reacted and indirectly instructed Julian what to do, limiting his work, and promptly changed the attention by talking to Rick obstructing utterance of Julian. These two excerpts describe his dominant behaviors showing the agency of the group. Unlike our assumption that the independent group will be more collaborative than the interdependent group because of the different content distribution, the independent group worked more cooperatively, and the agency was affected.

Group 2 represents distributed agency. Bryce interpreted the situation by asking a question about a task, and Josh provided solutions by mentioning other team members' maps shared in advance. In their decision-making process, they coordinated their understanding and came up with a solution how they wanted to work on, though the process took a long time. This is rather a collaborative process of decision-making than knowledge building of the learning content. Each member had authority or expertise in terms of the book knowledge because they all read the different sections of a textbook and constructed relevant parts of the map individually.

Group 2- Interdependent
Josh –so, if we just take systems design and development, put like a couple nodes off of it, then we can each tackle one of those nodes and just get the [Brian – Yeah.] high- the first two levels done – and then split off of a second tier.
Melissa –Right.
Bryce – Yeah.
Josh – Is that the three main categ – is that what they're – what they're - it's how people make programs, [garbled] programming languages and methodologies, and what else is there? Or is that it? Programs and perspectives? Systems analyst – analysis – and systems [garbled]?
Melissa – Yeah, it's right here…three nodes.
Josh –Then there's the science of computing. The next one…
Melissa – State of software.
Bryce - Oh, I see what you're doing. You're going through each thing.
Josh - Yup. And…that's it.
Bryce – That's it.
Josh – That's it.

Bryce – Um…OK. So, Melanie, for yours system development [Melanie – Yeah.] and lifecycle, your main points are analysis – I'm gonna write these down – analysis, design, development…
Melissa- Um, OK, sorry my screen is really small so I have to go back and forth. Um, analysis, design, development, implementation…
Bryce- I'll help you.
Josh - You want me to – [Melanie – Yeah.] is it cool if I start going from the beginning? I'll just start, start from the 'how people make programs'?
Bryce – Yeah, yeah. Um, retirement… um, implementation…oh maintenance, Melanie? OK and then…
Melissa –Is that all we really need for that, or do we wanna go in-depth at all?
Bryce – So with retirement we can do 'in with the old', the 'out with the new'.
Melissa – Let's see…
Bryce – Um, implementation…one of them is approaches to implementation.
Melissa – Yeah.

In the first excerpt, about 40% of the dialogue is to express agreement. Josh suggested creating a node, "system design and development" to begin, and the collaborative map was developed with each of the personal maps. After that, Bryce checked the assigned parts, and Josh created a few key nodes from his part, asking other key nodes to connect with. This excerpt reveals that Josh is leading the direction but not in a completely authoritative manner. The second excerpt represents Bryce helping Melissa to find relevant terms to connect with retirement and implementation. Again, there was no dominant leader in group 2. When the groups are compared regarding agency, the nature of group 2, distributed content expertise, made them cooperate more with positive social dependence. In contrast, the members in group 1 had the same content knowledge, even having a personal map of the content, so ideally, they were supposed to collaborate to negotiate the connection among nodes. However, instead, one dominant figure led the group conversation with relatively low social dependence.

Verbatim knowledge as a strong indicator of shared knowledge

Verbatim knowledge often refers to the items stated directly from the original text, such as remembering facts and stating knowledge as a lower order thinking, while inferential knowledge(conceptual knowledge) refers to the items needed to connect multiple concepts such as concept formation and problem-solving as higher-order learning (Clariana & Koul 2006; Blunt & Karpicke 2014). The concept mapping tasks require both verbatim and inferential knowledge given the complex procedures of identifying the main concepts and finding relationships among nodes by focusing on the organizational structure of the text while viewing the learning materials (Novak & Gowin 1984).

The unique and confounding aspect of this dataset is that all participants have their reference maps when collaborating to construct the group map, but retrieving and reciting those individual verbatim knowledge maps cannot be the evidence of shared knowledge. Thus, the verbatim knowledge we consider here is only when they refer to the textbook. Both groups referenced their textbook but were rare because of the personal reference maps. The behavior referencing their textbook appeared when checking the connections among nodes.

Group 2- Interdependent
Bryce – What stuff? That's um…programming languages and methodologies.

Josh – What does that connect to?
Bryce – Uh…let me open my [cut out] page book.
Josh – That go…
Bryce –…connect off the center. I hate this thing. So people make programs, and then programming languages and methodologies.

Group 1- Independent
Craig- Is computer science and the science of computing – are they the same thing?
Julian – Com…
Rick – Wait, what's that?
Craig – Uh, if you – the science of computing and computer science. Are they one and the same? Are we saying the same thing there?
Julian – Uh, the, um, that starts off the, um… it starts it off. If you look on 536 –
Craig – Yeah.
Julian -that's the title: The Science of Computing.

Knowledge Convergence

Interesting part in this discourse data originates from the artifacts: individual concept mapping. As all participants construct their personal concept maps based on their assigned reading before joining a collaborative work, their knowledge should be reflected on those individual maps, which are frequently referred to during discussion in both groups. Thus, we could induce that their references in these dialogues are mostly from their personal maps and could assume that when participants refer to their own maps during the group map construction (identifying the concept), negotiation occurs, and their group maps reflect their negotiation (finding relationship among nodes), we could see them as a process of knowledge convergence.

Group 2 Interdependent
Josh - …going to connect this here. This guy really needs to go here.
Bryce – What's up?
Josh - I, I'm only, I, I'm double linking up here…going crazy.
Bryce – Wait why are you double linking?
Josh – I – cause it make sense, I guess? I don't know where I'm going…[garbled] cross the stream.
Bryce – Do that magic thing to it.

In the excerpt above, Josh tried to double link with one node, and Bryce asked why he wanted to do it, which could be evidence of negotiation if Josh explained the reasons, but Josh intuitively did it saying "cause it make sense, I guess". To them, the auto-format function, "magic thing," seems like a convenient backup skill to verify their map. This excerpt is interesting considering the aspect of knowledge convergence: Josh brought a double linking problem and cannot explain the reason. Josh and Bryce both could have referenced the textbook, but instead, Bryce suggests auto-formatting, which might solve the problem without the retrieval process, whether that is either verbatim or conceptual knowledge. Thus, we cannot find the clues of knowledge convergence.

Group 2 Interdependent
Melissa – What still needs done yet?

Josh -…program with machine language.
Bryce – Are we going to put everything underneath, or…what did you guys wanna do? I guess we'll…
Bryce – I guess we can let it auto format? Or do you wanna –
Melissa – Well the systems lifecycle should be closer to the bottom cause that was like the end of the chapter.
Bryce – What? Oh are you saying this – is this wrong? Well would – I thought this would be the center and then there would be arrow pointing to each. Is that incorrect?
Melissa – No, no, I mean that's fine. It's just like the systems development comes after the programming languages – in the chapter, at least.
Bryce – I think we're good.
Melissa – Yeah.

In the excerpt above, they are checking the parts in the map not completed yet. Josh found a part (program with machine language) that needs attention, and Bryce suggested intuitive solutions, either putting everything underneath based on his knowledge or autoformatting. Melissa doubted his solution as she thought the node should go down to the bottom of the map because she assumed the terms in the textbook are chronologically delivered, which is incorrect. Bryce expressed his thought with reasoning, and Melissa did not rebut the point Bryce made but confirmed her understanding was slightly inaccurate in that system development should come after the programming languages. This dialog looks like a weak version of the negotiation process.

Group 2 Interdependent
Josh – It's gotta go there like that. That guy's gotta go there. [last part garbled] …get this over here…and then put this one…
Bryce – Do you just wanna do the [middle part cut out] the whole thing?
Josh – Uh it gets, I mean if we do it, we can try- we can try it out – Whoa! Whoa, what's go- what just happened? Hold on.
Melissa – Oh no.
Josh – That made no sense. Yeah that got bad real quick. Um the auto-format thing can sometimes mess up, so if we do it we gotta just one person do it so they can -can- they can undo it if it doesn't look right. But I think we're looking kinda good. It's pretty good. Well except for that one down there.

Before this excerpt above, the auto-formatting function had helped them organize the map, which led them not to deal with complex conceptual understanding connecting distributed concepts. Josh structured the map, and Bryce wanted to use the autoformat function again to make sure Josh was right. They realized this function does not always provide the solution indicating this team could at least notice when the map goes wrong. Each member's knowledge was not entirely engaged in this collaborative concept mapping process: they tried to solve problems working on the group map but did not show deeply engaging conversation using their individual knowledge.

Group 1- Independent
Craig – OK Rick, would you say macro languages off of languages as well?

Rick – Yeah...so then there’s um, you can have 4th generation languages and 5th generation languages. Craig –for macro you just had 4th generation and 5th generation? Rick – No, uh, make, make those just go off of languages too. Craig - Oh just – oh just keep macro languages by itself then? Rick – Yeah. Craig – OK. Rick – And under 4th generation you could have query language. And that’s all I had for – that’s all I had before for that. Craig - OK and you want me to do languages by itself? Rick – Yeah like have, uh, programming like branch off of languages. Craig – Like that? Rick – Yeah and then connect them. Yeah. Craig – OK, OK. So we do programming, we do languages. I remember there’s – there’s like what? There’s hi – there’s, uh, low level and high level languages, right? Rick – Yeah.

In the above two excerpts, members structurize the map to organize terms. Their dialogues above are questioning from Craig and answering and confirming from Rick. Craig primarily relies on the opinions of Rick, and Rick refers to his personal map. There is no further negotiation process as proof of converging knowledge, so their symmetry of knowledge in the content seems slant toward Rick even though all are supposed to read a whole chapter.

Group 1- Independent
Craig- computer science as one and then, um, off of computer science I actually had a ton, so I’ll work on that and then the other- the other big one that I had was system development lifecycle. I’m not sure if you guys had that or not. Rick – Wait, what was the first one you had? Craig – Computer science. Rick – OK. Craig – And then off of that was like I had – uh, actually from that one right there, that node – I had computer theory, algorithms, data structures, uh, programming concepts and languages, management information systems, software engineering, and computer architecture. There’s a ton. Rick – Yeah… Maybe we should put a node for like, um, chapter four – the name of chapter 14 somewhere? Then we could connect like the two main ones to that. Julian – That’s – that’s what we started with.

In comparison to the interdependent group (group 2), the collaboration of group 1 was superficial even though we assumed they were supposed to have an in-depth discussion as all members read the entire chapter. For example, some cognitive outcomes, a conceptual change based on the verbatim knowledge from the textbook, were expected by in-depth discussion to construct the map but not observed. There were some moments of shared knowledge, such as checking where each one is at in order to discuss from there, but that did not clearly represent knowledge convergence. The shared knowledge here is considered as a contribution of mutual knowledge in the process of grounding.

When it comes to the Cmap tool, group 1 did not desire to explore other functions besides connecting nodes to construct a map, whereas group 2 used the tool effectively to connect a chunk of nodes to another chunk though it became a time-saving tool not to do complex thinking. Whenever they were in problems connecting vertices, they agreed to use that auto format though they eventually learned this function did not always work. Finding relationships among nodes by focusing on the organizational structure of the chapter involves inferential and higher-order thinking.

Agency in knowledge convergence

We examined how the distributed agency affects the knowledge convergence compared to the concentrated agency. A context engenders different levels of collaboration: the collaborative work is more likely to be effective with people having a similar status and action (Dillenbourg, 1999). The agency particularly influenced the symmetry of action in this case. Craig's controlling and initiative manners led to unbalanced communication in collaboration. For example, turn-taking between Craig and Rick and Craig and Julian was more than 95%. From the beginning, Craig referred to Rick's map complementing and asked his opinions, and those Q&A style interactions were maintained until the end. His questions at the beginning were to distribute their mapping tasks and later to ensure specific nodes with links were right. Craig mainly initiated conversation without intent to learn; he has never tried to validate reasons or rationalize the concept, so there seem rare opportunities to converge their knowledge while constructing the map. This discussion, driven by one leader with this type of conversation, Q&A, did not lead members to converge their knowledge to identify the main concepts and find relationships among vertices.

However, the members of the interdependent group with the relatively distributed agency were more actively participated in elaborating the map by finding relationships referencing their textbooks. This distributed agency positively affects knowledge convergence. There were conflict-oriented consensus and integrate-oriented consensus (Weinberger and Fischer, 2006). For example, when Bryce asked the overall structure of the map to connect different chunks of nodes, two members replied, and that process went on for a couple of minutes (shared knowledge) while looking at the common map to decide the path of some nodes. Even though certain words were not explicitly spoken, interlocutors understood, and they maintained their interaction. Regarding the tool, they had a good collaborative process while exploring the tool; Josh tried to use a specific tool function, auto-format, to organize it. Melissa knew how to do it, and Bryce was interested in applying it.

Group 1- Independent
Craig- Um, tell me what goes, uh, Julius – what I would go to from low level languages?
Rick – Well low level's, um, machine and assembly languages.
Julian – Yeah I see machine, yeah.
Craig – OK hold on.
Julian – It says, it says, uh, machine, assembly, assembler, and low level.
Craig – OK.
Julian – And high level is completely separate.
Craig – OK. Machine is one –
Julian – So you could –
Craig – What – what are the other ones? Assembly?

Julian – Yes. Rick – Yeah. Craig – And what was the third one? Julian – Um... low level. Craig – Oh I thought machine and assembly were low level? Oh I think that's it. Rick – Those are the only two that – those are the only two I had in mine.

CONCLUSION

Online discussion, either asynchronous or synchronous, has been emphasized as an effective instructional strategy. In this research, we tried to investigate knowledge convergence while constructing a collaborative concept map, and little knowledge convergence as a clue of deeper learning in these two cases was found. The required individual task, drawing a concept map in advance, influenced collaborative work as most students rely significantly on their individual maps regardless of their groups, which is likely to reduce the situation for socially sharing meaning. Having an additional artifact, a concept map, obstructs students' discussion, so even if there was knowledge convergence, that was not observed. Also, creating a concept map with the unfamiliar tool was already an arduous task whose cognitive loads are probably negatively affected. That is, there were too many confounding factors to affect their knowledge convergence in their collaborative work. Instead of negotiating to connect nodes, students just used a certain function of the tool to avoid complex thinking, intuitively connected nodes, and passively accepted others' thoughts. Furthermore, knowledge convergence was not frequently observed in collaborative work when the content builds foundational knowledge. The group difference reveals a slight difference in their collaborating process in extent, but we could not find an absolute difference in knowledge convergence by analyzing the discourse in terms of grouping.

Finally, a verbatim recitation of a concept or inference rule was searched as this will be the strong evidence of shared knowledge. Their verbatim recitations were either from the textbook or their individual maps, but these recitations were not evidence of shared knowledge. Those citations were only the references. We assume it is because the content itself is not meaningfully interrelated but linearly arranged to the novice, unlike the concepts of Physics (Roschelle 1992). There still can be a negotiable place for knowledge convergence, but participants should understand the contents more thoroughly to interactively communicate for negotiating to link the nodes to reach that point. Future research will be needed to focus more on the attributes of knowledge convergence and design the intervention accordingly.

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Exploring the Characteristics of Instructional Design Professional Knowledge from a Facebook Community of Practice (CoP)

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Abstract

Online communities of practice (CoPs) in Instructional Design play an important role in creating and transferring professional knowledge (tacit knowledge). This study examines the characteristics of professional knowledge from 4,717 anonymized users' posts available in the Instructional Designer Facebook group from August 3rd, 2017 to September 9th, 2020. This group is the largest public group on Facebook with 17,640 members as of September 29th, 2021 (About Us CrowdTangle, n.d.). Natural language processing approaches, including n-grams, sentiment analysis, visualization of named entities, and topic modeling, were implemented to extract tacit knowledge from written forms of communication. Three topic models, including bag-of-words, TF-IDF, and sentence embeddings, showed topics related to corporate training, online training, authoring e-learning tools, resource downloads, virtual reality, mobile learning, and outsourcing e-learning development. In the visualization of relationships between named entities, this particular CoP is characterized by (1) the recognition of members' contribution and request for feedback, (2) the use of hashtags related to e-learning development and trends, and (3) the request for career advice related to the Instructional Design profession. The study has implications for developing practitioners' pedagogical proficiencies and establishing community knowledge management and curation practices.

Keywords: Communities of Practice, Natural Language Processing, Social Media

Introduction

Tacit knowledge, or tacit knowing, was initially coined by Polanyi (1983) to describe the type of knowledge that is difficult to transfer to another person. Lave and Wenger (1991) stated that CoPs are characterized by a shared domain of interest, joint community activities, and a shared domain of practice. While present studies examine Instructional Designers' professional development needs and roles in academic and corporate settings using observation and survey methods, studies examining sources of articulated professional knowledge (explicit knowledge) in a virtual environment are required to understand current knowledge structures and gaps in Instructional Design communities. In the knowledge management literature, empirical studies in tacit knowledge extraction use n-grams and topic modeling algorithms to capture semantic relationships from explicit knowledge. The study uses natural language processing approaches, including topic modeling techniques to make topic representations and word sequences from users' posts.

Literature Review

The following literature review identifies the ways technology supports online communities of practice, the collaborative context using information and communication technologies (ICT), and the characteristics of Instructional Design communities.

Technology to Support Communities of Practice

With the advent of more collaborative ICT in Web 2.0, members in a CoP can co-produce, organize, discover, and share knowledge within a collaborative online context. Using ICT to support knowledge production and collaboration, CoPs have become increasingly virtual or Internet-mediated communities of practice. Rheingold (2000) initially coined the term virtual community to emphasize the evolution of ICT technologies and human-computer interactions that connect individuals with organizational structures. Online communities are defined as "online social networks in which people, with common interests, goals, or practices, interact to share information and knowledge, and engage in social interactions" (Chiu et al., 2006, p. 1873).

Akoumianaki (2011) argued that technologies must support virtual communities of practice regarding functional and non-functional requirements. Functional requirements are the critical pieces of technology that support members' participation and engagement. In contrast, non-functional requirements refer to the supporting technological mechanisms that enable participants to facilitate and refine their knowledge exchange. According to Heap and Kelly (2004), technical means must support the core function of knowledge creation and sharing of online communities regarding functionality, integration, usability, security, performance, reusability, and support. When these mechanisms are present in online communities, ICT tools support members in four ways; (1) ideation, information and document sharing, (2) contact management, (3) messaging and discussion, and (4) meeting and conferencing (Heap & Kelly, 2004).

As knowledge consumers, Nilan et al. (2004) stated that users in online communities try to make sense of information within a specific search context. The design of online communities can either facilitate or hinder users' movement within the community. In their findings, Nilan et al. (2004) found that members spent most of their time searching and reading within the community. Examples of searching within the community included scanning for topics or news topics, checking out other users, selecting or clicking on options, and reading within the community (e.g., reading existing content, announcements, and responding to others). The authors also reported the hindrances that users faced in virtual communities. Poorly designed interfaces hindered users' iterative searching, reading, and writing/talking within communities.

Instructional Design and E-Learning CoPs and Competencies

Schwier et al. (2004) argued that Instructional Design CoPs are born of convenience that allows informal engagement to solve specific project challenges or issues. The authors also investigated the features of Instructional Design CoPs in terms of history and culture, mutuality, plurality, knowledge repository, and tacit knowledge. They found that shared history and culture were not prominent features in Instructional Design CoPs. In contrast, passive participation as a spectator was a critical element aligned with practitioners' agendas and community values. In terms of mutuality, community members developed their protocols for contribution and interaction with others. At the same time, community participation was based on the plurality of the intermediate relationships with other members (i.e., experts in the field) that provided a wide range of considerations and solutions to learning problems.

Due to the absence of a recognized accrediting body that identifies the required competencies for Instructional Design and Technology professionals, professional organizations have developed the competencies that define the knowledge, skills, and abilities of professionals in the field. Though several professional organizations developed their competencies, three prominent professional organizations use competencies to encapsulate the professional benchmarks, responsibilities, and capabilities of these professionals serving in different roles (e.g., Training Manager, Evaluator, Instructional Designer, and Instructional Technologist). These organizations are the American Talent Development (ATD), the International Board of Standards for Training, Performance, and Instruction (ibstpi), and the Association for Educational Communications and Technology (AECT).

Problem Statement

The characteristics of professional knowledge creation among Instructional Design CoPs in virtual environments are primarily unknown in the instructional design and technology literature. While present studies examine Instructional Designers' professional development needs and roles in academic and corporate settings, exploring sources of professional knowledge in virtual environments is required to understand the current knowledge structures and gaps in Instructional Design professional knowledge. Professional knowledge (tacit knowledge) is conveyed and shared in explicit or written form for and by community members.

Purpose & Significance of the Study

The purpose of the study is to extract tacit knowledge at the externalization stage (i.e., articulated professional knowledge) from users' written professional knowledge who are members of the Instructional Designer Facebook group. In the externalization stage articulated in the SECI model by Nonaka and Takeuchi (1995), explicit and tacit knowledge is generated, transferred, and recreated in organizations through socialization, externalization, combination, and internalization processes. The study explores the following research questions:

- **RQ 1**: What are the most frequent words and word sequences used in the CoP?
- **RQ 2**: What are the characteristics of sentiment, named entities, and relationships among entities in the CoP?
- **RQ 3**: What latent topic structures exist in the CoP?

The significance of this study involves a community's ability to manage their existing body of knowledge and leverage members' collaboration to generate new professional knowledge. CoPs act as knowledge stewarding communities where members can organize and manage a body of knowledge from which the community can draw professional learning to improve their practice. CoPs also act as a crowdsourcing mechanism where community members can generate professional knowledge by converting tacit knowledge, or know-how experiences in the field, into explicit forms (e.g., written texts, videos).

Theoretical Framework

Research studies in the knowledge management literature examine tacit knowledge extraction from explicit forms of knowledge in the workplace (e.g., online platforms, documents, and e-mail communication). These studies are explored through the SECI model, where knowledge is continuously created through socialization, externalization, combination, and internalization phases (Nonaka & Takeuchi, 1995). First, tacit knowledge is created through a socialization process, and its tacitness is difficult to codify into explicit knowledge. Second, tacit knowledge is externalized or articulated in symbolic language for sharing with other groups or individuals. Third, the combination step requires applying and reorganizing explicit knowledge. Fourth, when explicit knowledge is applied, individuals embody the knowledge as tacit through action and reflection.

Methods

The Instructional Designer Facebook group was chosen as a data source for this study. This public Facebook group was founded in 2011 by the E-learning Industry website. According to CrowdTangle Intelligence, a public insights tool from Facebook, the Instructional Designer group is the largest public group on Facebook with 17,640 members as of September 29th, 2021 (About Us CrowdTangle, n.d.; Instructional Designer, n.d.). Any Facebook user can request access to this group by answering a filter question related to their reason for joining the group.

A total of 6,760 anonymized users' posts from August 3rd, 2017 to September 9th, 2020 were extracted with Python scripts. After cleaning Facebook posts that contained "hi," "hi there," "hello all," and "good morning professionals," the dataset was reduced to 4,717 posts. Then a sentiment analysis was performed using the Textblob Python package. (*TextBlob: Simplified Text Processing — TextBlob 0.16.0 Documentation*, n.d.). Posts were also analyzed with a variety of natural language processing tasks, including (1) n-grams with NLTK, (2) Name Entity Recognition (NER) with the spaCy Python package, and (3) topic modeling using the Latent Dirichlet Allocation algorithm (LDA) and BERT (Bidirectional Encoder Representations from Transformers) (*Linguistic Features · SpaCy Usage Documentation*, n.d.; *Natural Language Toolkit — NLTK 3.5 Documentation*, n.d.; *Open Sourcing BERT: State-of-the-Art Pre-Training for Natural Language Processing*, n.d; *NetworkX — NetworkX Documentation*, 2014). N-grams are a sequence of words that predict the probability of the occurrence of words in the corpus. NER is a natural language processing task that locates named entities in texts into eight predefined categories or tags, including geographical entity, organization, product, person, time indicator, artifact, event, and natural phenomenon.

The known limitation involved the removal of external resources placed in Facebook posts, including shared resource documents, recommended articles, and video links. While the tacit knowledge representations of these communities are static for a given period, topic models will continue to evolve as members engage in knowledge creation and sharing in their respective communities.

Findings

After cleaning Facebook posts from 6,760 to 4,717, the study results are summarized below by research question.

RQ 1: What are the most frequent words and word sequences used in the CoP?

The average word count was 38.75 words, whereas the average sentence count was 3.14 sentences in the Instructional Design Facebook Group. In Figure 1, the most frequent words included “anyone,” “id,” “course,” and “looking.” In terms of n-grams, the top three most frequently occurring bigrams were “instructional, designer,” “instructional, design,” “hi, everyone,” and “im, looking.” The top three most frequently occurring trigrams were “elearning, elearningtrends, elearningdevelopment,” “hi, everyone, im,” “instructional, design, technology,” “thanks, advance, hi,” and “would, love, hear.” As shown in Figure 2, the most frequent 4-grams were “follow, u, learningpark, learn,” “elearning, elearningtrends, elearningdevelopment, lm,” and “learnandgrow, learnfromhome, learner, learningeveryday.”

Figure 1

Instructional Designer Facebook Group Word Frequencies

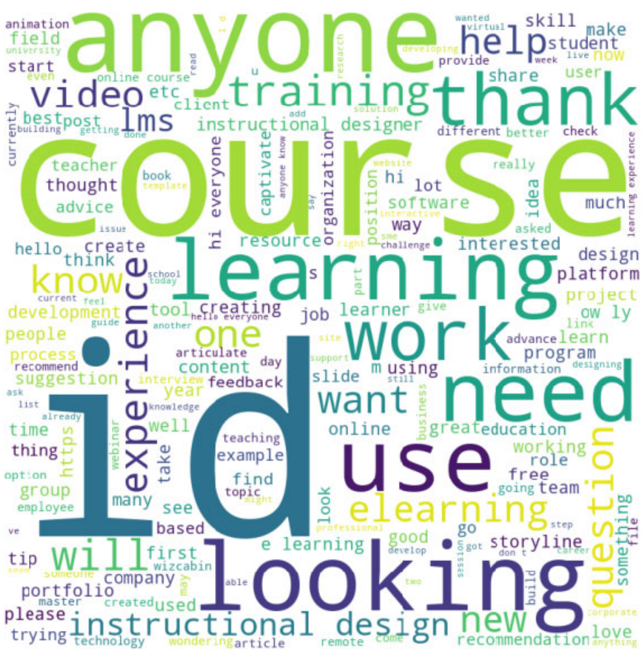
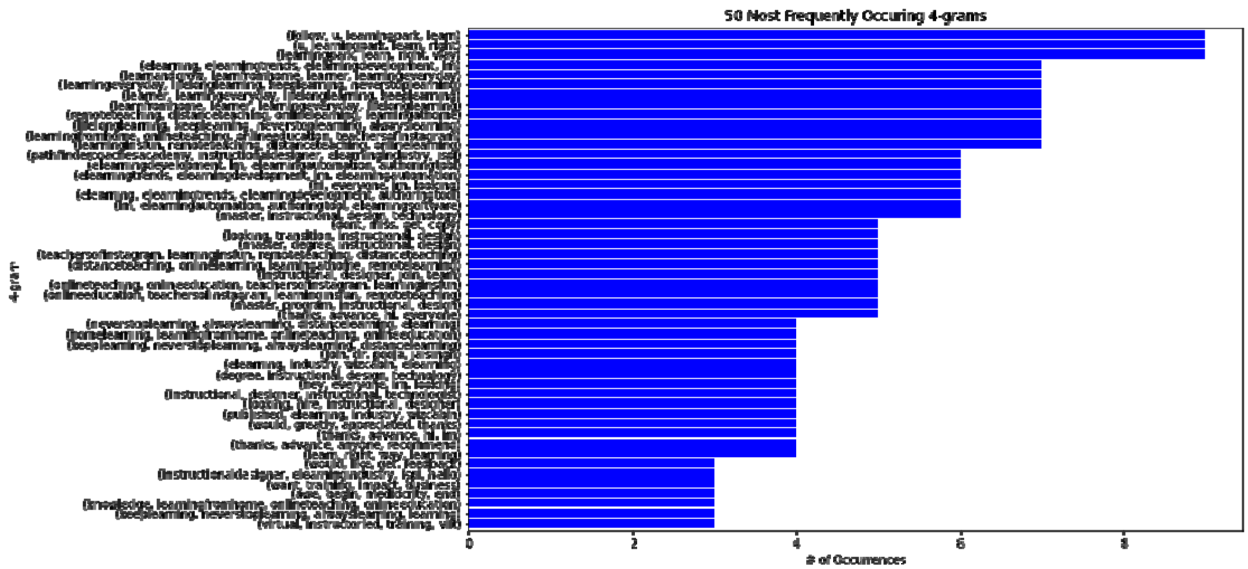


Figure 2

50 Most Frequently Occurring 4-Grams

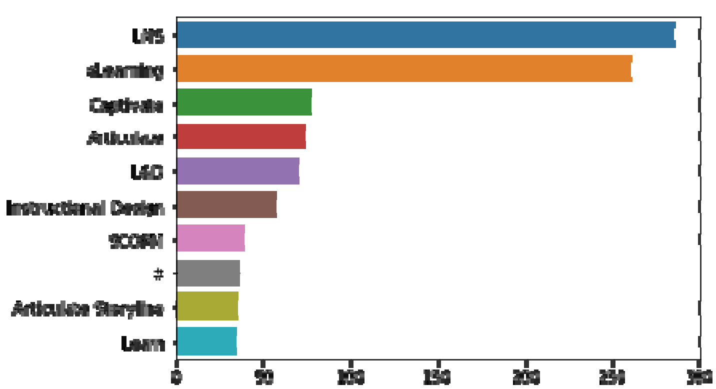


RQ 2: What are the characteristics of sentiment, named entities, and relationships among entities in the CoP?

The sentiment analysis indicated that most posts (3,298) had a positive sentiment, whereas other posts were either neutral (1,011) or negative (408) sentiment. In terms of recognized named entities, most entities were related to the organization entity. In Figure 3, most organizational entities were related to LMS, elearning, Captivate, and Articulate. The limitation of NER involved the lack of differentiation between entity types related to organization, product, person, and country or nationality entities. For example, NER assigned person and nationality entities to web conferencing tools, authoring software, and learning management systems. In terms of product entities, shared resources (e.g., e-books) were also recognized in the community. The entity relationships with the highest degree included "educational, animation," "instructional designer, e-learning industry," "responsive e-learning design, multidevice," and "just for fun, effective learners."

Figure 3

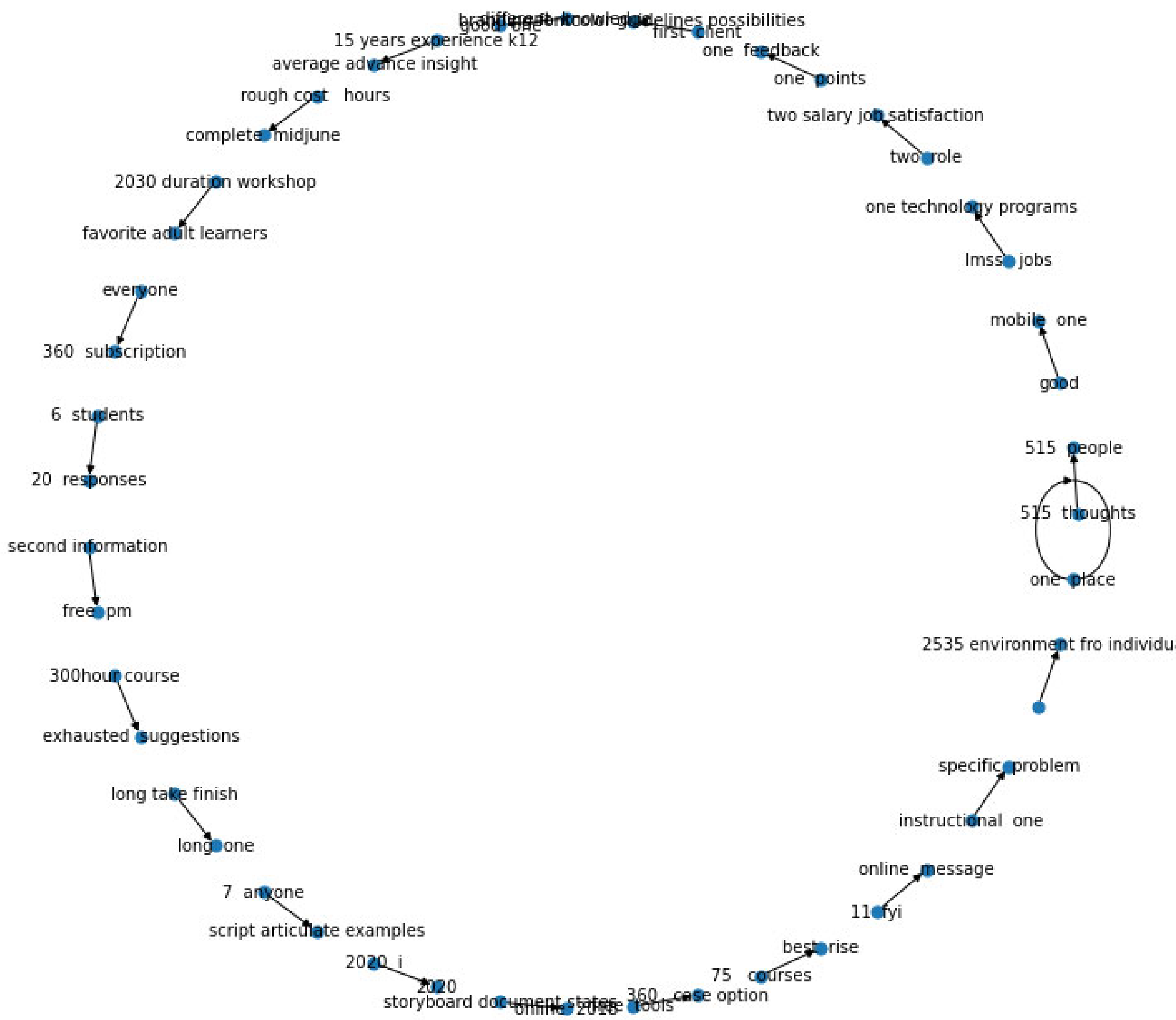
Most Frequently Recognized Entity Types



The most popular entities included “one” and “today,” whereas the most popular target entities had “good one” and “https.” The most popular relationships among entities were “thanks,” “thank” and “want.” When visualizing “thanks” as a popular relationship, as shown in Figure 4, members in this CoP appeared to engage with each other’s requests related to various topics, including resource sharing, Instructional Design graduate programs, and e-learning authoring software and hardware.

Figure 4

Most Popular Relationships for “Thanks” Entity



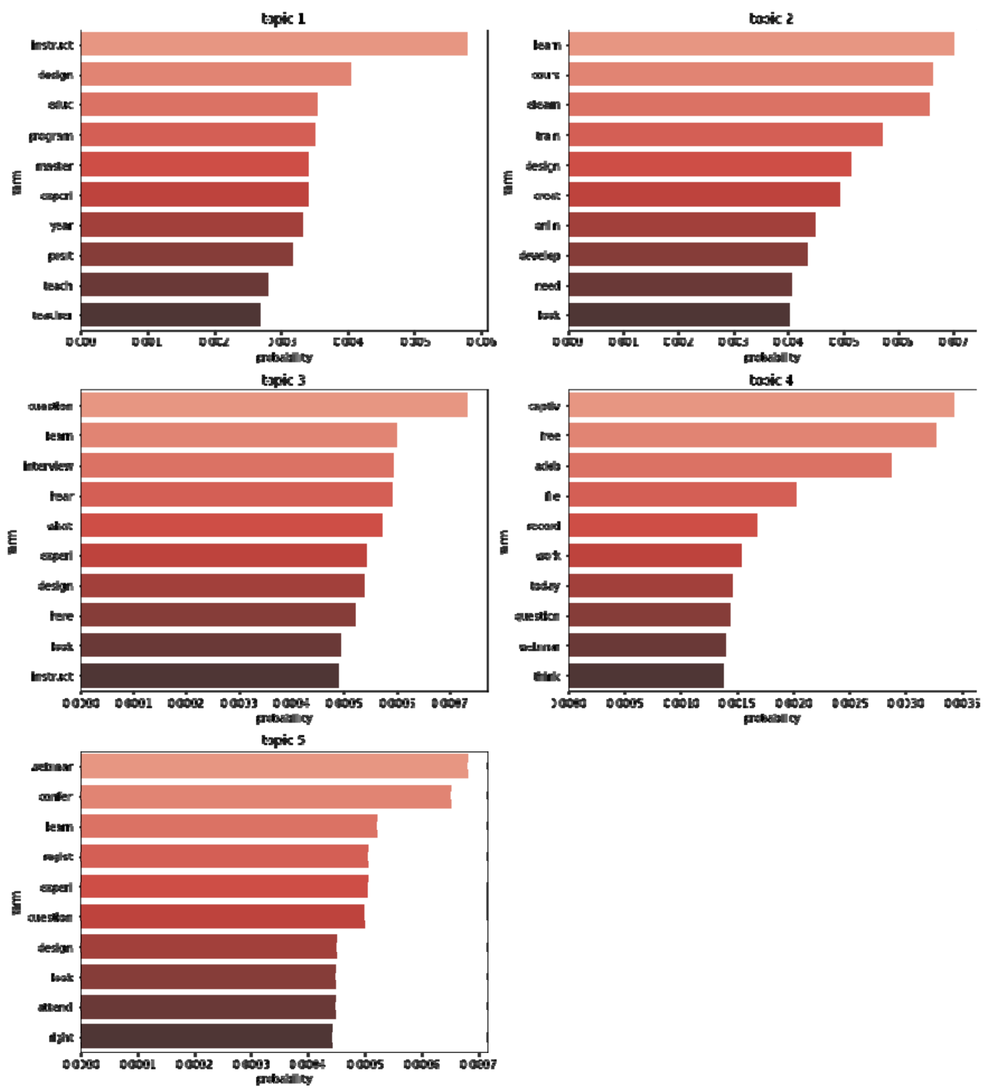
RQ 3: What latent topic structures exist in the CoP?

The bag-of-words, TF-IDF, and sentence embeddings topic models were developed to identify latent topics from the Facebook group. After obtaining the highest semantic coherence of 0.48 using five topics for the LDA algorithm topic parameter, as shown in Figure 5, the five topics in the bag-of-words and TF-IDF models had a similar distribution of topics related to:

1. Instructional Design job postings
2. Learner or student online training
3. Asking for advice related to e-learning authoring tools
4. Online course and video development
5. Sharing of webinar events

Figure 5

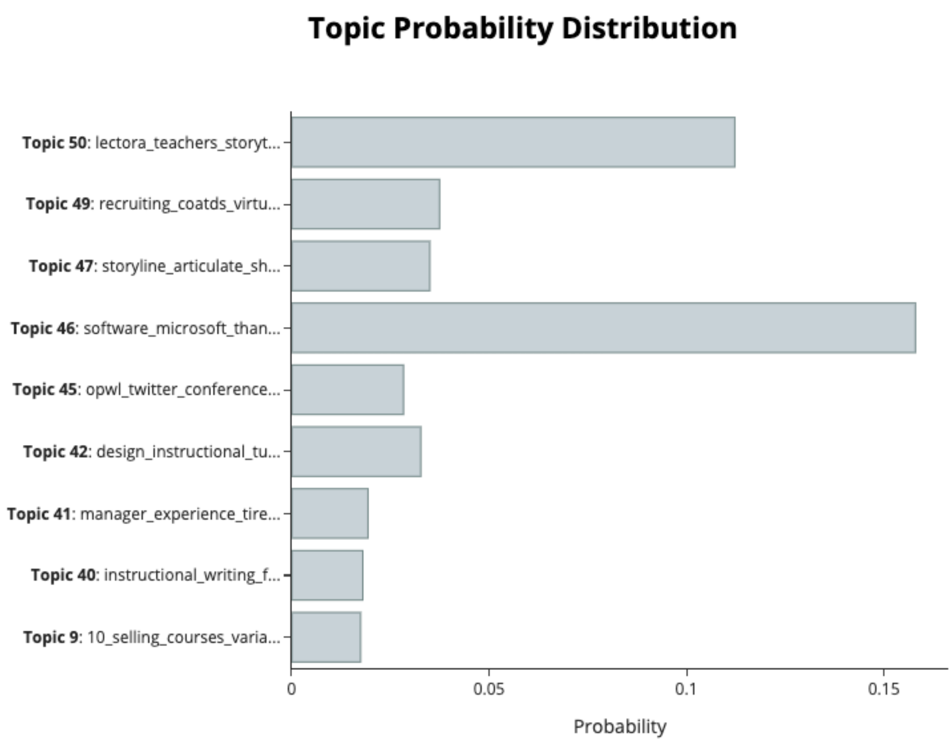
TF-IDF Model Topic Distribution



In the last model using sentence embeddings with BERT, the model automatically performed a dimensionality reduction and clustering of texts. Based on the intertopic distance map, the 74 topics were present in nine clusters. In Figure 6, the nine topics with the highest probability were as follows: (1) Microsoft products, (2) lectora and storyline e-learning authoring, (3) virtual recruiting, (4) story articulate, (5) conferences, (6) Instructional Design, (7) managerial/trainer jobs, (8) instructional writing, and (9) selling online courses.

Figure 6

BERT Topic Probability Distribution



Discussion

In the analysis of 4,717 users' posts from the Instructional Designer Facebook group, the average sentence word count was 38.75 words, and the average sentence count was 3.14 sentences. In terms of sentiment, 3,298 posts were positive, 1,011 posts were neutral, and 408 posts were negative. Words with the most frequency included: "id," "course," "learning," "anyone," and "looking." The most frequent 4-grams were "follow, u, learningpark, learn," "elearning, elearningtrends, elearningdevelopment, lm," and "learnandgrow, learnfromhome, learner, learningeveryday." The entity relationships with the highest degree included "educational, animation," "instructional designer, e-learning industry," "responsive e-learning design, multidevice," and "just for fun, effective learners."

In this particular CoP, there was an emphasis on learning management systems that support various tasks, including task management, employee onboarding, and compliance training. Based on the observed n-gram sequences and entities, the Facebook group posts appeared to suggest three aspects of knowledge sharing among members:

1. Recognizing members' contributions and requests for feedback through informal salutations and following certain users and posts
2. Using hashtags related to e-learning development and trends for resharing and following
3. Requesting career advice related to transitioning to the Instructional Design field

Although topic representations in the bag-of-words and TF-IDF topic models were almost identical using the LDA algorithm, LDA relied on semantic similarities based on words rather than the context of the words. To compensate for the shortcomings of LDA, BERT allowed for discovering subtopics and topic outliers based on the context of the surrounding words. In the BERT topic model, nine topics were prominent in the Facebook group, including (1) Microsoft products, (2) lectora and storyline e-learning authoring, (3) virtual recruiting, (4) story articulate, (5) conferences, (6) Instructional Design, (7) managerial/trainer jobs, (8) instructional writing, and (9) selling online courses.

Implications & Future Research

The empirical evidence of tacit knowledge structures informs researchers and practitioners about the present capabilities and strengths of CoPs in producing and sharing knowledge in certain areas of Instructional Design expertise. Other research can build on new ways of creating and supporting new tacit knowledge production in virtual CoPs by experimenting with content curation practices, knowledge discovery mechanisms, repository tools, and social knowledge representation methods described by Cagliero and Fiori (2012) (e.g., subject-based classification, folksonomy, and structured knowledge). It is recommended that Instructional Design CoPs adopt a taxonomy or classification system based on professional competencies to organize existing professional knowledge and improve knowledge discovery within the community. Even though the primary function of this CoP is to support educational technology needs, building pedagogical proficiencies in Learning Sciences, Instructional Design, and Knowledge Management is also essential for practitioners' professional development.

Conclusion

The resulting study contributes to understanding the knowledge production capabilities and shared practices in Instructional Design CoPs. After analyzing 4,717 anonymized posts from a public Facebook group in Instructional Design, popular word frequencies and n-grams were related to asking peers and looking for solutions. While named entities were related to learning management systems and e-learning tools, the network visualization of these entities showed active engagement in seeking advice related to resources, Instructional Design graduate programs, and software tools.

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Visualizing Google and YouTube Search Trends for COVID-19, Instructional Design, and Remote Learning

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Abstract

As educational institutions switched from in-person to Remote Learning or Emergency Remote Teaching (ERT), this study explores the search popularity indices of three search terms globally and in the USA from January 2020 - April 2021. Google search terms, such as *COVID-19*, *Instructional Design,* and *Remote Learning*, showed considerable search interest in Google Trends at the peak of the pandemic on Mach 11, 2020 (WHO, 2020). Pytrends was used to extract search interest of the primary and related terms from Google and YouTube Search globally and in the USA (Pytrends, n.d.). The search interest of the three search terms and associated terms exhibited similar peaks and dips of interest at the beginning of the pandemic and the 2020-2021 school year. Educational technology tools, including *SeeSaw Learning* and *Zoom,* were present as related search terms for *Remote Learning*. Search queries in YouTube revealed educational channels that host various lecture materials related to K-12 and professional development. The interactive visualizations in Tableau Public enable users to explore the search trend patterns of the three main terms and related queries. This project serves as an archive of users' conscious information seeking to highlight the pivotal roles of Instructional Design and Remote Learning observed in search popularity indices in light of the pandemic. The project can be accessed at edtechtrends.javierleung.com or on Tableau Public (Leung, n.d-a, n.d.-b).

Keywords: Instructional Design, Remote Learning, COVID-19

Introduction

The World Health Organization (WHO) declared the novel coronavirus (COVID-19) outbreak a global pandemic on March 11th, 2020 (WHO, 2020). Since the beginning of the pandemic, 1.3 billion learners are still affected by the school, and university closures as institutions implement entirely online and hybrid solutions (UNESCO, 2020). As instructors in higher education and K-12 adapt their face-to-face curricula to distance delivery formats, the role of Instructional Design and Technology has been a critical element in creating equitable access to learning experiences for all kinds of learners.

This study reports on a data visualization project of global and USA search trends related to *Instructional Design, Remote Learning,* and *COVID-19* before the pandemic and at the peak of the pandemic across Google and YouTube Search. This project explores popularity indices in a single interactive interface using Tableau Public by querying the Google Trends API. The project also enables users to explore search popularity indices of multiple search terms over time from January 2020 through April 2021. In these visualizations, the audience can interact with the search popularity indices for trending searches and related queries for three search terms (i.e., *Instructional Design, Remote Learning,* and *COVID-19*). Although Google Trends provides a way for exploring the popularity index (0% - 100% being the most popular) of an individual search term for the past 12 months or since 2004 for specific search terms, the interface of Google Trends does not allow for exploration of multiple related terms. This project provides a better understanding of the pivotal role of Instructional Design, Remote Learning, educational technology tools in the context of the COVID-19 popularity index.

Literature Review

The following literature review is divided into two sections. The first section describes the needs of educators in ERT during the COVID-19 pandemic. The second section describes the applications of Google Trends in academic and clinical research.

Emergency Remote Teaching and Learning

During the Spring of 2020, K-12 schools and institutions of higher education moved face-to-face classes to online formats to prevent the spread of the virus that causes COVID-19. As the 2020-2021 school year has progressed, schools have faced the difficult transition to emergency remote teaching (ERT) while keeping students, faculty, and staff safe. Hodges et al. (2020) clearly defined the differences between ERT and online learning. ERT is the shift of instructional delivery to alternate delivery modes due to crisis circumstances. In contrast, online learning involves design decisions for effective online learning based on Instructional Design choices that generally require six to nine months before the course is delivered (Hodges et al., 2020). Furthermore, Barbour et al. (2020) identified the four phases of educational institutions responding to the COVID-19 pandemic. The first phase involved a rapid transition to remote teaching and learning where the health and safety of students and educators were the most critical aspect while transitioning course materials to synchronous (e.g., video over Zoom or WebEx) and asynchronous (e.g., Google Slides and VoiceThread) online formats in four weeks. The second phase required ERT to include essential components, including (1) course navigation, (2) equitable access, (3) student support mechanisms, and (4) academic integrity. As face-to-face courses were transitioned to ERT with acceptable mechanisms for delivering quality learning experiences, the third phase involved careful planning in supporting students and educators for a full term for online delivery. In the fourth phase, K-12 schools and institutions of higher education had new levels of online learning infrastructure to support students and educators.

Supporting the Needs of Educators

Recent studies have identified the needs and challenges of educators (e.g., faculty in higher education) and staff (e.g., Instructional Designers and Technologists) in delivering ERT to students and supporting the professional development needs of educators in the light of the ongoing global COVID-19 pandemic. Redstone and Luo (2021) reported the types of professional development (e.g., teaching, community, and organization support) that instructors in higher education needed during ERT. Their principal findings included a centralized information hub for resources to support ERT transition and community support for self-directed and peer-to-peer social activities (Redstone & Luo, 2021). Also, Vollbrecht et al. (2021) identified design considerations for ERT delivery. Seven suggestions include (1) considering learners in different time zones, (2) team-based teaching in synchronous sessions, (3) increasing faculty availability for student questions, (4) providing specific time for troubleshooting technical difficulties and classroom breaks in synchronous sessions, (5) providing several learning opportunities in both synchronous and asynchronous formats, (6) considering the well-being of students and educators, and (7) findings ways to engage students virtually.

Google Trends for Research

Google Trends is widely used to complement traditional academic and clinical research to predict or forecast outcomes (e.g., economic activity, disease tracking, and user's search behavior) in a given geographical area (Levinthal, 2021). In epidemiology, several studies using Google Trends data helped predict the spread of respiratory diseases in geographic regions of interest (Polgreen et al., 2008; Brownstein et al., 2009; Valdivia & Monge-Corella, 2010; Mavragani & Gkillas, 2020). Google Trends can also be used as a surveillance system to detect disease outbreaks. For example, Carneiro and Mylonakis (2009) argued that Google Trends could detect regional influence outbreaks 7-10 days before conventional surveillance systems used at the Centers for Disease Control and Prevention. In economics, Google Trends is used to predict several economic metrics, including unemployment claims in the US, Germany, and Israel (Choi & Varian 2009; Askitas & Zimmermann, 2010) and consumer and consumption sentiment (Huang & Penna, 2009; Schmidt & Vosen, 2009).

Problem Statement

The COVID-19 crisis brought immense challenges to educators and instructional staff around the globe. It is hypothesized that Instructional Design, Remote Learning, educational technology tools are critical knowledge and skills for ERT delivery. Therefore, Google and YouTube searches should reflect users' information needs, especially at the beginning of the pandemic and the 2020-2021 school year.

While models of information behavior exist to explain why users seek information, this exploratory study does not adhere to a specific information behavior model due to various users' motivations, needs, and their roles in the search, and possibly avoidance, of information. Despite the lack of generalizability of information behavior captured in Google Trends, Case and Given (2016) identified the agreed-upon terminology in the information behavior literature, including information need, information seeking, and information behavior. An information need refers to the inadequate knowledge that users have. Information seeking is the conscious effort to acquire knowledge in response to the need or gap. Information behavior is complex and encompasses both conscious and unconscious information seeking, encountering, or avoidance.

Purpose & Significance of the Study

The purpose of this study is two-fold. First, this study explores the popularity indices of *COVID-19, Instructional Design, and Remote Learning* as the primary search terms from Google and YouTube Search from January 2020 - April 2021 globally and in the United States. Second, the study seeks to identify the peaks and dips of user search interest in light of the COVID-19 pandemic. The study explores the following research questions:

- **RQ 1**: What are the related search terms for *COVID-19, Instructional Design,* and *Remote Learning* from Google Search and YouTube Search globally and in the USA?
- **RQ 2**: What are the peaks and dips in popularity indices for *COVID-19, Instructional Design,* and *Remote Learning* from Google Search and YouTube Search globally and in the USA?

The study's findings allow for an exploration of search interest for knowledge in Instructional Design, Remote Learning, and educational technology tools to support the transition from face-to-face to the ERT format as educational institutions grapple with the pandemic. The following section describes the extraction methods and visualization components.

Methods

The Python Pytrends package was used to connect to the Google Trends API to extract search popularity indices of three keyword searches, *COVID-19*, *Instructional Design*, and *Remote Learning,* from Google Search and YouTube Search (*Pytrends*, n.d.). These search trend reports identify the normalized search volume of keywords and topics by state or province, country, and continent. Although Google Trends data does not indicate the real-time volume of searches, the data is normalized from 0 -100 to describe the search interest of topics (i.e., 0 being the lowest and 100 being the maximum peak of interest) for the past five years or 2004 for specific search terms (*FAQ about Google Trends Data - Trends Help*, n.d.).

For this particular study, the *TrendReq*, *Interest Over Time*, and *Related Queries* methods in the Pytrends Python package were implemented to automate the download of search trend reports from Google Search and YouTube Search from January 2020 - April 2021. Each report described the popularity indices of the keywords mentioned for the United States and globally. To further identify the related search term queries for *COVID-19*, *Instructional Design*, and *Remote Learning,* the *Related Queries* method in Pytrends allowed the extraction of the search trend data of related queries. Five known limitations of this study involved the following:

1. Filtering certain search terms
2. Extracting top search terms over rising search terms
3. Eliminating related and repeated main search terms and their variations that do not align with the context of Instructional Design and Remote Learning
4. Censorship of Google and YouTube in certain countries
5. Global search volume can be skewed

First, Google Trends filters certain types of searches, including searches with a volume of *0* or very few searches made by few people, duplicate searches, or repeated searches from the same person over a short period, and searches with special characters that use apostrophes and other special characters. Second, Google Trends allows extracting top and rising searches. While top searches are the terms with the most frequency, rising searches are the terms that have had significant growth over time. For this particular study, rising terms were not considered because of the changing nature of search volume growth. Unlike rising terms, top searches reflected the real search interest of individuals in the USA and globally. Third, the visualizations did not include related and repeated main search terms, including *breathing exercises covid-19, covid-19 vaccine, instructional materials design,* and *instructional design jobs*. However, the terms above are included in Tables 2 and 3. Fourth, certain countries do not allow access to Google and YouTube. Crimea, Cuba, Iran, North Korea, and Syria do not allow access to Google services (*Countries or Regions Where Google Workspace Is Available - Google Workspace Admin Help*, n.d.). China, Eritrea, Iran, North Korea, Sudan, South Sudan, Syria, Tajikistan, and Turkmenistan do not allow access to YouTube services (Wikipedia contributors, n.d.). Fifth, there is a possibility that search index volume from Google and YouTube Search can be skewed based on a country's search volume. For example, the majority of search volume may come from the USA and India for global search trends. For this study, the global search index includes the United States and other countries, excluding countries where Google and YouTube are banned.

Two datasets were assembled to represent the popularity indices of various search terms to describe the search trends for the primary keyword searches and related terms in the United States and globally. Each dataset was subsequently visualized on a weekly basis in Tableau Desktop. Even though trend reports are insightful in understanding the peaks and dips of search interest of specific terms, the COVID-19 pandemic adds a vital context related to the information seeking of users in understanding the need for information in Instructional Design and Remote Learning. The design of the Tableau dashboards involved following six fundamental principles of information design by Tufte (1983), including comparison, causality, multivariate, integration, documentation, and context. Each Tableau dashboard is contextualized around COVID-19 milestones and news related to vaccine development by the World Health Organization (WHO), U.S. Food Drug and Administration (FDA), United Nations (UN), and National Institutes of Health (NIH). These important milestones are annotated in the search trend data for the *COVID-19* term along with its respective search popularity index. While the beginning of the 2020-2021 school year varies in the USA, the school year was annotated on August 1st, 2020. A summary of milestones and indices is depicted in Table 1.

Table 1

Summary of Milestones and Search Popularity of Main Terms by Google and YouTube Search

Date	Milestone	Global COVID19 Index	USA COVID/ COVID19 Index	Global Instructional Design Index	USA Instructional Design Index	Global Remote Learning Index	USA Remote Learning Index
03/11/2020	**Milestone 1:** WHO declares COVID-19 a pandemic	Google 86 YouTube 67	Google (Covid) 100 YouTube (Covid19)	Google 37 YouTube 57	Google 51 YouTube 51	Google 100 YouTube 63	Google 63 YouTube 63

			19				
06/26/2020	WHO announces 2 billion doses of COVID-19 vaccine	Google 11 YouTube 12	Google (Covid) 82 YouTube (Covid19) 12	Google 76 YouTube 76	Google 69 YouTube 69	Google 17 YouTube 69	Google 71 YouTube 21
07/27/2020	Phase 3 clinical trial of an investigational vaccine for COVID-19 begin	Google 12 YouTube 11	Google (Covid) 73 YouTube (Covid19) 11	Google 79 YouTube 71	Google 87 YouTube 79	Google 60 YouTube 60	Google 73 YouTube 60
08/01/2020	**Milestone 2:** Beginning of 2020 school year (USA)	Google 75 YouTube 7	Google (Covid) 63 YouTube (Covid19) 7	Google 84 YouTube 84	Google 71 YouTube 71	Google 79 YouTube 79	Google 88 YouTube 79
12/18/2020	**Milestone 3:** FDA grants emergency use authorization to Pfizer and BioTech's coronavirus vaccine	Google 59 YouTube 35	Google (Covid) 85 YouTube (Covid19) 35	Google 30 YouTube 46	Google 51 YouTube 46	Google 100 YouTube 10	Google 30 YouTube 19
02/27/2021	**Milestone 4:** FDA grants emergency use authorization to J&J 's Covid-19 vaccine	Google 35 YouTube 6	Google (Covid) 67 YouTube (Covid19) 6	Google 60 YouTube 60	Google 13 YouTube 60	Google 10 YouTube 15	Google 16 YouTube 15
04/20/2021	**Milestone 5:** Global tally of deaths from Covid-19 surpasses 3 million	Google 19 YouTube 32	Google (Covid) 53 YouTube (Covid19) 32	Google 42 YouTube 42	Google 38 YouTube 42	Google 10 YouTube 10	Google 8 YouTube 14

Four Tableau dashboards were published to identify Google and YouTube search trends globally and in the United States for *COVID-19, Instructional Design,* and *Remote Learning.* The terms *Instructional Design, Remote Learning,* and *COVID-19* are selected by default in the dashboards. Also, the terms of interest contained annotations of the selected terms with their respective peaks of search interest and their average popularity indices. Multiple terms can be selected and highlighted using the selection menu to compare search trend data further. As search terms are chosen, the terms are color-coded with their respective labels on the trend chart. To better navigate the charts, it is recommended to view the dashboards in full-screen mode.

Findings and Discussion

It is essential to point out that *Covid19* had more peaks in Google Search globally than *Covid-19*. In the United States, *covid* was more prominent than other term variations (e.g., *Covid-19, Covid 19, and Covid19)* in Google Search. In the United States, *Covid* was the primary search term in Google Search, whereas *Covid19* was the prevalent search term in YouTube Search. Interestingly, the term *Emergency Remote Teaching* and its variations (e.g., *ERT, Emergency Remote Learning, and Emergency Remote Teaching and Learning*) did not appear as related terms to *Instructional Design* or *Remote Learning*. It seems that users were more acquainted with *Remote Learning* and associated educational technology tools.

RQ 1: What are the related search terms for *COVID-19, Instructional Design,* and *Remote Learning* from Google Search and YouTube Search globally and in the USA?

For *COVID-19*, the related terms included *Covid19* for global Google Search and *Covid* for USA Google Search. Also, related search terms (i.e., cases, deaths, news, symptoms, and testing) to *Covid19* were prevalent in Google Search in the United States. Related combinations such as *Instructional Design + Remote Learning* were present in both global and USA Google Search. *Remote Learning* also contained related terms, including *E-Learning + Remote Learning* in global Google Search and *covid19 + remote learning* in the USA Google Search.

Interestingly, related terms to *Remote Learning* in global Google Search included an educational technology provider (i.e., *Seesaw Remote Learning*) and a web conferencing tool (i.e., *Zoom*). Seesaw Remote Learning is an online classroom app that delivers asynchronous and synchronous learning with feature-rich communication and class management tools. In addition, Seesaw provides integration of Google Classroom and support of BYOD (i.e., Bring Your Own Device) to allow students' personal devices with access to school resources (*Seesaw*, n.d.). Zoom is better suited for synchronous remote and hybrid learning as a web conferencing tool for teaching and learning. Zoom also supports a variety of engagement strategies, including formative strategies (e.g., quizzes and surveys) and brainstorming activities (e.g., breakout rooms, screen sharing, and interactive whiteboard) (*Zoom for Education*, n.d.). Table 2 summarizes the related terms or queries for the search terms of interest (*COVID-19, Instructional Design,* and *Remote Learning*) from Global and USA Google Search.

Table 2

Related Search Terms for Global and USA Google Search

COVID-19		***Instructional Design***		***Remote Learning***	
Global	**USA**	**Global**	**USA**	**Global**	**USA**
Covid-19 *Covid19* *covid19 + remote learning*	*Covid* *Covid 19* *Covid-19* *Covid19* *Vaccine* *Covid19 Cases* *Covid19 Deaths* *Covid19 News* *Covid Symptoms* *Covid19 Us* *Covid19 Testing*	*Instructional Design* *Instructional Design + Remote Learning*	*Instructional Design* *Instructional Design + Remote Learning*	*E-Learning + Remote Learning* *Elearning + Remote Learning* *Zoom* *Seesaw Remote Learning* *School Remote Learning*	*Doe Remote Learning* *Zoom* *Seesaw Remote Learning* *Zoom Remote Learning* *Zoom For Remote Learning* *What is Remote Learning* *Remote Learning Tips* *Remote Learning Setup* *Remote Learning Fall 2020*

					remote learning *covid19 + remote learning*

For the term *Covid-19*, the related terms were variations of the search term (*covid* and *covid 19*), *covid-19 vaccine*, and *covid-19 + remote learning* in global Youtube Search. In contrast, in USA YouTube Search, related terms were *covid* and *breathing exercises covid-19*. In terms of *Instructional Design* in global YouTube Search, related terms were related to the design of instructional materials and jobs in Instructional Design. However, related terms to *Instructional Design* were not present in the USA YouTube Search. For *Remote Learning* in global YouTube Search, three related terms were related to *covid* and two YouTube channels that host free educational content, including Vidura and Gours. Vidura eLearning is based in Sri Lanka with approximately 19,000 subscribers and provides educational content from grades 1 through 5 (*Vidura eLearning*, n.d.). Gours eLearning is based in India with about 52,000 subscribers and offers financial education and certification resources in online instructor-led and self-paced formats (*Gour's e-Learning*, n.d.). Table 3 summarizes the related terms or queries for the primary key search terms (*COVID-19, Instructional Design,* and *Remote Learning*) from Global and USA YouTube Search.

Table 3

Related Search Terms for Global and USA YouTube Search

COVID-19		***Instructional Design***		***Remote Learning***	
Global	**USA**	**Global**	**USA**	**Global**	**USA**
covid *covid-19 vaccine* *covid 19* *covid-19 + remote learning*	*covid* *breathing exercises covid-19*	*instructional materials design* *instructional design jobs*	N/A	*covid* *vidura elearning* *gours elearning*	N/A

RQ 2: What are the peaks and dips in popularity indices for *COVID-19, Instructional Design,* and *Remote Learning* from Google Search and YouTube Search globally and in the USA?

A total of ten findings were found in comparing popularity search indices for Google and YouTube Search in the United States and globally. Overall, this study's terms of interest and related terms exhibited similar peaks and dips of search interest at the start of the pandemic in March 2020 and the 2020-2021 school year. The section below highlights the findings by global and USA Google Search and YouTube Search.

Global Google Search

Finding #1. The search term *Covid19* had more peaks than *Covid-19*. *Covid19* received more search interest than *Covid-19* in Google Search globally.

Finding #2. The search terms *Covid19, E-Learning + Remote Learning, Elearning + Remote Learning, Instructional Design + Remote Learning,* and *Remote Learning Fall 2020* exhibited similar peaks of interest in Google Search globally.

Finding #3. *Remote Learning* had two significant peaks of interest at the beginning of the pandemic and the 2020-2021 school year, followed by a downward trend in Google Search globally.

USA Google Search

Finding #4. The term *Covid* was the most prominent with an upward trend than any other variation of the term (*Covid-19, Covid 19, and Covid19)* in USA Google Search.

Finding #5. The term *Instructional Design* was at its highest peak (100) on July 12th, 2020. Then it levelled off in 2021 with search interest approximately at 65 in USA Google Search. *Instructional Design* remained independent of the pandemic's peaks of interest for *Covid* and its related terms.

Finding #6. The terms *Covid* and *Remote Learning* terms exhibited similar peaks of interest at the beginning of the pandemic and the 2020-2021 school year. About *Covid*, *Remote Learning* was at its highest after 18 days of the beginning of the pandemic and after 32 days at the beginning of the school year in August 2020. After October 2020, the *Remote Learning* term experienced a drastic downward trend by the end of 2020 and the beginning of 2021. It would be possible that public and private institutions have leveraged educational technologies to deliver learning in online and hybrid formats at the beginning of the Fall of 2020.

Global YouTube Search

Finding #7. The terms *E-Learning + Remote Learning, Elearning + Remote Learning, Remote Learning,* and *remote learning* had similar peaks and dips search interest in YouTube Search globally.

Finding #8. *Remote Learning*, *remote learning,* and *Instructional Design + Remote Learning* experienced two significant peaks at the height of the pandemic and the 2020-2021 school year, followed by a downward trend in early 2021. Global YouTube Search interest for *Instructional Design* did not seem to show significant peaks and dips in 2020 and early in 2021.

USA YouTube Search

Finding #9. In the USA YouTube Search, *Zoom, Zoom Remote Learning, Covid19, Covid-19, Instructional Design + Remote Learning,* and *covid19 + remote learning* exhibited significant peaks at the beginning of the pandemic in March 2020 and the 2020-2021 school year in August 2020.

Finding #10. In the USA YouTube Search, *Instructional Design + Remote Learning* and *Zoom* showed similar search interest with peaks of interest at the beginning of the pandemic and

2020-2021 school year. However, *Instructional Design* exhibited no significant peaks or dips in search interest on YouTube and experienced two significant peaks (100% interest) on July 12th and September 20th, 2020.

Implications & Future Research

The study presents implications for practice and research. The significance for practitioners involves bringing awareness of centralized information hubs to help educators and students transition to ERT and establishing communication plans for resource-sharing among Instructional Designers and Technologists who support educators' professional development. The implication for researchers identifies the need to study the main search terms and their related queries to understand users' information seeking and needs in emergency situations. Research can also focus on anticipating information seeking by exploring upward and downward trends in search queries.

Conclusion

This study accomplishes two goals: (1) keeping an archive of information seeking from search engines and (2) highlighting the search interest of Instructional Design, Remote Learning, and educational technology globally and in the USA across Google and YouTube Search from January 2020 - April 2021. The search term *Remote Learning* and *Covid* had similar peaks of search interest in USA Google Search at the beginning of the pandemic in March 2020 and the 2020-2021 school year. In USA Google Search, the highest peak for *Remote Learning* occurred 18 days after the highest peak for *Covid*, and 32 days after the beginning of the school year, given the assumption that the school year began in the first week of August.

The search term variations of the *COVID-19* terms were C*ovid-19, Covid19,* and *covid19 + remote learning* in global Google Search. Related terms to *COVID-19* included *Covid19, Covid19 Cases, Covid19 Deaths, Covid19 News, Covid Symptoms, Covid19 US,* and *Covid19 Testing* in USA Google Search. Related terms to *Instructional Design* were *Instructional Design + Remote Learning* in USA Google Search. Associated terms for *Remote Learning* showed educational technologies (e.g., *Zoom, SeeSaw, Remote Learning Setup,* and *E-Learning*) in global and USA Google Search. In USA Google Search, related terms to *Remote Learning* included governmental guidance (e.g., *Doe Remote Learning*) at the beginning of the 2020-2021 school year.

The related search terms for *COVID-19* were *vaccine* and *remote learning* in global YouTube Search, whereas *breathing exercises covid-19* was present in USA YouTube Search. *Instructional Design* did not have any related terms to *COVID-19* and *Remote Learning* in global and USA YouTube Search, except for *instructional materials design* and *instructional design jobs.* In global YouTube search, related terms to *Remote Learning* included educational channels that target K-12 students and professional development resources. However, no associated terms for *Remote Learning* were present in USA YouTube Search.

As educational institutions face last-minute adaptations of face-to-face curricula to online and hybrid formats, the COVID-19 pandemic has accelerated the need for knowledge related to Instructional Design, Remote Learning, and educational technology tools.

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Intelligent Classroom Teaching Behavior Analysis System Based on S-T Analysis Method

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Abstract: Compared with traditional classroom teaching observation, the classroom behavior analysis system using information technologies can effectively improve the validity and accuracy of interpretation of classroom teaching behaviors. With the development of information technology, the combination of the application of teaching methods and artificial intelligence has become an inevitable trend. Based on the S-T teaching behavior analysis method, an intelligent classroom teaching behavior analysis system using multi-modal recognition technology was proposed, which applied various information technologies to collect classroom teaching behavior data and code them automatically. The accuracy and reliability of the presented system was verified through the collection and analysis of a large number of classroom behavior data, which provided a valuable scientific analysis tool for classroom teaching behavior research.
Keywords: Classroom teaching behavior analysis, S-T analysis method, Multi-modal recognition technology

1 Introduction

Today, as education informatization is gradually deepening, the theory of teaching and learning continues to develop. Gradually integrate new educational concepts and technical means into classroom teaching, and traditional teaching evaluation methods have gradually failed to meet the needs of teaching development. Classroom teaching evaluation methods need to keep pace with the times, classroom teaching practice calls for in-depth study of classroom teaching behavior (Taut & Sun, 2014). This study completed an intelligent analysis system based on S-T analysis method and multi-modal recognition technology, and verified its accuracy and reliability. This not only provides a basis for teachers to improve teaching content and teaching methods, but also has great significance for promoting the development of teachers' professional ability.

2 Literature Review

2.1 the S-T Analysis Method

The advantages and disadvantages of classroom teaching are largely related to the interaction between teachers and students. Classroom is the main place where teaching activities take place. Classroom behavior takes place in this space and the information transmission between teachers and students interacts and interacts in this space. As the main body of the teaching process, the behavior of students in the classroom can directly reflect their learning status. As a guide for students to learn, teachers also play an important role in guiding behavior. Therefore, analysis of classroom teacher and student behavior is conducive to analyzing classroom teaching process. Some scholars have been working on software for collecting and analyzing classroom teaching behavior data and have made good progress (Yun et al. , 2018). Some scholars have conducted classroom observations from multiple angles and at multiple levels, and also provided new ideas for data collection and processing of this study (Xie & Cao, 2010). Japanese scholars first proposed the S-T teaching analysis method for classroom teaching analysis. S-T analysis method is the Student-Teacher analysis method, which is a teaching analysis method that visually expresses the teaching personality in a graphical way (Jun & Ou, 2011). The main steps of the method are divided into data sampling, analysis of time series data, drawing S-T diagram, and drawing RT-CH diagram to judge the teaching mode analysis. In the actual classroom teaching process, the specific manifestations of Teacher's behavior and Student's behavior are shown in Table 1. Since the Student's behavior includes all behaviors other than the Teacher's behavior, in addition to the 11 behaviors described in Table 1, it can be classified as "Others" as a form of Student's behavior.

Table 1: Specific manifestation of T behavior and S behavior

Category	Number	Manifestations	Category	Number	Manifestations
Teacher's behavior	1	explanation	Student's behavior	7	Student's speech
	2	demonstration		8	Student's thinking, calculation
	3	blackboard		9	Student taking notes
	4	using various media to prompt		10	Doing experiments or finishing homework
	5	question and name		11	Keeping silence
	6	evaluation and feedback		12	Others

This study draws on the traditional classroom teaching behavior analysis method, and uses a variety of information technologies to collect and analyze classroom teaching behaviors. It will record actual classroom teaching behaviors, help researchers and teachers analyze classroom teaching behavior, and promote professional development of teachers.

2.2 Kinect System Principle

In 2010 and 2014, Microsoft released KinectV1 and V2 successively. KinectV2 includes a color camera, depth camera, infrared light emitter and microphone, which can realize real-time dynamic capture, image recognition, microphone input, voice recognition, social interaction and other functions. . The official system of Kinect, Kinect for Windows SDK, contains drivers, original sensing data flow development interface, user interface, installation file data, and can be used for secondary development. KinectV2 uses TOF technology (Time of Flight) to obtain depth image information by calculating the projected infrared rays and the return time after reflection, and then segment the human body from the background image through the machine learning algorithm, and then estimate the three-dimensional coordinate information of the human body joint points (Roque et al. ,2019). It is less affected by the environment and light. It gets rid of the high requirements of traditional motion capture technology in experimental environment, experimental equipment, and the accuracy of markings. It can capture user actions, facial expressions and voice sequences in real time for the purpose of machine interaction. Skeleton tracking technology is the core function of Kinect. This technology uses deep vision technology and uses complex algorithms such as machine learning and matrix changes to determine the three-dimensional coordinates of joint points.

Skeleton tracking technology is the core function of Kinect. The deep vision technology adopted by this technology uses complex algorithms such as machine learning and matrix changes to determine the three-dimensional coordinates of the joint points. The working process includes(He & Li 2020):

①Human contour segmentation: Kinect obtains the depth image information through the depth sensor, and through edge detection, Noise threshold processing and other technologies separate the human target (“T”-shaped object, which will be recognized as a human body by Kinect) from the environmental background to obtain a depth image of the human body;

②Human body part recognition: the human body separated from the depth image Different parts of the human body are identified in the contour, and a large amount of data is used to train and classify through the classification algorithm of the decision forest. Each pixel is labeled with a category label and classification probability to classify various parts of the human body, such as the head and shoulders;

③Joint point positioning: After completing the recognition of human body parts, Kinect analyzes all aspects of the human body and uses machine learning algorithms for joint positioning.

In traditional sports teaching and training, the teaching method is one-to-many, and students' understanding and learning progress are uneven, resulting in poor teaching or training effects. In order to solve these problems, more and more professional sports training began to apply motion capture to sports training and teaching. Kinect determines the accuracy of the exerciser's movements by accurately grasping the contour and position of the exerciser's body, and performs corresponding training or operation according to the movement function. The trainer's technical movements are identified through the Kinect device. After the computer processes the collected data, it makes correct judgments on the technical movements and feeds them back to the practitioners to encourage them to practice repeatedly, correct wrong movements and improve teaching or training efficiency.

The system analysis results show that there are 22 researches on the development and application of Kinect in auxiliary physical education and training; these researches involve competitive events (badminton, basketball, etc.), flexibility events (yoga, Tai Chi, etc.). Kinect's process characteristics as an auxiliary teaching and training tool are:

① Use Kinect-based system equipment to capture human bones and depth information;

② Using self-occluded joint point information restoration algorithms and filters to collect depth images or motion information of each joint Process;

③ Compare and analyze the collected information with the pre-set standard actions;

④ Provide real-time feedback or evaluation to inform the trainer how to adjust the actions and posture, improve the actions in time, and continue training.

3 Model building

With the development of computer science and precision manufacturing, the automation of video-based classroom teaching observation has become an inevitable trend. Multi-modal recognition technology uses a variety of sensory recognition techniques such as depth image and phonetic intonation to perform behavior recognition. This will help to further improve classroom information collection efficiency, coding efficiency, information classification accuracy, and greatly enhance teachers' interpretation of classroom teaching effects. Therefore, in order to realize this idea, this study collected classroom teaching behavior data through the various information technologies, such as depth image analysis technology, human skeleton tracking technology, speech analysis technology and so on.

S-T analysis method is an analytical method that expresses the character of teaching in a graphical way. This analysis method divides the behaviors into two categories: student (S) behavior and teacher (T) behavior, which reduces the ambiguity of behavior classification in the teaching process and increases the objectivity. For the recorded behavior sequence data, it can calculate the T behavior occupancy rate (Rt), the behavior conversion rate (Ch), and plot the Rt-Ch diagram (Jun & Ou, 2011). According to this, the teaching mode adopted in the class can be judged, and the teaching method can be improved by using a visual method. It does not require other complicated calculations, and it is very convenient to use, which is conducive to promotion and implementation.

The depth image analysis technology is used to recognize the objects in the visual filed and analysis the geometric characteristics of objects (Yeloglu et al. , 2015). This technology improves the accuracy of computer image recognition and promotes its development. The human skeleton tracking technology is to recognize the joints of human skeleton and collect the coordinate data of human skeleton. Some scholars use the human skeleton tracking technology in the rehabilitation measurement of disabled people, determine and improve the accuracy of the system’s joint tracking, which achieves good results (Mobini et al. , 2014). Some scholars use the human skeleton tracking technology to apply the somatosensory interaction system to multimedia teaching in the classroom environment (Sommool et al. , 2013). The speech analysis technology is to recognize the speech features of human, which has been used in many human-computer interaction systems.

Based on the above analysis, this study constructs a classroom teaching behavior analysis model based on S-T analysis method and multi-modal recognition technology, as shown in Figure 1.

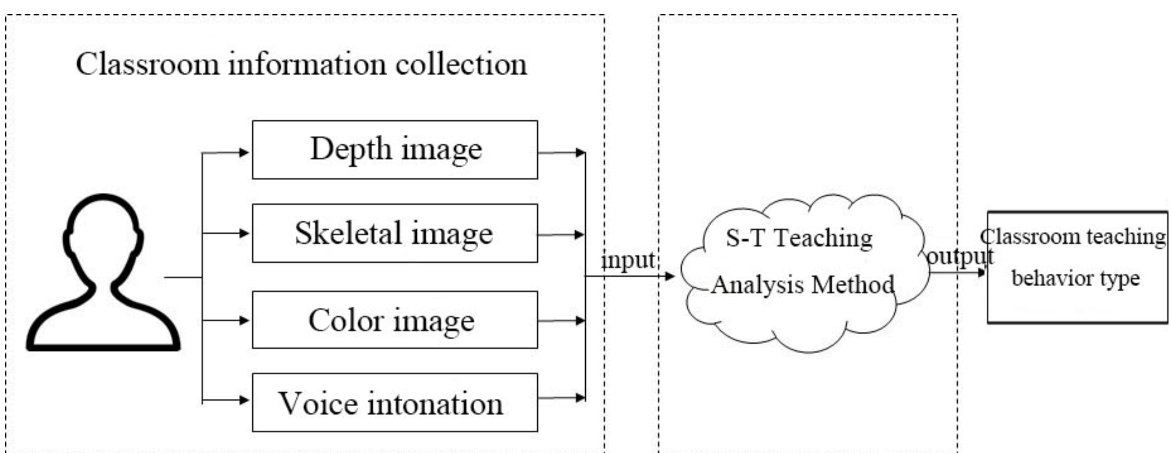

Figure 1 Classroom behavior analysis model

Through the depth image recognition technology and the human skeleton tracking technology, combined with the speech recognition technology, it can collect all the data such as posture and facial behavior of teachers. At the same time, the model combines with the S-T analysis method to encode the teacher behavior data, so as to comprehensively collect the teachers' status, to establish a low-cost, real-time classroom state detection system that does not affect the original listening state of the classroom.

The system software architecture based on S-T analysis method is mainly divided into display layer, business layer and data layer. The display layer is mainly used for the display of the interface and the interaction with the user, mainly using the Microsoft .NET Framework form application technology. On the interface, users can choose to run programs, draw charts, view statistics and view data sources. It is a simple and effective operating system for users. The business layer mainly implements the functions of data processing and chart drawing. It mainly uses the .NET Framework form application and Windows.Forms.DataVisualization. Charting to realize the chart drawing. It is a layer of internal logic implemented throughout the software. The data layer implements the function of storing data and reading data by the user, and uses a text file to store data, as shown in Figure 2. The design idea of the whole system is to complete the coding information of the program design by comparing the continuous changes between every 50 frames.

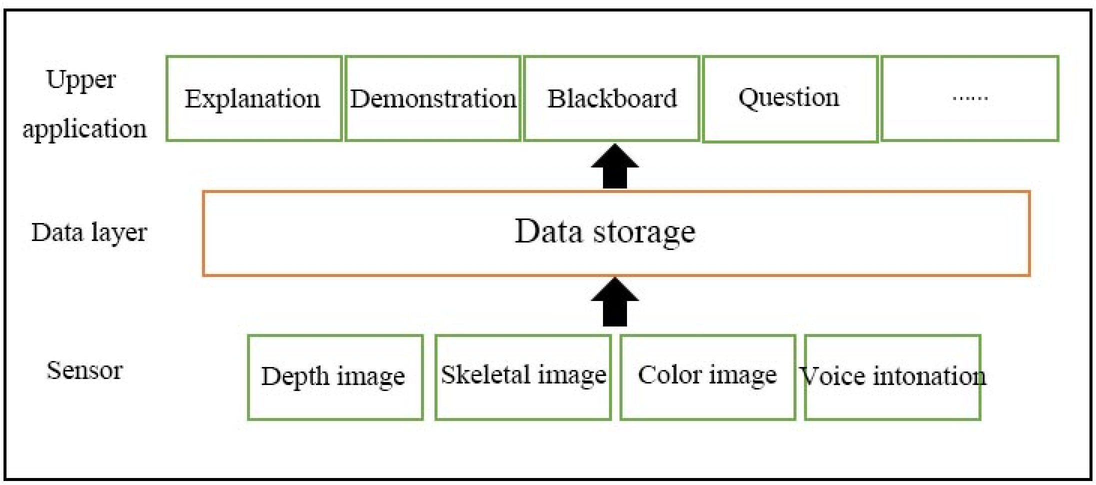

Figure 2 System software architecture diagram

4 Method

4.1 Participants

In this study, two teachers from a university in East China are used as experimental subjects to carry out experiments, and the course of "Human-Computer Interaction" in Educational Information Technology is selected as the research sample. The specific unit course selected is a practical course of human-computer interaction. The content of the course mainly guides students to use six degrees of freedom robotic arms. The course of this unit is relatively difficult, and students need to be guided to complete the course study, program writing, and exchange summary independently.

4.2 Experiment Procedure

The experiment is carried out on the basis of ensuring that the normal classroom order of teachers and students will not be affected. Before the course starts, first of all, arrange the equipment to ensure that the depth sensor camera and high-definition camera can record all the actions of the teacher in the classroom. Monitor whether the equipment is operating normally during the course. Then distribute the course videos to three researchers, and manually code the teacher behavior. Finally, the manual coding result is compared with the system coding. The specific classroom content is required to be designed to be diversified, including at least one of the codes in the S-T teaching analysis method, and to ensure a certain proportion of classroom interaction design.

5 Results

The system encodes and analyzes classroom behavior in a frequency of 5 seconds. In order to detect the reliability of the system, after the automatic coding is completed by the intelligent teaching behavior analysis system, the experiment initiator organizes the experimenter to complete the video-based classroom coding analysis, and finally compares their analysis results. The results show that the coincidence degree between the intelligent analysis system and the manual coding method reaches 86%, which verifies the feasibility and effectiveness of the presented intelligent system.

In order to increase the user's intuitive perception of the time dimension of classroom teaching behavior, this study visualized one course’s classroom data according to time while ensuring accuracy. The broken line in Figure 3 not only reflects the changes in teachers' classroom behavior. The abscissa is time in seconds. 1-6 respectively indicate different classroom teaching behaviors, namely explanation, demonstration, blackboard, using various media to prompt, question and name, evaluation and feedback. From the overall behavior data, the teacher's classroom behavior corresponding to the data in Figure 3 has the largest proportion of explanations, indicating that the teacher has more explanation time in the classroom.

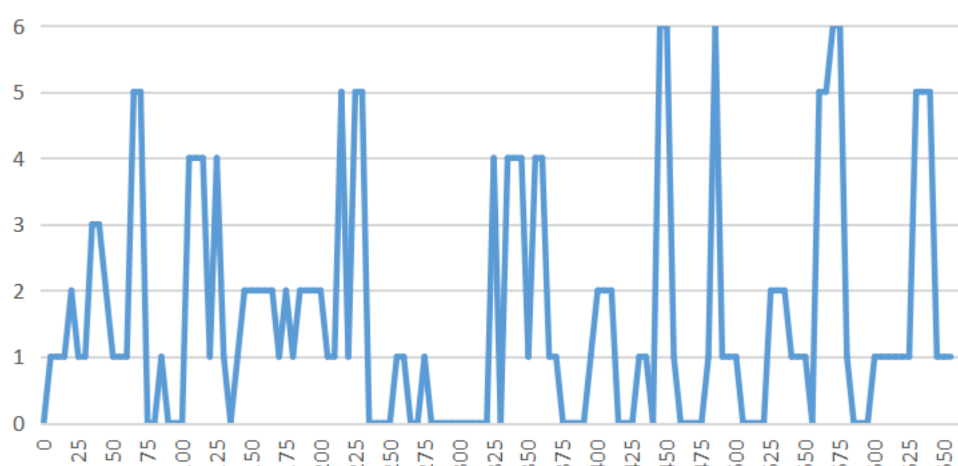

Figure 3 Distributions of classroom teaching behavior

6 Conclusion and Discussion

Researchers and teachers use the proposed intelligent classroom teaching behavior analysis system based on S-T method and multi-modal recognition technology to analyze teaching activities in the classroom, which will improve the quality of classroom teaching and learning effectively, be helpful to the professional development of teachers, and students can also benefit a great deal. This study explored the classroom teaching behavior model, designed and developed the intelligent analysis system to reduce the difficulty of classroom teaching behavior observation, improve the efficiency and quality of classroom teaching activities. It is of great significance to improve the quality of education.

This research has achieved multi-modal classroom behavior recognition, but the research currently only uses two teachers as samples for experiments. When it is extended to more teachers, different behaviors of different teachers need to be considered to improve the accuracy of classroom behavior recognition degree. Future research will add students' classroom behaviors to form a complete multi-modal classroom behavior recognition system for teachers and students.

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Teachers' Experiences with Emergency Remote Teaching During the COVID-19 Pandemic

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The COVID-19 pandemic quickly and drastically changed the field of education in 2020. Teachers faced challenges when confined to their homes and had to begin emergency remote teaching with their students. It is important to recognize what these teachers experienced and find ways to prepare for a crisis-prompted teaching situation in the future. The purpose of this phenomenological study was to explore the lived experiences of Pennsylvania elementary classroom teachers who engaged in emergency remote teaching during the COVID-19 pandemic. Semi-structured Zoom interviews of eight elementary teachers who participated in emergency remote teaching provided data for qualitative phenomenological analysis. Findings revealed five themes: Emotional stress with the transition to emergency remote teaching, technological and instructional barriers, changes in content, pedagogy and technology use, increased workload and self-reliance, and positive relationships with students and colleagues. Mishra and Koehler's (2006) technological, pedagogical, and content knowledge (TPACK) framework was used to guide the data collection and discussion of the findings in this study. The practical implications of this study include training and policies related to pandemic or emergency teaching planning.

Keywords: COVID-19, Emergency Remote Teaching, Teachers

INTRODUCTION

In December 2019, a novel coronavirus was identified in a virus outbreak in Wuhan, China (Centers for Disease Control and Prevention [CDC], 2020a; CDC, 2020b). Schools across the nation closed in order to prevent the spread of this novel coronavirus. As early as late February 2020, superintendents and governors closed schools across the United States, first temporarily and then extending to the rest of the academic year, affecting at least 50.8 million public school students (Decker et al., 2020). On March 13, 2020, Pennsylvania Governor Tom Wolf ordered the closure of all schools in Pennsylvania for two weeks, a measure aimed at slowing the spread of the COVID-19 ("Governor Tom Wolf," 2020). School teachers in Pennsylvania had to find an alternate means of providing education to their students, turning to emergency remote instruction for the remainder of the spring of 2020. Many teachers found themselves unprepared for the challenges they faced (Hodges et al., 2020).

About COVID-19

Coronaviruses are a large family of viruses that may cause illness in animals or humans (WHO, 2020). In humans, coronaviruses cause respiratory diseases as simple as the common cold or as complex as severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS) (Centers for Disease Control and Prevention [CDC], 2020a; WHO, 2020). COVID-19 can be spread from person to person via small droplets in the nose or mouth when a person coughs or exhales (CDC, 2020a; WHO, 2020). On February 11, 2020, the World Health Organization (WHO) announced the new coronavirus's official name, using their best practice to name new human infectious diseases (CDC, 2020a). The CO stands for corona, the VI for the virus, the D for disease, and -19 for the year when the outbreak began, 2019 (CDC, 2020a). On March 11, 2020, the WHO declared the novel coronavirus outbreak a global pandemic (Cucinotta & Vanelli, 2020). The potential for spread led to social distancing and mask use across the country.

COVID-19 and Emergency Remote Teaching

Remote teaching, which is different from online teaching, allows educators to teach with technology to ensure students' continuity of learning at a distance (Trust & Whalen, 2020). Remote teaching occurs "during emergencies when teachers and students are not accustomed to using online platforms or technology to deliver instruction" (Russell, 2020). Since March 2020, emergency remote teaching has become the terminology used to refer to this teaching type during the pandemic (Craig, 2020; Hodges et al., 2020).

As a result of emergency remote teaching, teachers experienced an unprecedented and unplanned disruption to education that changed the work of many teachers suddenly and in many aspects (Kaden, 2020). Teachers around the world "frantically and emergently switched to remote teaching" (Schlesselman, 2020). Teachers were given anywhere from a few hours to a few weeks to prepare to move all instruction to a remote format (Gacs et al., 2020) and expected to become online teachers overnight (Gudmundsdottir & Hathaway, 2020). Teachers were suddenly confined to working from home, removed from students, and challenged to learn new technologies (Kaden, 2020).

When teachers begin instructing in an online environment, they generally have time to meet their needs before beginning (Gacs et al., 2020; Moore-Adams et al., 2016). Many teachers who experienced emergency remote teaching did not have time to prepare or receive the professional development necessary to begin such a massive undertaking (Paesani, 2020). With this sudden transition to emergency remote teaching, educators faced an abnormal environment where they had to get ready quickly, without the help commonly available and access to quality resources, all while confined to their homes (Huang et al., 2020; Wake et al., 2020). Teachers had to use whatever resources they had access to at the time without any clearly defined standards or understanding of online teaching (Schlesselmen, 2020). This move to emergency remote teaching resulted in an increased workload for teachers, challenging them to provide meaningful educational experiences to their students, despite what was happening around them (Kaden, 2020).

The change to emergency remote teaching happened so fast that it is essential to pause and reflect on those experiences (Pacheco, 2020). The emergency remote teaching situation experienced by educators in the spring of 2020 offered many "lessons on preparedness that can and should be addressed in anticipation of another crisis teaching situation" (Pacheco, 2020). The COVID-19 pandemic completely disrupted the education system and forced a wake-up call to strengthen public education (Kaden, 2020). Teachers need to be prepared to teach entirely online and immediately shift to emergency remote teaching (Major, 2020). Teachers will need tools and guidance should the need for emergency remote teaching arise in the future (Gacs et al., 2020).

METHODOLOGY

This study employed a qualitative design using a phenomenological approach.

Participants

Interview data were collected from eight teachers at various public schools in Pennsylvania. The participants were recruited from different schools and elementary grade levels (kindergarten through sixth) to get stories from multiple contexts, richer data, and avoid homogenizing their experiences. A purposeful sampling strategy was used and the criteria for selection of the participants included: (i) being elementary classroom teachers in Pennsylvania who transitioned to emergency remote instruction due to the COVID-19 pandemic, (ii) having no prior experience with online teaching or emergency remote teaching, (iii) being self-contained elementary classroom teachers. Eight participants were purposefully selected to participate in the study using these criteria.

Instrumentation

The interview protocol consisted of 14 semi-structured questions. The interview protocol was created based on Brinkmann and Kvale's (2015) method of preparing for the interview by setting the stage and working off a script, yet moving through the interview like a conversation between "two partners about a theme of mutual interest" (p. 149). The interview protocol was designed using topics and questions related to the focus of the study. The interview protocol contained questions aimed at gathering a detailed description of the participants' experiences with the phenomenon. This approach is supported by Merriam and Tisdell's (2016) findings that interviewing is the primary method of data collection to arrive at the essence of a lived phenomenon. The questions asked in the interview protocol were based on the work of Brinkmann and Kvale (2015), who emphasize the importance of attempting to understand the world from the participants' point of view.

Data Collection and Analysis

Interviews were conducted via Zoom due to ongoing safety concerns related to social distancing and the COVID-19 pandemic. The Zoom interviews were recorded using the application; the Zoom application allows users to record audio and save it right to the computer in an M4A format. M4A is an extension that signifies an audio recording. Each interview lasted between 30 and 50 minutes. They were transcribed using the website Otter, a service that turns voice conversations into transcribed notes. The transcripts were reread for precision twice and then sent individually to each participant to check them for accuracy and report any discrepancies. Having the participants review the transcripts was done to increase the reliability and validity of the data. The transcripts were then coded using Dedoose. The data were analyzed based on code frequency, key terms, and themes across all interviews. Pseudonyms were used for confidentiality.

RESULTS

The analysis of the interviews revealed five themes resulting from the categorization of codes: emotional stress with the transition to emergency remote teaching, technological and instructional barriers with emergency remote teaching, changes in content, pedagogy and technology due to emergency remote teaching, increased workload and self-reliance with emergency remote teaching, and positive relationships during emergency remote teaching.

Emotional Stress

The study revealed that no one expected a worldwide pandemic and did not predict the resulting shift in education. Teachers had difficulty grasping the notion of what was happening in the world. They experienced stress when setting up their new virtual classrooms and working from home.

Fay: I cried. Like cried. I cried because, you know... And then, I don't know if we had a week to prepare or try to figure it all out. But no, I think I just went through a realm of emotions, you know. First of all, we're scared. We don't know what's going on.

Anne: Like just teacher burnout, we worked all day and then all night. We were always willing to do it, but it led to extremely long, long, long days. I have children I need to take care of, so it was hard balancing my family and being a teacher and supporting all of their families at the same time.

Technological and Instructional Barriers

This study revealed that all teachers experienced difficulty with device access and connectivity. The teachers in this study were without their materials and had issues with students attending online classes and completing their work.

Anne: We are a country school. Some of our children's homes don't have cable TV running to their properties. So, to get a hotspot to work in a wooded area or where a mountain is blocking you, sometimes they were very spotty. So, we had a lot of messages that they were behind because it was difficult for them to complete the assignments with the lagging.

Jane: It's obviously not where I wanted it to be. Because it wasn't direct, I wasn't in person with my students. I did the best I could with what I had to work with. Knowing I didn't have access to any of my materials at school, so I was able to just take my thoughts and put them into writing and pass that along to the parents and hope that, you know, they had things at home that they could utilize to practice those skills. After they left on March 13th, I had no interaction or contact with my students at all.

Changes in Content, Pedagogy, and Technology

The teachers in this study all experienced changes and adaptations to content in some way. The teachers either changed the content they were used to teaching or taught the same content but with a different effort. The teachers all reported learning how to use new technology and then altering their content and practices to work with the new technology use.

Anne: A colleague of mine mentioned Loom, so I started recording myself teaching the lessons. The students would have direct links to me teaching them on a recording. 90% of it was asynchronous. I would hold a Zoom every day. They had to sit and listen from their dining room tables instead of the classroom.

Lila: I saw a lot of creativity come out of kids that I don't know if I would have seen had we not gone remote. I really did see some kids do some projects that I felt like, wow, they put forth a lot of time and effort into this. I got to see a different side of the kids in that manner.

Increased Workload and Self Reliance

All participants found themselves with a new, more intense workload in addition to needing to rely on their ability to provide instruction to students remotely since the time and resources for professional development were not perfect for this situation.

Sue: They kept on throwing things at us. Like, you have to do this. You have to document that. And there was not much guidance; it was just a list of to-dos without how to do them. And it worked out wonderfully, but there were really high demands on us. I truly felt like I was flying the plane as I was building it. Each day I would learn something new, or something would go wrong. And I would have to learn on the fly how to fix it. I did not have my materials. I was learning not only how to do Zoom and teach material online, but I was home as well.

Nancy: On a Monday and a Friday, I had two different meetings because of working schedules and stuff like that. During the day, we were required to be there for almost like office hours. We needed to respond to a parent. I spent a lot of time creating different content for the kiddos.

Positive Relationships

Each of the eight participants noted positive relationships with either colleagues, students, or both. Some even found positive relationships with administration or students' parents during the pandemic. The participants found that the circumstances allowed them to get to know their students on a level that may not have been possible without the pandemic. The reliance on their coworkers to get through this unprecedented time also strengthened their relationships with each other.

Fay: The students really just wanted to talk to us. And I think we were told that's pretty much okay. Especially for eight-year-olds, you know, it was just to check in. They most wanted us like making sure the kids were okay. Not like their safety but you know like, mentally okay. I would do one on one meetings with them. And that didn't really work. Because, again, they just want to show you, their cat. And I'm like, okay, let's talk about your math.

Pam: We have like a very close group with our special ed teachers. So, we're constantly in group chats together; we opened like Google Classrooms to communicate, share ideas, like if we wanted to use the same thing in our classroom. So just the ongoing communication and collaboration, we always share ideas with each other, which is helpful.

DISCUSSION AND CONCLUSION

Discussion

This study's findings provided an understanding of the lived experiences of elementary teachers who participated in emergency remote teaching during the COVID-19 pandemic. The analysis of the interviews uncovered five themes related to these experiences.
Each participant described the changes they experienced in their teaching as a result of emergency remote teaching.

All participants noted emotional stress with the transition to emergency remote teaching; they felt fear, frustration, and uncertainty. The teachers were not prepared to become emergency remote teachers. Even the teachers with advanced technological skills reported they never expected a worldwide pandemic to change how they provided education to their students. Teachers were given little to no notice that everyone would be sent home to learn, at first for two weeks and then for the remainder of the 2019-2020 school year. The teachers did not have time to prepare and gather all the materials they would need to instruct from home and found this time very stressful. Teachers reported they did not get clear directions from their administrators, who were also trying to figure out what was going on and what to do.

Each of the participants noted numerous issues with technological and instructional barriers when conducting emergency remote teaching. Teachers faced technological barriers right away because not all students had a device at home. Many districts worked to get devices to students, but this took time. Some teachers were surprised, but students lacked access at home, so districts had to provide things like hot spots to connect to the Internet. The schools in rural areas had consistent connectivity problems, with students reporting glitchy connections or lack of connection in bad weather. The teachers had to figure out how to use these platforms and apps and then teach the students, who were also unfamiliar. As emergency remote teaching continued, teachers encountered consistent technology problems and solved them as they came up.

They also faced changes that had to be made to their content, pedagogy, and use of technology with their students. They had to learn to use technology as the main part of their teaching instead of an add-on. They had to learn how to make technology work with their existing content and pedagogy. They had to change some content and pedagogy to adapt to using technology with their students. The teachers had to learn how to use Zoom or Google Meet to communicate with their students and adjust to not being face-to-face. They had to record themselves teaching. Many teachers who never used platforms like Google Classroom reported that they still use it because they now like it. Teachers used the Internet and different websites to find activities and content instead of their teacher manuals and traditional curriculum. The teachers in this study noted they had to change how they were teaching because they could not hold small groups, do science experiments, or use other hands-on methods to teach.

Most participants noted a substantial increase in workload and the need for self-reliance when developing ways to reach students during the school shutdowns in the spring of 2020. The teachers in this study reported not having many directions from their administrators because they were unsure of what to do. While many teachers received some guidance, the participants had to figure out what to do independently. The participants had to take on many new tasks such as contacting the parents and students, setting up their virtual classrooms, and learning the new platforms and apps. These tasks were not only unfamiliar but also time-consuming. Teachers spent many hours reaching out to parents, trying to find devices and connectivity for students. The teachers had to figure out how to use things like Zoom and Google Classroom. They had to spend the time to look for resources, websites, and materials that could be used online with their students. Many teachers delivered devices or materials themselves directly to the students' homes. Many of the teachers in this study said they felt like they were on their own. Some said they had things being thrown at them without being told exactly how to do it.

All participants expressed having experienced positive relationships with either colleagues or students during emergency remote teaching. The teachers in this study stated that the students looked forward to the Zooms or online meetings, even when the discussion was not academic. They felt it gave the students something to look forward to and created a sense of normalcy at a very uncertain time. It was not always academic, and sometimes the students and teachers would talk about what was going on in the world or show their pets. Some of the participants thought this made the students feel safe, and they enjoyed being able to check on the students, both physically and mentally. Many teachers felt that emergency remote teaching allowed them to get to know their students better, bond with them, and see certain qualities they may not have seen in a traditional format. All eight participants in this study noted positive relationships with their coworkers due to emergency remote teaching. The teachers worked together, sharing materials and ideas. They were texting and calling each other constantly. They found ways to get through this difficult time together, and they split up tasks to share the workload. Some teachers felt that emergency remote teaching brought them closer to their colleagues because they depended on each other.

Implications for Future Practice

School districts in the post-COVID-19 world must be ready for the possibility of a crisis-prompted teaching situation in the future. Changes can be made to education to prepare administrators, teachers, parents, and students to face something like a worldwide pandemic. The emergency remote teaching situation experienced by educators in the spring of 2020 offered many "lessons on preparedness that can and should be addressed in anticipation of another crisis teaching situation" (Pacheco, 2020). The research done in this study suggests school districts need to look at the measures they have in place for teaching during an emergency, such as a pandemic.

First, the results of this study demonstrate the need for school districts to have a 1:1 device program in place, where each student has a mobile device that they use in school and at home. Based on this study's findings, educators felt unprepared to enter emergency remote teaching because their students did not have the devices necessary to connect with the teachers.

Second, school districts might also want to examine the professional development offered for technology use in the classroom and align it with teachers' needs and daily use. School districts should consider ongoing professional development in the practical use of technology. The professional development has to be relevant and applicable to their classrooms. Third, teachers might want to increase their daily technology integration in their classrooms. A suggestion would be to get students and teachers familiar with the devices and use those devices in conjunction with a specific platform, such as Google Classroom, to communicate with students from a distance. Fourth, school districts should have a pandemic plan in place. A clear plan will help teachers face an emergency remote teaching situation with more confidence and less of a sudden increase in workload. The support and guidance on what is expected will save teachers time and make them feel less unprepared for an emergency.

Recommendations for Future Studies

There is value in studying teachers' experiences with emergency remote teaching to evaluate what did and did not work and what we can learn to improve current and future practice (Hartshorne et al., 2020). The COVID-19 pandemic completely disrupted the education system and forced a wake-up call to strengthen public education (Kaden, 2020). This study was conducted to elementary classroom teachers' experiences with emergency remote teaching during the COVID-19 pandemic. The data analyzed from this study suggests the need for further research on the phenomenon of emergency remote teaching.

All school districts in the United States could benefit from additional research about teaching during the COVID-19 pandemic. It is recommended that this research study be replicated with teachers from various grade levels and subject areas. Future studies on emergency remote teaching should include teachers from middle school and high school. Studying middle school and high school teachers' experiences and comparing them to that of an elementary school teacher would provide a basis for comparison to determine whether the themes for emergency remote teaching are seen at all grade levels. This comparative study would also highlight the potential differentiated needs of teachers transitioning to emergency remote teaching.

A future study on emergency remote teaching could include the experiences of individuals other than the teachers. Studies could be done with administrators, parents, or students. The unique perspective of these groups of people could be compared and contrasted to teachers. The input from administrators, parents, and teachers could provide valuable information for educators regarding the best methods of conducting emergency remote teaching.

Another recommendation for future studies is to conduct an identical study and include teachers from other states. Because every participant in this study had experience as a Pennsylvania teacher, it would be interesting to contrast the teachers' experiences in other states. States experienced shutdowns due to COVID-19 at different rates and with different guidelines for emergency remote teaching.

An additional recommendation for a future study is a study on existing pandemic plans. There is a need for future research studies to determine if school districts have adopted a pandemic plan or updated one previously in place. The details of these pandemic plans could provide valuable insight to school districts that lack one. School districts can use a study like this to provide support and specific guidance outlining what should be done for emergency remote teaching in their pandemic plan.

A study could be conducted comparing the experiences of male to female teachers. Since all of the participants in this study happened to be female, the experiences of male elementary teachers were not represented.

Finally, a research study could compare schools with 1:1 device programs and educational platforms in place to schools that were not using technology daily with their students before the pandemic. The study could analyze the difficulty of the transition for these two groups.

Conclusion

The COVID-19 pandemic found educators across the world in a situation they never expected. The demands placed on teachers to suddenly switch to emergency remote teaching revealed that many school districts were unprepared to teach virtually due to a pandemic. This study aimed to examine the experiences of elementary classroom teachers who participated in emergency remote teaching. This study was necessary because it is important to step back and look at what teachers experienced during a worldwide pandemic and learn from those experiences. There was a dearth of research on online learning but minimal research on emergency remote teaching due to its timely nature. This study's findings indicate that the experiences of elementary classroom teachers with emergency remote teaching were complex and characterized by emotional stress with the transition, technological and instructional barriers, changes in content, pedagogy, and technology, increased workload, and positive relationships. Future studies on emergency remote teaching should help to further the conversation about how to be best prepared for a crisis-prompted teaching situation in the future.

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Investigation of Psychological and Environmental Factors that Influence Assignments Completion

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1. Introduction

1.1 Education in Today's Japan

The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) (2020) has indicated the need to improve classes from the perspective of proactive, interactive, and authentic learning (so-called active learning) in the new curriculum guidelines to be implemented in high schools on an annual basis starting in 2022. It is essential to realize this improvement, not within a single lesson but a coherent unit or subject matter. In addition, since there will be no reduction in learning content from the existing curriculum guidelines, high school mathematics departments are required to plan lessons that consider teaching content and time allocation (MEXT, 2018). Thus, in today's Japan, students are expected to study more in-depth content in a limited amount of time.

Therefore, flipped classroom teaching is an effective way to realize the improvement of teaching required today.

1.2 Flipped Classroom

According to Bergmann and Sams (2012), a flipped classroom is a learning method in which students do essential learning, such as the content of explanatory lectures, before class as homework, and learning necessary for retention of knowledge and cultivation of applied skills, such as tutorials and project learning. Abeysekera and Dawson (2015) found three critical components of flipped classroom teaching:

1. Information-transmission teaching moves to outside of class time
2. Lesson time used for learning activities
3. Students require completing pre-and/or post-class activities to benefit from in-class activities fully

These components suggest that it is possible to incorporate active learning into class time without reducing the learning content by introducing flipped classroom teaching.

One of the characteristics of flipped classroom teaching is the relationship between home-studying (preparation and review) and face-to-face teaching. According to Shinogaya (2012), all learning breaks down into three stages: prior learning, core learning, and post-learning. Shibukawa (2021) summarized the flow of learning in lecture-based and flipped classroom teaching based on three stages of learning (Table 1).

Table 1. Difference between lecture-based class and flipped classroom

<table>
<tr><th>Learning Stage</th><th>Lecture-based Teaching</th><th>Flipped Classroom Teaching</th></tr>
<tr><td rowspan="2">Prior Learning</td><td rowspan="2">Preparation
Ex) Reading Textbook</td><td rowspan="3">Pre-Class Learning
Ex) Watching lecture videos
Acquire new knowledge</td></tr>
<tr></tr>
<tr><td rowspan="2">Core Learning</td><td rowspan="2">Class Lesson
Ex) Knowledge Acquisition</td></tr>
<tr><td rowspan="2">Class Lesson
Ex) Engaging in developmental activities</td></tr>
<tr><td rowspan="2">Post Learning</td><td rowspan="2">Revision
Ex) Summarize Class</td></tr>
<tr><td>Post-Class Learning</td></tr>
</table>

On the one hand, in lecture-based teaching, students learn the content of the class through preparation, acquire knowledge in the face-to-face class lesson, and practice problems and summarize the class content in the revision. On the other hand, in a flipped classroom teaching, the student acquires knowledge of the lesson's content in the pre-class learning, performs exercises in the face-to-face class lesson, and summarizes the content in the post-class learning. In this way, in the flipped classroom, students need to learn new knowledge on their own while studying at home. Therefore, the materials for the pre-class learning in the flipped classroom need to be designed so that the teacher's explanation of the study contents, the pre-class learning, and the face-to-face class lesson is considered one learning process.

However, the implementation of prior learning can be problematic because there are no instructors present where learners can conduct prior learning.

1.3 Problems with Pre-Class Learning in Flipped Classroom

Some prior studies have shown that pre-class learning did not work well in flipped classroom teaching. One of the reasons is that learners do not carry out pre-class learning. For example, in Yamamoto et al. (2018) 's practice, a teacher needs to provide individual attention if students do not do the pre-class learning. Furthermore, Long et al. (2017) found that students might not prepare for pre-class learning, so teachers need to encourage their motivation for pre-class learning before in-class activities for all students to enjoy active learning. Wei et al. (2020) also stated that teachers need to encourage students to conduct pre-class learning to make in-class activities more active. Thus, the learner's implementation of prior learning is a necessary element for the success of the flipped classroom.

Based on the above, we thought it necessary to examine what kind of support is needed to improve the rate of students' implementation of assignments.

2. Purpose

It is still unclear what kind of support effectively encourages high school students to carry out their assignments. Therefore, this study aims to investigate the difference in the awareness of the students who submitted their assignments and those who did not submit their assignments, examine the factors that affect the students' implementation of the assignments, and propose support methods for each factor.

3. Methods

3.1 Participants of Research

We surveyed 80 second-year high school students (40 students in each of two classes) enrolled in a public high school in Chiba Prefecture, Japan. The participants are taking a course called "Mathematics B," The unit covered in this study is "Space Vector."

3.2 Flow of Research

Figure 1 shows the flow of this survey. This survey was conducted within the "Space Vectors" unit in October 2020. The subject took a class on "Components of vectors and operations with components" within the unit. In the class, new knowledge was explained, and problems were practiced. In the review assignment, the students were required to practice five similar problems to the problems in the class. After the students submitted their assignments, a questionnaire survey was conducted on their motivation to perform the assignments.

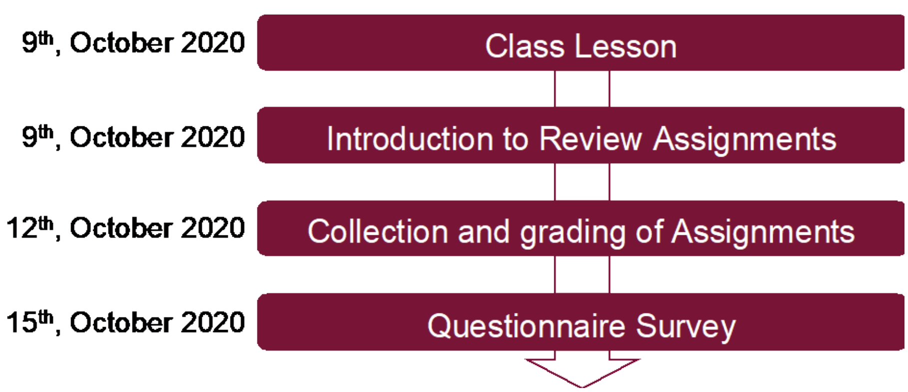

Figure 1. Flow of Research

3.3 Questionnaire survey

A unique questionnaire was developed and administered to investigate the psychological situation and the learning environment in the students were performing the assignment. The questionnaire items were divided into three categories based on the different ways in which the students carried out the assignments:

(1) When they carried out the assignments and finished them
(2) When they carried out the assignments but did not finish them
(3) When they did not carry out the assignments

The total number of questions was 17 items: (1) 7 items, (2) 5 items, and (3) 5 items, and each item used a 5-point Likert scale (1 = disagree, 5 = very much agree). In addition, they were asked about the most significant causes for each of the times when they performed the assignments and when they did not perform the assignments in an open-ended question.

4. Results

Among the 80 participants in this study, 53 (approximately 66%) who responded to the questionnaire without flaws were included in the analysis. Table 2 shows the implementation status of the assignments for the 53 participants in the analysis.

Table 2. Status of students' implementation of the assignments

Group	n	Score (5-point scale)	
		M	*SD*
Submitted	42	4.36	0.84
No-Submitted	11	-	-
total	53		

4.1. Reliability of the Questionnaire

To investigate the reliability of the original questionnaire, Cronbach's alpha was calculated for the responses to the 17-item questionnaire. As a result, ± = 0.73, the results of the questionnaire used in this study are considered reliable and will be analyzed.

4.2. Attitudes toward Assignment Implementation and Environmental Differences

In this research, a comparison of means was conducted on the responses to the questionnaires to examine whether there were differences in attitudes and environments between students who submitted the review assignment (submitted group) and those who did not submit the assignment (not submitted group). Shapiro-Wilk's normality test was conducted on the results of the questionnaire for each group, and no normality was found. In addition, there was a difference in the sample size of each group (submitted group=42, not submitted group=11). Therefore, Mann-Whitney's U test was adopted as the analytical method for comparing the means.

We compared the differences in attitudes toward the implementation of the assignment between the submitted and un-submitted groups based on the responses to the first question (When they carried out the assignments and finished them) of the questionnaire survey. The results are shown in Table 3.

Table 3. Differences in attitudes toward completing assignments

	(1) When they carried out the assignments and finished them	Submitted		Not Submitted		M_1-M_2	*U*	*r*
		M_1	SD_1	M_2	SD_2			
1	I do assignments because I believe that I should do the assignments at	4.26	0.59	3.55	1.04	0.71	$136.50^{\dagger}$	0.32

school.

2	I do assignments because I believe that turning them in is related to my grades.	4.07	0.78	3.64	1.12	0.43	178.00	0.18
3	I do assignments because it is necessary for me to do so to understand and master the course content.	3.83	0.85	3.45	1.13	0.38	187.00	0.14
4	I do assignments because I know the purpose of doing them.	3.67	0.85	3.09	1.14	0.58	148.50†	0.26
5	I do assignments because I like learning about the subject assigned.	2.76	1.10	2.45	1.04	0.31	195.00	0.11
6	I do assignments because I enjoy learning about the subject assigned.	2.71	1.15	2.45	1.21	0.26	204.00	0.08
7	I do assignments well in advance of the deadline.	2.76	1.19	2.45	1.44	0.31	196.00	0.12

n=53, 5-point Likert scale $^{\dagger}p<.100$

As a result of comparing students' attitudes toward "carrying out and completing assignments," there was a significant tendency toward the submitted group on the p<.100 criterion for items (1)-1 and (1)-4.

We compared the difference in the awareness of the submitting group and the not-submitting group regarding the case where they carry out the assignments but do not finish it, based on their responses to the second question (When they carried out the assignments but did not finish them) of the questionnaire survey. The results are shown in Table 4.

Table 4. Differences in attitudes when assignments are done but not completed

(2) When they carried out the assignments but did not finish them		Submitted		Not Submitted		M_1-M_2	U	r
		M_1	SD_1	M_2	SD_2			
1	I do not finish assignments when I feel that they are too much.	3.14	1.18	2.73	1.42	0.41	184.50	0.14
2	I do not finish assignments when I feel that I cannot solve the problems.	2.50	1.09	3.27	1.35	-0.77	153.00†	0.24
3	I do not finish assignments when I do not know what to refer to when doing my assignments.	3.02	0.84	3.45	1.37	-0.43	162.00	0.22
4	I do not finish assignments when I do not have enough time due to assignments in other subjects.	2.83	1.06	2.73	1.01	0.10	221.00	0.03
5	I do not finish assignments when I	3.05	1.31	3.00	1.34	0.05	225.00	0.02

	don't have time for club activities, lessons, cram school, or other commitments.							

n=53, 5-point Likert scale †p<.100

As a result of comparing the students' attitudes toward "doing the assignment but not finishing it," there was a significant tendency toward the not-submitted group on the p<.100 criterion for item (2)-2.

We compared the differences in attitudes of the submitted group and the un-submitted group regarding the non-implementation of assignments based on their responses to the third question (When they did not carry out the assignments) of the questionnaire survey. The results are shown in Table 5.

Table 5. Differences in attitudes when assignments are not completed

(3) When they did not carry out the assignments		Submitted		Not Submitted		M_1-M_2	U	r
		M_1	SD_1	M_2	SD_2			
1	I do not do assignments when I forget that I have them.	2.90	1.28	2.73	1.10	0.17	217.00	0.04
2	I do not do assignments when they do not count toward my grade.	3.48	0.97	3.00	0.89	0.48	165.50	0.21
3	I do not do assignments when I feel that they are not necessary for my learning.	3.64	1.03	3.00	0.77	0.64	143.00*	0.28
4	I do not do assignments when I feel that doing them is a hassle.	3.83	0.88	3.18	0.98	0.65	150.50†	0.26
5	I do not do assignments when I do not understand the purpose, meaning, or intent of doing them.	3.71	0.94	3.36	0.92	0.35	182.50	0.15

n=53, 5-point Likert scale *p<.050, †p<.100

As a result of comparing the students' attitudes toward not carrying out assignments, there was a significant difference in the submitted group based on p<.050 in item (3)-3. Furthermore, in item (3)-4, there was a significant trend toward the submission group at the p<.100 criterion.

4.3. Categorization of Learner Characteristics of Assignment Implementation

There was no significant difference between the submitted group and the un-submitted group when the difference in the attitude toward the assignments was examined by comparing the mean values. Therefore, we conducted a factor analysis to examine the factors that influence students' performance of the assignments. The questionnaire items were categorized into two types: items related to factors for performing the assignments and items related to factors for not performing the assignments, and factor analysis was conducted on each of the two types of items to identify factors that influence the performance of the assignments.

First, to examine the students' motivation to perform the assignments, factor extraction using the principal factor method and exploratory factor analysis using ProMax rotation were conducted on (1) of the questionnaire. The results are shown in Table 6.

Table 6. Students' attitudes toward performing the assignment

Questionnaire		factor I	factor II	factor III
(1)-5	I do assignments because I like learning about the subject assigned.	0.94	0.02	0.01
(1)-6	I do assignments because I enjoy learning about the subject assigned.	0.94	-0.03	0.03
(1)-4	I do assignments because I know the purpose of doing them.	0.16	0.8	-0.02
(1)-3	I do assignments because it is necessary for me to do so to understand and master the course content.	-0.14	0.62	-0.04
(1)-7	I do assignments well in advance of the deadline.	0.05	0.54	-0.18
(1)-1	I do assignments because I believe that I should do the assignments at school.	-0.11	0.54	0.32
(1)-2	I do assignments because I believe that turning them in is related to my grades.	0.05	-0.11	0.8
Cronbach's alpha		0.94	0.69	-
factor correlation	I			
	II	0.16		
	III	0.03	0.31	

n=53, Kaiser-Mayer-Olkin's measure: .57, Bartlett's test: χ^2=129.13.
Factor extraction by principal factor method, ProMax rotation

The results of the factor analysis showed that the motivation to perform the assignments was categorized into three factors. The factor I consisted of (1)-5 and (1)-6, Factor II consisted of (1)-4, (1)-3, (1)-1, and (1)-7, and Factor III consisted of (1)-2. There was also a weak inter-factor correlation between factors II and III.

Next, to examine students' motivation to not perform the assignments, factor extraction using the principal factor method and exploratory factor analysis using ProMax rotation were conducted on (2) and (3) of the questionnaire. Also, all items were reversed because the questionnaire items were written in such a way as to ask for negative items. The results are shown in Table 7.

Table 7. Students' attitudes toward not performing the assignment

Questionnaire		factor I	factor II	factor III	factor IV
(3)-5	I do not do assignments when I do not understand the purpose, meaning, or intent of	0.86	0.13	-0.06	-0.10

	doing them. (R)				
(3)-3	I do not do assignments when I feel that they are not necessary for my learning. (R)	0.73	0.08	0.06	-0.06
(3)-4	I do not do assignments when I feel that doing them is a hassle. (R)	0.50	-0.23	0.03	0.30
(2)-5	I do not finish assignments when I don't have time for club activities, lessons, cram school, or other commitments. (R)	-0.04	1.01	-0.05	0.00
(2)-4	I do not finish assignments when I do not have enough time due to assignments in other subjects. (R)	0.13	0.49	-0.01	-0.01
(2)-2	I do not finish assignments when I feel that I cannot solve the problems. (R)	-0.15	0.05	0.85	0.00
(2)-3	I do not finish assignments when I do not know what to refer to when doing my assignments. (R)	0.15	-0.11	0.67	-0.17
(3)-1	I do not do assignments when I forget that I have them. (R)	-0.10	0.00	-0.16	0.62
(3)-2	I do not do assignments when they do not count toward my grade. (R)	0.08	-0.02	-0.06	0.58
(2)-1	I do not finish assignments when I feel that they are too much. (R)	0.09	0.21	0.22	0.48
	Cronbach's alpha	0.73	0.67	0.63	0.59

factor correlation	Ⅰ			
	Ⅱ	0.30		
	Ⅲ	0.16	0.35	
	Ⅳ	0.37	0.41	0.49

n=53, Kaiser-Mayer-Olkin's measure: .55, Bartlett's test: χ^2=146.47.
Factor extraction by principal factor method, ProMax rotation (R): Reverse items

The results of the factor analysis showed that the motivation to perform the assignments was categorized into four factors. The factor I consisted of (3)-5, (3)-3, and (3)-4, Factor II consisted of (2)-4 and (2)-5, Factor III consisted of (2)-2 and (2)-3, and Factor IV consisted of (2)-1, (3)-1 and (3)-2. Also, weak inter-factor correlations were found between Factor I and Factor II, Factor I and Factor IV, and Factor II and Factor III, while moderate inter-factor correlations were found between Factor II and Factor IV, and Factor III and Factor IV, respectively.

5. Discussion

The above results suggest that the students in the submitted group feel more obligated to submit assignments than the students in the un-submitted group for the subjects of this study. In addition, it is thought that students are aware that they should perform and submit the assignments that are given to them regardless of the effect of performing the assignments on their academic performance or the ease of performing the assignments. Therefore, it is possible that "submitting the assignment" itself is the purpose of the assignment.

Furthermore, on the one hand, the results of the factor analysis for the questionnaire (1) suggest the following factors for the student's implementation of the assignment.

- Students understand the purpose and need for the assignment
- Students' interest in the subject matter is high
- Students know that the assignment will be graded

On the other hand, the factor analysis results for questionnaires (2) and (3) suggest the following factors that prevent students from performing the assignments.

- Lack of time to complete the assignment
- The assignment is too difficult for students

These suggest that five factors affect students' performance of the assignments. The following five ways of supporting students to promote the implementation of their assignments can be identified from the above five factors.

- Specify the purpose of doing assignments
- Conduct the class in a way that attracts interest
- Clarify the relationship to grades
- Allow sufficient time for submission / Give time estimates
- Adjust the difficulty level based on the student's grade

Among these, "Specify the purpose of doing assignments" is particularly effective because it is consistent with the students' attitudes in the submission group, and it is easy for professors to provide support.

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Examination of Change in Perception Toward Virtual Medical Education After COVID-19 Pandemic in the U.S. Using Twitter Data

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Abstract

COVID-19 introduced a large percentage of the world's students and teachers to virtual learning. The purpose of this study was to examine the changes in perception toward virtual medical education during the pandemic in the U.S. Twitter data (tweets) associated with the virtual educational experience in the medical fields was obtained. Three analysis methods (topic modeling, sentiment analysis, and longitudinal cluster analysis) were adopted for the study. Across the selected topics, we found differences in conversations in virtual medical education fields. The topical patterns by frequency, polarity, and subjectivity identified the needs of those involved in virtual medical education and the areas that need to be overcome to improve virtual learning. More findings and implications are further discussed.

Keywords: virtual medical education, twitter, pandemic, COVID-19

Introduction

The COVID-19 pandemic has been changing our world significantly. In this situation, many fields mostly get a negative impact, but some do not. Virtual education can be the second case. Under the severe restriction of contacting others to prevent the spreading of the disease, virtual education grabs a chance to be utilized in most educational organizations. Even people who did not favor virtual learning and did not have experience of it face the situation where there is no choice but to receive virtual learning. In this situation, they might be able to find positive aspects of it. On the contrary, the probability of finding virtual education's problems that have not been detected also increases by the increment of the frequency of virtual learning. Remote work and virtual education are likely to continue, albeit less intensely than at the pandemic's peak. As the pandemic has brought the future to the present with communication, professional development, and technology in medical education, virtual learning may have influenced a shift in people's perception of medical education during the pandemic. This leads to examining the changes in perception of virtual medical education to identify a need to improve the quality of virtual medical education.

Literature Review

The pandemic has had profound impacts on medical education globally. One of the fields that has the greatest resistance toward virtual learning is medical education. Many medical schools have adapted to virtual classes by altering their real-time clinical exposure to online modes (Rose, 2020; Ferrel & Ryan, 2020). Some schools echoed concerns over clinical experience and assessment during these times because practice-based learning is the backbone of medical education. Inevitably, most medical students' clinical placements stopped, and learning in classrooms and laboratories was cancelled, leaving students to continue their studies remotely (Ahmed, Allaf, & Elghazaly, 2020; Ferrel & Ryan, 2020; Sahi, P. K., Mishra, D., & Singh, T., 2020). Medical professionals also have cancelled their training to cope with pressures from cases of COVID-19, which is considered fundamental in their education, training, and progression (Gill, Whitehead, & Wondimagegn, 2020; Rajab, Gazal, & Alkattan, 2020; Sandars & Patel, 2020).

The emergence of social media platforms can be traced back to 1996, but truly emerged in their modern form in the early 2000s (Singh, 2019). With platforms such as LinkedIn, Facebook, Twitter, Instagram, YouTube, and more, the number of worldwide users has jumped from almost a billion in 2010 to 2.62 billion in 2018 (McFadden, 2018; Singh, 2019). Social media platforms allow users to share knowledge simultaneously (Toprak v.d., 2009, pp.28-84). In this vain, social media opens up new possibilities to understand people's perception (Selwyn, 2007). Studies show that Twitter, which is one of the most commonly used worldwide social network tools, is used all around the world as the most chosen educational tool (Elavasky, Mislan, & Elavsky, 2011; Feliz, Ricoy, & Feliz, 2015; Junco, Heiberger, & Loken, 2010; Park, 2013; Rinoldo, Tapp, & Laverie, 2011; and Zainal & Deni, 2015). This research study was conducted to analyze the use of Twitter.

The worldwide COVID-19 pandemic crippled health systems and closed schools across the globe. This challenge makes educational organizations, educators, and instructional designers fall into problematic situations. As we move forwards, a COVID-19 generation of students and doctors need to continue their education and training. While pandemics have historically created challenges, identifying these challenges is the first step in converting them into opportunities.

Purpose of the Study

The pandemic has provided an opportunity to investigate whether learners or education providers in medical education have positive or negative perceptions, or whether there is a change in their perceptions for virtual learning. These investigations would allow us to identify their needs in virtual medical education, the reason why they do not favor virtual learning can be analyzed, and the way to break through the problems. This study, thus, aims to examine the changes in perception toward virtual medical education after COVID-19 pandemic in the U.S. using tweets. This study has the following research questions: (a) What are the topical patterns in tweets related to virtual medical education over the past five years?; and (b) What are the trajectories in the characteristics (i.e., frequency, polarity, and subjectivity) of the topical patterns on virtual medical education?

Analytical Framework

Given the nature of our research questions, the study adopted a quantitative research method to yield a comprehensive analysis. In this study, the change in perception toward virtual education of stakeholders in medical education organizations in the U.S. were examined by Twitter data (tweets). The topic modeling method is useful to find how many topics in the collected tweets dataset and what do the topics represent. Cross-validation is a type of model validation technique for assessing how the results of a statistical analysis generalize to an independent data set. Each topic can be allocated to individual tweets, and the change in the number of tweets in the topics for each year can be inspected to find the change in people's interest. Also, sentiment analysis is useful to find the changes in people's polarity and subjectivities in a period. The segment analysis allows to systematically identify, extract, quantify, and study affective states and subjective information. Lastly, longitudinal cluster analysis is useful to find groups that share trends among trajectories of the topics over a certain time.

Method

Data Collection

In order to extract tweets that represent the perception toward virtual medical education, predefined keywords that can be categorized in four primary ways (virtual: 10, medical: 30, education: 24, and region: US) and Twitter Premium API were used. Two software tools, Python 3.8 and Microsoft Visual Studio 2019, were used to execute this process iteratively for one year after the national emergency declaration for the COVID-19 pandemic (March 13th, 2020 - March 12nd 2021) and the period of four years precedent the declaration (March 13th, 2016 - March 12nd 2020). A total of 6,542 tweets over five years were collected.

Preprocessing

Before analysis, by following steps, the extracted dataset was cleaned to increase the clarity of the result. First, tweets that were too short thereby often meaningless (i.e., < 60 characters) and were therefore excluded. Second, using the NLTK library (Bird et al., 2009) in Python, stop words such as pronouns, prepositions, and postpositions were filtered out. Finally, 'term frequency-inverse document frequency (tf–idf) was used to select words that frequently occur but are not shared across all tweets.

Data Analysis

Three primary analysis methods, the Latent Dirichlet Allocation (LDA; Blei, Ng, & Jordan, 2003), sentiment analysis, and longitudinal cluster analysis, were employed to examine the changes in perception of stakeholders of medical fields toward virtual education after the COVID-19 pandemic situation.

Latent Dirichlet allocation (LDA; Blei et al., 2003), so-called topic modeling, one of the unsupervised machine learning techniques, was employed to identify topics in a set of documents (e.g., tweets). The topic models (Grün & Hornik, 2011) package in R (R Core Team, 2020) and RStudio 1.3.1056 (RStudio Team, 2020) was utilized for LDA. As the initial stage of LDA, the optimal number of topics were determined (Zhao et al., 2015) using the ldatuning package (Nikita & Chaney, 2020). Figure 1 shows three different metrics of Griffiths (2004), Cao and Juan (2009), and Arun (2010). They all suggested 20—30 topics as optimally emerging in the tweets—i.e., with 20 - 30 topics, the Griffith value was maximized (approaching 1), and the Cao and Juan and Arun values were stabilized.

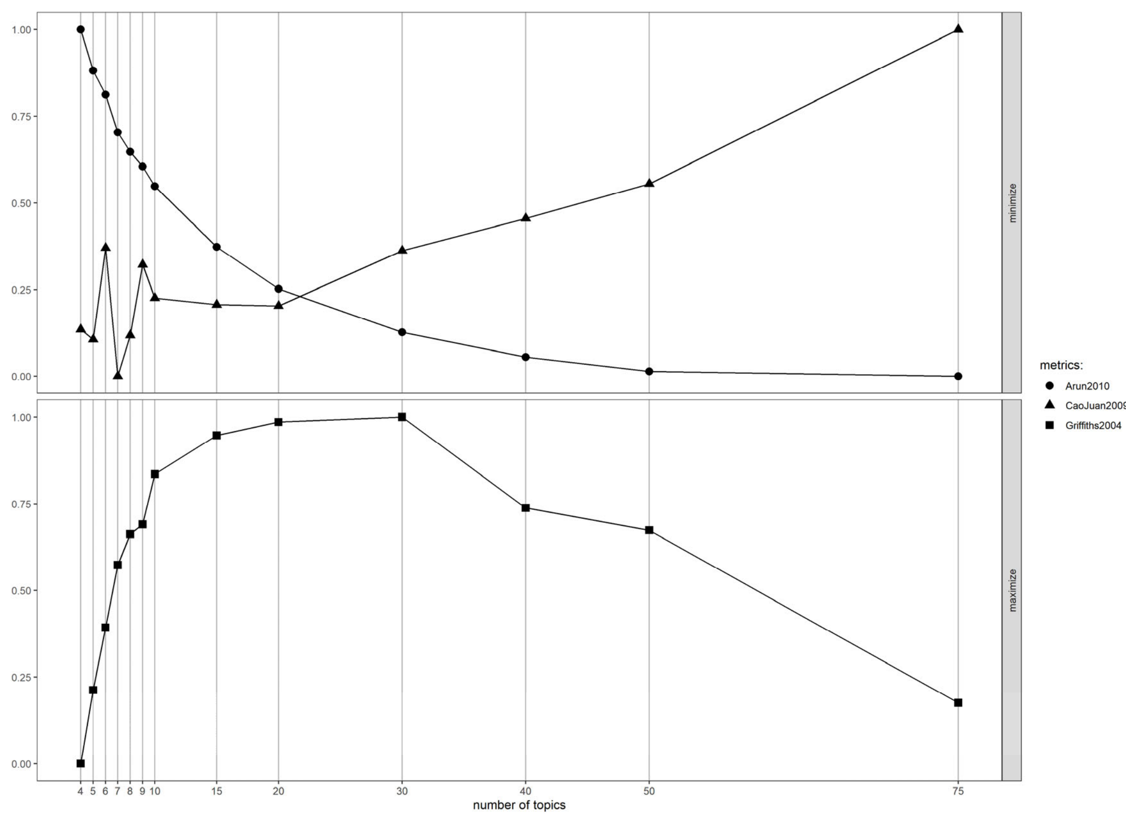

Figure 1. The optimal number of topics identified by different metrics

Sentiment analysis was conducted for finding the authors' emotional states using the TextBlob library in Python. Specifically, the tweets having a subjectivity value (range from 0 to 1) greater than or equals to .50 were classified as subjective otherwise categorized as objective. The polarity and subjectivity were estimated for each tweet. Polarity has ranged from –1 to +1, and the tweets were classified by the polarity value— negative (polarity ≤ –0.30), neutral (–0.30 < polarity < 0.30), and positive (polarity ≥ 0.30).

The longitudinal cluster analysis, an unsupervised machine learning technique, could find groups that share trends (such as increasing, decreasing, steady) among trajectories of the topics over a certain time without human intervention. When there are too many objects to be compared, it is more effective and easier for interpreting that grouping objects to a smaller number of groups according to characteristics (trends) and compare the groups rather than directly comparing each object; therefore, in this study, longitudinal cluster analysis was hired to find clusters of the topics that share unique joint-trajectories across the 5-years. The changes in three factors 1) frequency of the topics, 2) averages of polarities, and 3) average of subjectivities over the 5-year period were used to group topics, using kml (Genolini et al., 2013) package.

Findings

LDA found 30 topics from the extracted tweets, but only 24 were clearly interpretable and relevant to the study of those topics; therefore, the remaining 6 topics and their words were excluded from the analysis. The 24 selected topics were labeled as remote learning (topic 1), support (topic 2), virtual program (topic 3), family support (topic 4), nursing program (topic 5), social distance and safe (topic 6), Benefits (topic 7), anatomy class (topic 8), mental health (topic 9), negative feeling (topic 10), professional development (topic 11), clinical study (topic 12), course assignment (topic 13), registration (topic 14), virtual meeting (topic 15), virtual medical lab (topic 16), quality of education (topic 17), stakeholders (topic 18), gratefulness of online learning (topic 19), working from home(topic 20), nursing classes (topic 21), hybrid modality (topic 22), virtual commencement (topic 23), medical training/certification (topic 24).

From the sentimental and longitudinal cluster analyses, four clusters are identified with 19 selected topics using their trajectories for the 5 years. The longitudinal clustering algorithm found three, four, and two unique trajectories of topics from the frequencies of the topic, polarities, and subjectivities across the 5-years, respectively (see Figure 2, 3, & 4).

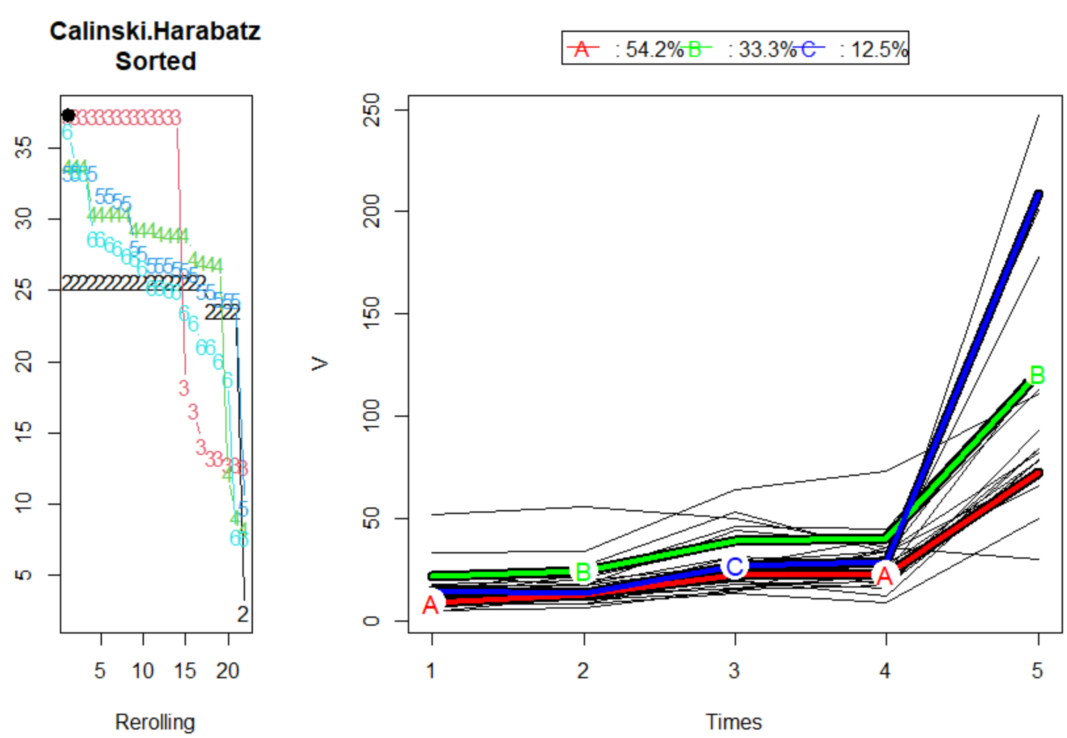

Figure 2. Graphs for results of longitudinal cluster analysis by frequency

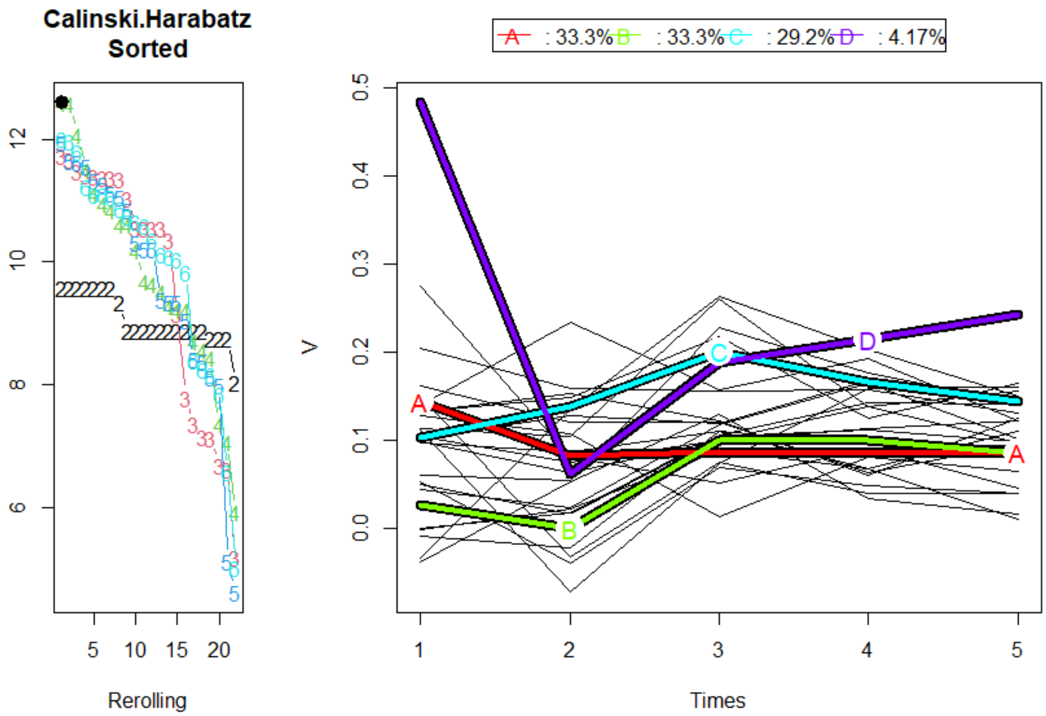

Figure 3. Graphs for results of longitudinal cluster analysis by polarity

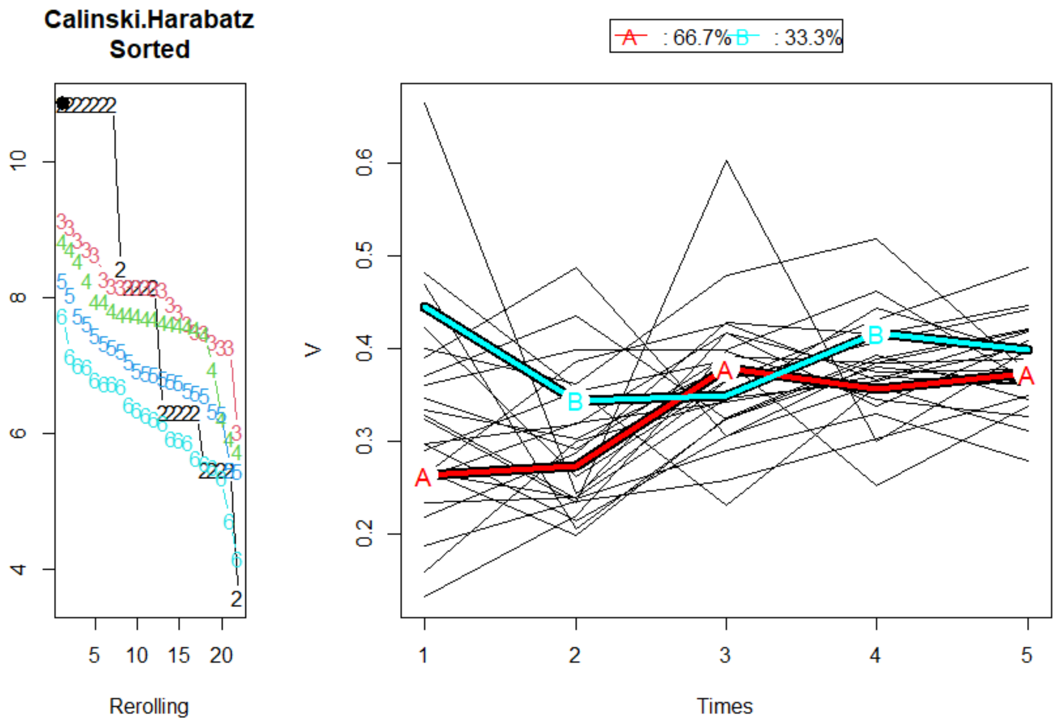

Figure 4. Graphs for results of longitudinal cluster analysis by subjectivity

In frequency, cluster A (54.2%) showed the tendency of increasing frequency after the pandemic but compared to other clusters, the slope was gradual. As the graph shows, cluster B (33.3%) reported medium steeper increasing trend after the pandemic. The most dramatic trend—an exponential increase after the pandemic—was displayed in cluster C (12.5%).

In polarity, the algorithm found four clusters. Cluser A (33.3%) shows mostly steady polarity around 0.1 after dropping in 2017, which means the topics belong to cluster A had been written in a neutral mood in the period. Cluster B (33.3%) and C (29,2%) displayed slight decrease tendencies after 2020, so it can be said that there were a few more negative tweets on the topics after the pandemic. However, cluster C has noticeably more positive tweets compared to cluster B during the whole period. Cluster D showed a very unique pattern that it was rapidly dropping in 2017, after then has been increasing regardless of the pandemic. Thus, it might be guessed that something probably happened in 2017 that influenced in the negative direction to cluster D which has only one topic, gratefulness about online learning (topic 19). However, after 2017, the mood has been moving toward a positive direction.

In subjectivity, only two clusters were suggested. As through the pandemic, cluster A (66.7%) showed a slight increase pattern that means people wrote more subjective tweets, and cluster B (33.3%) illustrated the opposite result (more objective viewpoint). All identified clusters by three factors and their topics are shown in Table 1. The cluster names were arbitrary assigned by the algorithm. For instance, Cluster A found by frequency is different from cluster A identified by polarity.

Table 2. *Identified clusters and their topics by frequency, polarity, and subjectivity.*

Cluster	By frequency (Topic #)	By polarity (Topic #)	By subjectivity (Topic #)
A	professional development (11) clinical study (12) course assignment (13) registration (14) virtual meeting (15) virtual medical lab (16) quality of online course (17) stakeholders (18) gratefulness about online learning (19) working from home (20) hybrid modality (22) virtual commencement (23) medical training/certification (24)	remote learning (1) benefits (7) anatomy class (8) clinical study (12) virtual medical lab (16) quality of online course (17) working from home (20) medical training/certification (24)	remote learning (1) support (2) virtual program (3) nursing programs (5) benefits (7) anatomy class (8) mental health crisis service and support (9) professional development (11) clinical study (12) course assignment (13) registration (14) virtual meeting (15) virtual medical lab (16) working from home (20) virtual commencement (23) medical training/certification (24)
B	support (2) virtual program (3) family support (4) nursing program (5) benefits (7) anatomy class (8)	virtual program (3) social distance and safe (6) mental health crisis service and support (9) negative feeling (10) course assignment (13) stakeholders (18)	family support (4) social distance and safe (6) negative feeling (10) quality of online course (17) stakeholders (18) gratefulness about online learning (19)

	negative feeling (10) nursing classes (21)	nursing classes (21) hybrid modality (22)	nursing classes (21) hybrid modality (22)
C	remote learning (1) social distancing and safe (6) mental health crisis service and support (9)	support (2) family support (4) nursing programs (5) Professional development (11) registration (14) virtual meeting (15) virtual commencement (23)	-
D	-	gratefulness about online learning (19)	-

Discussion and Implications

The study examined the changes in perception of medical fields toward virtual education on tweets for the last five years including the COVID-19 pandemic period. Across 24 selected topics, major themes were identified in conversations in virtual medical education fields. First, medical education schools were unprepared and ill-equipped to handle the overwhelming obstacles and immediate needs (e.g., new planning, support, accessibility, mental health crisis, registration). Second, COVID-19 has accelerated reshaping of medical education (e.g., leadership, safe learning environment, clinical study, group activities, virtual lab, quality of online course, hybrid). Third, virtual medical education was not only challenging for the last 12 months but they also look to the future possibilities (e.g., benefits, professional development, experiential learning).

The results from the sentimental and longitudinal cluster analyses identified clusters and their topics by frequency, polarity, and subjectivity. The trajectories information over the past five years helps explain a need in virtual medical education and the reason whether they favor virtual learning or not. Virtual education has grown rapidly since the pandemic. Medical education has also seen a rapid increase over the past year. As formal medical education had to move to remote format for social distancing, mental health crisis also increased (Cluster C). In order to reduce these side effects, many supports have also been increasing (Cluster B).

The polarity of the tweets over the period shows that there were more positive statements, especially since the pandemic of gratefulness for virtual education has seen the highest rise in positivity on average. Conversely, there was a slight decline in other clusters (Clusters A, B, & C, indicating many difficulties and challenges for virtual medical education.

Lastly, the subjectivity. Subjective statements about virtual medical education generally represent personal opinions, feelings, or judgments, while objective ones represent factual information. Both clusters identified were found to be subjective due to the nature of expressions on social media. In the past, there was a large difference between Cluster A and B, but recently the gap has been gradually narrowing. Social safety, negative emotions, and family support have been expressed a more subjective expression on their tweets. On the other hand, as for the general views of virtual medical education, the effort was reflected by increasing objectivity during the period (Cluster A).

Virtual education continues, although less intense than at the peak of the pandemic. We hope that this study contributes to broadening our understanding of virtual medical education. By understanding their needs for virtual medical education, we expect to be connected in a concrete way to how to solve problems in virtual medical education.

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Investigating Cognitive Presence Patterns and Content Knowledge Levels in Asynchronous Online Discussions (AODs): A Longitudinal Study

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Abstract

Students construct knowledge during asynchronous online discussions (AODs). Discussion postings show students' cognitive presence (CP) patterns and content learning levels. The purpose of this longitudinal field observation study was to investigate the patterns of, and relationships among, the same cohort of graduate students' cognitive presence and content knowledge level demonstrated within and across the AODs in two consecutive courses over two semesters. Content analysis of online discussion postings, descriptive and correlational statistics were used to analyze data. The results indicated that the exploration was the most active phase that emerged in AODs, followed by the integration, triggering event, and resolution. There was a significant change in the integration phase of CP and content knowledge levels over time. Moreover, the results yielded significant relationships among CP patterns and content knowledge levels. The findings have important implications theoretically in confirming the CP patterns that emerged in AODs and practically by identifying the dynamics of each of the CP phases and their associations with content learning.

Keywords: Asynchronous Online Discussions; Cognitive Presence; Content Knowledge

Introduction

For decades, asynchronous online discussions (AODs) have been used as a social, collaborative learning environment in higher online education. Social constructivism views learning in such an environment as an act of constructing knowledge through socially informed cognitive engagement where participants share, debate, listen, reflect, and confirm their knowledge in the context of communicating with others (Jonassen et al., 1995; Johnson & Johnson, 1996; Vygotsky, 1978).

AODs are primarily designed to prompt learners to engage cognitively to enhance their content learning through social interactions. Current research in AODs often studies cognitive engagement using the cognitive presence (CP) construct of the Community of Inquiry (CoI) framework to examine students' learning process (Garrison et al., 2000). CP defines ways that students mentally navigate the social learning process; how they consider new problems, seek to develop understanding, and share understanding with their learning community during the process of validating and modifying their understanding (Akyol & Garrison, 2011).

In AODs, students co-construct their knowledge through iterative interactions and collaborations with others in their learning community (Hew & Cheung, 2003; Joksimovic et al., 2014). Such collaborative interactions can prompt co-regulation and metacognition among those participating in communication events, activating, and enhancing cognitive processing within the individual and across the community (Jonassen et al., 1995).

AODs can activate a student's cognitive processing beyond surface learning into deeper learning through CP (Garrison et al., 2001). "In AODs, learners who have different ideas and prior experiences share their thoughts, read, reflect on, and react to others' postings using their cognitive processes (behavior) to collaboratively create a richer understanding of the content topic at hand (learning)" (Koszalka et al., 2021, p, 3). Such interactions represent higher-order thinking (Anderson et al., 2001) and suggest behaviors that indicate the construction of deeper content knowledge (Akyol & Garrison, 2011; Garrison et al., 2001; Jonassen et al., 1995).

However, studies have shown that learning expectations for multiple CP phases and deeper content learning in AODs are not always achieved (Chen et al., 2019; Koszalka et al., 2021; Koszalka et al., 2019). Researchers have examined factors that may contribute to exploration activities during cognitive engagement processes to understand these deficiencies. But few studies were found that directly studied the relationships among cognitive presence (CP) and level of content knowledge demonstrated in AODs. Koszalka et al. (2021) recently suggested a significant relationship among levels of idea exchange, content focus, and surface/deep learning in AODs, but only studied this phenomenon in several one-time, short AOD sessions, not directly investigating CP. Since individual cognitive engagement can result in different cognitive development outcomes, e.g., levels of demonstrated content learning (Jonassen et al., 1995; Koszalka et al., 2021), it is important to unpack the relationships between CP and content learning levels. And how learners enter deep content learning during AODs with the development of CP processes and whether they maintain or build different patterns and levels of deep learning in subsequent AOD experiences are lack of study. Therefore, it is necessary for us to explore how CP presences and content learning changes over time. Such studies may inform design strategies for conducting effective AODs.

The current study focused on studying the relationships among each phase of CP (trigger, exploration, integration, resolution) and the level of content learning demonstrated within the same cohort of students, across two consecutive core courses, offered over two semesters (longitudinal study). We hope to identify whether students who engage in various surface and deep learning strategies during AODs in an early course benefit from this initial experience and continue to engage in deeper learner behaviors in subsequent AODs. These questions suggest looking at longitudinal patterns of cognitive presence and learning levels across multiple, sequential AODs within and across courses. Therefore, the present study aims to add our understanding of the relationships between CP and depth of content learning and how these patterns form (or not) longitudinally.

Research Questions

The current study involved analyzing the AODs transcripts. We collected the convenient data from the same cohort of 12 graduate students from two courses. These students were pursuing a master's degree in instructional design. Before taking the two courses, all students have had experience in online courses. IRB exempt status was granted for this study. Female and male students were 2 (16.7%) and 10 (83.3%), respectively. The average age of the cohort is 44. All participants have military experience. The average length of their military service is 22 years. Two of them are veterans, and the rest of them are active-duty service members.

Students' CP patterns were coded and examined using Garrison et al.'s (2000) CoI framework. Content knowledge levels were identified and analyzed using Anderson et al.'s (2001) updated version of Bloom's taxonomy and previously developed protocols from Koszalka et al. (2021). There were three research questions:

1. What patterns of cognitive presence and content knowledge levels emerge within and across the AODs?
2. How do the cognitive presence patterns and content knowledge levels of the same cohort of students change (or not) over time in the two courses investigated?
3. Is there any significant relationship between cognitive presence patterns and content knowledge levels of the same cohort of students across multiple AODs?

Method

The transcripts of 276 postings from Course A and 273 postings from Course B were retrieved from the Blackboard LMS, downloaded, cleaned, and saved in the qualitative data analysis software MAXQDA before coding. There was no information related to students' identities. The cohort of students participated in the AOD of Course A in the fall semester and then participated in the AOD of Course B in the spring semester of the same academic year.

We applied a quantitative content analysis approach, transferring students' postings into quantifiable codes. We followed the steps of a content analysis suggested by Neuendorf (2017, P. 67-69):

Step 1. We collected data that fit our research purpose

Step 2. We selected a single meaning as the unit of analysis.

Step 3. The two coders in our team independently divided each posting into one meaning and then dismissed the inconsistencies through a discussion.

Step 4. The two coders coded the meanings with two separate existing coding frameworks. The first is cognitive presence from Garrison et al. (2001), and the second is content level from Koszalka et al. (2021). The first four categories of the coding framework focused on the cognitive engagement process in the course content. The last two categories focused on the level of content learning (surface or deep) demonstrated in students' postings.

Step 5. The two coders coded the first 200 meanings of the AODs for checking the inter-rater reliability.

Step 6. The two coders discussed the inconsistencies, re-coded the 200 meanings to improve inter-rater reliability, and finished coding the rest of the meanings in the AODs.

Finally, relying on the numerical data in terms of the codes, we run descriptive and correlational statistics through the SPSS software for finding the patterns (RQ1), changes (RQ2), and relationships (RQ3).

Results

RQ1. What patterns of cognitive presence and content level emerge within and across the AODs?

Descriptive statistics were generated to understand the patterns. Through the content analysis, we produced 1630 meanings (n=1630) hidden in the postings of the AODs.

While all the four phases of cognitive presence appeared in the meanings, the ratios of their frequencies were different. The exploration phase was identified from 1382 meanings out of 1630, having the highest ratio (84.8%) among the four phrases. The integration phrase took second place with 349 meanings. Only 152 and 51 meanings correspondingly include the triggering event phrase and the resolution phrase.

The proportions of the content levels are only slightly different compared to the proportions of CP. 947 meanings were coded as content low, while 664 meanings were coded as content high. Only 19 meanings existed for social purposes and did not have any content relating to the discussion topics.

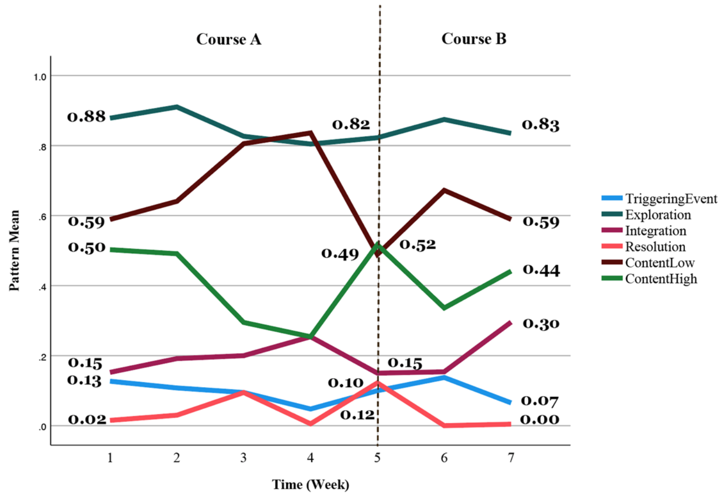
RQ2. How do the cognitive presence patterns and content knowledge levels of the same cohort of students change (or not) over time in the two courses investigated?

To better understand whether and how the cohort's patterns change over time in the two courses, we also coded each meaning of the AODs with the posted week as a time label. The AOD in Course A lasted five weeks, and the AOD in Course B lasted two weeks. The number of generated meanings from Week 1 to Week 7 are 197, 167, 190, 189, 180, 247, and 460. These numbers clearly demonstrated a tendency for the same cohort of students to become more engaged in the last two weeks as they created more meanings.

Figure 1 shows the changes in the CP and content level in the AODs over time. When we observed the changes from a seven-week range, both the cognitive presence and content level fluctuated over time and thus did not show a consistent tendency. With low mean values, both the triggering event and resolution phrases are stated at low mean values and fluctuate less than other phrases. This indicated that students rarely played as an ice breaker (i.e., the role triggering a new topic) and problem-solver (i.e., the role posing a solution to a problem) in any time spot of their AODs. Comparatively, the mean value of the exploration phrase stayed high all the time, implying that students were more likely to play the explorer (i.e., the role providing pieces of content) and stick to this role during the whole AOD process. The tendency of the integration phrase fluctuated less in the first five weeks, but it showed a sudden increase in the last two weeks. This could suggest that after finishing the AODs of Course A, the cohort of the students promoted their ability to integrate pieces of information into a whole new meaning unit as they were more willing to play the role of synthesizer.

The tendencies of content level fluctuated more fiercely compared to the cognitive presence tendencies. We were surprised that the two tendency lines of the content low and content high were highly symmetrical and even looked like mirror effects. It implied a strong correlation effect between the content low and the content high. In the weeks of Course A, the content low tendency was leveling up in the first three weeks, peaked in the fourth week, and then fell sharply in the last week. Oppositely, the content high tendency was leveling down in the first weeks, reached a valley in the fourth week, and then went back to the situation close to the start point.

Figure 1. AOD Patterns Over Time



RQ3. Is there any significant relationship between cognitive presence patterns and content knowledge levels of the same cohort of students across multiple AODs?

Inferential statistics were generated for understanding the relationships among the cognitive presence phrases and content knowledge levels. The matrix below (Table 1) shows the significant correlations. The content high variable was strongly and significantly correlated with the content low variable negatively ($r=-.836$, $p<0.01$). It could indicate that students rarely invested their endeavors in creating meaning with both content levels in the AODs. Another strong and significant correlation occurred between the exploration and integration phase variables ($r=-.674$, $p<0.01$). It revealed that the exploration phrase and integration phrase hardly co-existed in a single meaning of the AODs. In other words, students tended to stay with either a deductive phase (i.e., exploration) or an inductive phase (i.e., integration) rather than involve both when they created an AOD meaning.

Some correlations were found comparatively weak but significant. It seems that the resolution phase of CP was slightly correlated with the content low variable negatively ($r=-0.09$, $p<0.01$), but it was slightly correlated with the content high variable positively ($r=0.081$, $p<0.01$). It suggested that in the resolution phase, students preferred to stay at the content high level. The exploration phase variable was positively correlated with the content high variable ($r=0.08$, $p<0.01$). It suggested that when students explore information for building the meanings of the AODs, they tend to use the content with their higher levels of thinking (e.g., analogy, comparison).

Regarding the time variable, the data (r=-0.056, p<0.05) indicated that content level might increase as time went on. Furthermore, students seemed to become more cognitively engaged in the integration phase (r=0.083, p<0.01) and less cognitively engaged in the resolution phase (r=-0.063, p<0.05) when the AODs were closer to the end.

Table 1. Correlation Matrix for All the Patterns

		ContentLow	ContentHigh	TriggeringEvent	Integration	Exploration	Resolution	Time
ContentLow	Pearson Correlation	1	-.836**	-.034	-.021	-.007	-.090**	-.056*
	Sig. (2-tailed)		.000	.166	.394	.786	<.001	.025
	N	1630	1630	1630	1630	1630	1630	1630
ContentHigh	Pearson Correlation	-.836**	1	.005	.012	.080**	.081**	-.018
	Sig. (2-tailed)	.000		.851	.638	.001	.001	.456
	N	1630	1630	1630	1630	1630	1630	1630
TriggeringEvent	Pearson Correlation	-.034	.005	1	-.044	-.046	-.046	-.040
	Sig. (2-tailed)	.166	.851		.076	.062	.066	.105
	N	1630	1630	1630	1630	1630	1630	1630
Integration	Pearson Correlation	-.021	.012	-.044	1	-.674**	-.016	.083**
	Sig. (2-tailed)	.394	.638	.076		<.001	.506	<.001
	N	1630	1630	1630	1630	1630	1630	1630
Exploration	Pearson Correlation	-.007	.080**	-.046	-.674**	1	-.071**	-.035
	Sig. (2-tailed)	.786	.001	.062	<.001		.004	.153
	N	1630	1630	1630	1630	1630	1630	1630
Resolution	Pearson Correlation	-.090**	.081**	-.046	-.016	-.071**	1	-.063*
	Sig. (2-tailed)	<.001	.001	.066	.506	.004		.010
	N	1630	1630	1630	1630	1630	1630	1630
Time	Pearson Correlation	-.056*	-.018	-.040	.083**	-.035	-.063*	1
	Sig. (2-tailed)	.025	.456	.105	<.001	.153	.010	
	N	1630	1630	1630	1630	1630	1630	1630

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Discussion

Our analysis of the first research question suggested that the exploration phase was the most active in AODs, followed by the integration, triggering event, and resolution. The highest ratio of exploration frequencies and the lowest ratio of resolution frequencies in AODs is consistent with previous research (Chen et al., 2019; Garrison et al., 2001; Meyer, 2003; Vaughan & Garrison, 2005). Some previous studies pointed out that it was difficult for students to reach the integration phase (Akyol & Garrison, 2008; Garrison, 2007; Kanuka et al., 2007; Vaughan & Garrison, 2005), but in this study, the integration phase is the second most active phase emerged in AODs. This finding aligns with Akyol and Garrison's (2011) study, revealing that the integration phase is active (Akyol & Garrison, 2011). The different results on cognitive presence patterns that emerged in AODs might be explained by different instructional designs of courses, including types of prompt questions (Chen et al., 2019; Garrison, 2007) and duration of AODs. The prompt questions for causes seeking and problem-solving are more likely to facilitate students to connect and synthesize ideas to construct their meanings and provide solutions, that is, to reach the integration and resolution phase of cognitive presence. The length of AODs also can affect students to achieve the integration and resolution phase. The longer students participated in AODs, the higher the possibility of reaching the integration and resolution phase. As for the content knowledge levels, the previous study, which explored the evidence of student content learning levels in a single course, showed that students' content-low postings were dominant in AODs (Koszalka et al., 2021), which is consistent with our study.

Our analysis of the second research question suggested that both cognitive presence patterns and content knowledge levels could change over time. Among the cognitive presence patterns, integration and resolution phases fluctuate a lot more than the other phases. Both the triggering event and exploration were at the highest levels at the beginning of the course weeks, and then there was a decreasing trend, finally going back to a higher level during the late weeks. Both the integration and resolution reached the highest levels during the mid and late course weeks and then presented a decreasing trend. These findings highly align with Sezgin's (2020) study. However, Sezgin (2020) conducted their study only in a single seven-week online course. Since this longitudinal study focused on changes over time in two courses across two semesters, something unique we found about the changes was that integration was the only phase of cognitive presence increased in the second course, which might be explained by the type of discussion questions and time. Students are more likely to reach the integration phase with more structured questions, and they can better integrate ideas from different sources with practice and efforts through AODs (Akyol & Garrison, 2008; Sezgin, 2020). For the content knowledge levels, we found that there were more content-low postings during the early weeks in which students tended to focus on sharing facts, a summary of reading materials, and their general understanding of the discussion topics. As time goes by, students gradually connect their understanding of the discussion topics with their personal experiences to demonstrate higher-order thinking skills.

Our analysis of the third research question suggested the correlations between cognitive presence patterns and content knowledge levels. Such correlations may enlighten the instructional design of AOD in multiple aspects. First, the negative correlation between the content low variable and content high variable indicates that students tend to stay at a single content level (i.e., low or high) when constructing an independent meaning in the AOD. The correlation between the exploration and integration phases demonstrates a similar pattern: students focus on only one cognitive presence phrase when they construct meaning. Therefore, the instructors may need to require or encourage students to construct multiple meanings in a posting so that multiple content levels and phrases of cognitive presence can occur in the AOD. A tested instructional approach to making this happen is to design structured prompts for eliciting diverse meanings in a single posting (Darabi et al., 2013). Structured prompts often include sequential questions requiring students' responses in different cognitive or content levels (Darabi et al., 2011). A group of researchers has found that structured prompts would lead to the robustness of meanings with various cognitive learning indicators in the AODs (Darabi et al, 2011; DeNoyelles et al., 2014; Lee 2012). Second, both the exploration phrase and resolution phrase were significantly correlated with the content high variable. It suggests that if students are expected to engage in the AODs cognitively, they may need to equip their high-level content learning skills, such as comparing different concepts and creating real examples. The study conducted by Koszalka et al. (2021) involved a series of pre-work activities prior to the AODs. In the pre-work activities, students had the chance to read the assigned content and practice their high-level content learning skills by reflecting on some scaffolded questions. The result proved that students were more cognitively engaged in the AOD after taking the pre-work activities. Thus, preparing students for some high-level content learning skills in advance can benefit students' cognitive presence in the AOD.

Conclusion

The research findings indicate that the exploration was the most active phase in AODs, followed by the integration, triggering event, and resolution. There was a significant change in the integration phase of CP and content knowledge levels over time. Moreover, the results yielded significant relationships among CP patterns and content knowledge levels. To encourage multiple CP phases and achieve deeper content levels in AODs, the instructors may need to require students to construct multiple meanings in a posting. For example, provide specific participation guidelines, design a timely feedback system, use structured prompts to elicit diverse meanings, or prepare students some high-level content learning skills in advance through well-designed pre-work activities. Future research may include but is not limited to the following list of potential empirical research: 1) Collect discussion transcripts in a longer time range (e.g., five years) to examine students' CP patterns and content learning levels demonstrated in AODs; 2) Compare the CP patterns and content learning levels of military students with non-military students to examine if students' characteristics influence their performance; 3) Integrate self-reported surveys and interviews to triangulate the findings of content analysis.

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The Historical Development of Deep Learning and Its Research Trend: A Literature Review

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Abstract: Deep learning has recently received unprecedented attention from governments, schools, social institutions, and the media. The puspose of this study is to present an in-depth understanding of relevant research published in top-tier journals from 1976 to 2019 through a systematic review method.
The results reveavled: (1) four phases of deep learning research: dormant period, germination period, emerging period and rapid period; (2) the deep learning research is concerned more about process, little discussion on flexibility; (3) the concept shifted in two directions, one is from the pursuit of understanding to the pursuit of transfer and the other is from the focus on process to the focus on outcomes. Based on the findings, this study proposed a landscape to the concept of deep learning to deliever a full understanding of the deep learning and we suggest more research should focus on the problem of deep flexibility with the empowerment of smart classrooms.
Keywords: concepts evolvement; deep learning; learning architecture; literature review; research trend; smart classroom

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Influenced by the concept and framework of core literacy education, the deep learning movement has emerged. In addition, a series of education and teaching reforms triggered by information technology, especially AI technology, deep learning has once regained the wide attention of the academic community and the general public, especially at the time when machine defeated Lee Sedol, the world champion of Go. Deep learning in education has received unprecedented attention and recognition from governments, schools, social institutions, and the media (Zhu, & Peng, 2017). Currently, deep learning now is extremely valued among the school leaders (Johnson et al., 2014), and the shift to deep learning has also become a long-term trend driving the application of educational technology (Freeman, Adams , &Cummins, 2017). How to promote students' deep learning and cultivate their deep learning abilities has been an increasing important topic for an education reform.

Deep learning is not a newly emerging concept. Since 1976 when it was first time proposed, deep learning has experienced more than 40 years ‘ development and evolution. While there is little discussion regarding how deep learning developed, how the concept evolved, what are the current research bottlenecks we might need to focus on and what are the potential solutions, this study is to explore those questions and hope to help scholars and teaching practitioners construct a comprehensive understanding of deep learning and accurately grasp the orientation of deep learning research and development. By using a systamacti review method, this study deeply reviewed articles indexed in SSCI ranging from 1976 to 2019.

1.Literature Sources and Analysis Methods

According to the literature dispersion theory of most key literature is usually concentrated in a few core journals, this study uses the paper title names of "deep(er) learning, deep approach(es), deep strategy/strategies" to search articles indexed in SSCI on the Web of Science database. The obtained documents are selected according to the following selection criteria (Petticrew, &Roberts, 2006): a) not a duplicate article, b) the topic should be about education and teaching, c) the publication date is between 1976 and 2019. A total of 109 arctiles were included for the further analysis.

First, the trend of deep learning research popularity was explored using econometric analysis and visualized through social network centrality analysis. Content analysis was used for an in-depth understanding of the research bottleneck and possible solutions of deep learning. The social network centrality analysis was carried out according to the following steps: a) data cleaning (e.g., term unification); b) importing keywords of the literature into BICOMB2 software for a word frequency analysis; c) generating co-occurrence matrix through co-occurrence analysis of high-frequency keywords with word frequency greater than or equal to 3; d) importing co-occurrence matrix into UCINET6 software for the social network centrality analysis using the NetDraw tool.

2.The trend and status of deep learning

Content analysis results show that international scholars generally believe that the concept of deep learning was first proposed by Maton and Säljö in 1976, even though they did not use the term, deep learning. In fact, this term was gradually adopted after the 1990s, and the earliest user was the scholar Valerie Malhotra Bentz (1992).

2.1. The trend of deep learning research

Econometric analysis shows (see Figure 1) that deep learning has not been widely concerned by scholars until 21st century. Throughout the history of deep learning research, the trend of deep learning research has gone through four periods: dormant period, germination period, emerging period and rapid period.

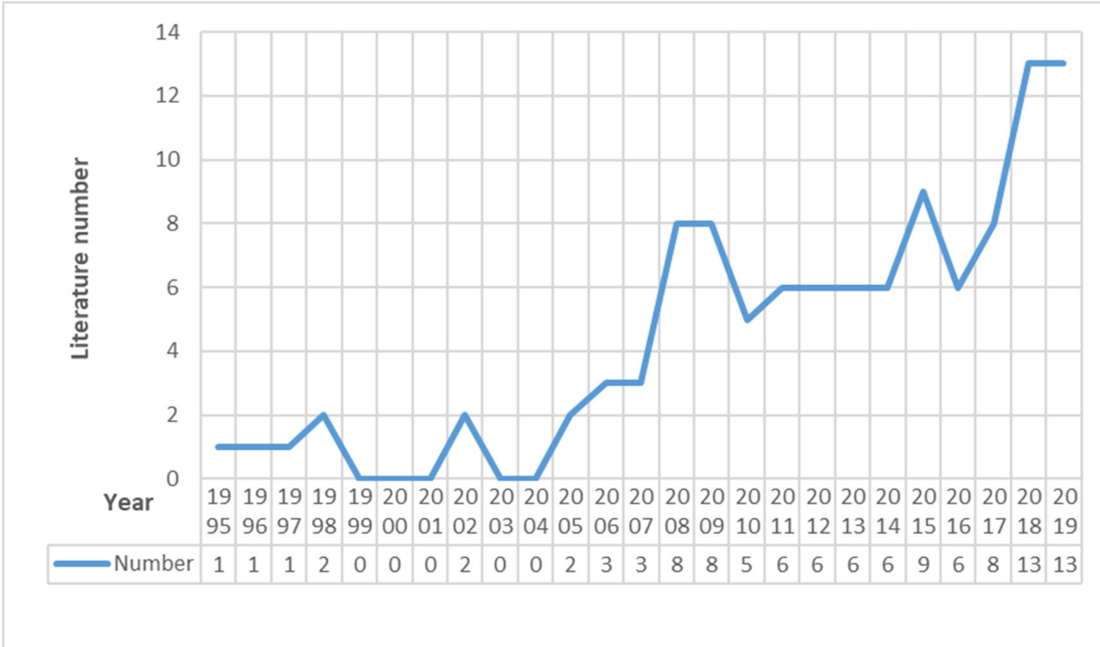

Figure 1 The annual Distribution of Deep Learning Literature

2.1.1.Dormant Period (1976-1995)

Since the birth of deep learning in 1976, deep learning has entered a long dormant period (see Figure 1). Although the literature of this period is not available in econometric statistics, we found there were still a group of scholars dedicated to deep learning research. John Biggs, professor of educational psychology, is one of the representatives. After in-depth research, they published many interesting results. The two most famous results are the SPQ Learning Process Scale and the SOLO taxonomy. The first one is to measure deep/superficial learning strategies and motivations. (Biggs, 1978), the second one is for measuring the results of deep learning (Biggs, &Collis, 1982). These two outcomes are still commonly used tools for scholars to measure the process and results of deep learning. In fact, after the 1970s, computers have gradually replaced some conventional tasks and manual tasks, and began to assist people in completing some unconventional tasks (Murane , &Levy, 1996), and promoted changes in in the enterprise's demand for talent structure: The demand for conventional skills has dropped sharply, and the demand for skills such as communication skills and expert thinking has soared (Conley, &Darling-Hammond, 2013). However, content analysis shows that deep learning at this time focuses more on the opposite of shallow learning (conventional memory, lack of deeply understanding, and just coping with exams), and it has not been in line with the above-mentioned social situation. This may be the reason why deep learning did not attract widespread attention and entered a long dormant period at this phase.

2.1.2.Germination Period (1995-2007)

Literature statistics show that in 1995, Hoon and others (1995) from Nanyang Technological University in Singapore applied deep learning strategies to high school chemistry classes for the first time to encourage students to visualize abstract concepts and explore the connections between numerous chemical facts. Since then, deep learning research has entered a germination period, during which a small number of scholars' research and application results have appeared one after another. Content analysis shows that the concept of deep learning during this period was similar to the dormant period, still focusing on process. But in addition to exploring more ways/strategies that can promote deep learning, scholars have begun to explore formative evaluation and the support of various learning environments.

2.1.3.Emerging Period (2007-2016)

After entering the 21st century, various international organizations and countries around the world have devoted themselves to exploring what kind of new century talents should be cultivated. As a result, a variety of talent competency frameworks emerged. For example, the OECD released the DeSeCo competency framework in 2003, the European Union released the key competences for lifelong learning in 2006, and the P21 released the 21st century learning framework in 2007. Those frameworks had prompted the research of deep learning to enter the emerging stage. During this period, influenced by these key competency frameworks, an international wave of deep learning movement emerged: In 2010, the Hewlett Foundation of the United States initiated a 15-year deeper learning strategic plan (The William and Flora Hewlett Foundation, 2012). Asia Society and other ten institutions have also worked together to promote the spread of deep learning experimental schools throughout the United States (Alliance for Excellent Education, 2017). Moreover, the Victoria University in Canada launched a global deep learning initiative, cooperating with more than 1,000 schools in 10 countries to seek solutions for deep learning changes (NPDL, 2017). In 2015, the United States even issued a report to take deep learning as the national policy of education in the 21st century (National Association of State Boards of Education, 2015).

2.1.4.Rapid Period (2016 – present)

In addition to the fact that the United States regards deep learning as a national education policy, the event signaling the arrival of the rapid development period of deep learning is when the intelligent robot AlphaGo defeated the world go champion Lee Sedol in 2016. This event once increased the concern that machines would replace humans, and prompted scholars to reflect on questions such as "since humans can teach machines to learn deeply, why can't we teach children to learn deeply in school?". During this period, deep learning research has been improved in all aspects: from concept expansion, strategies testing, model construction, to mechanism exploration, evaluation development, and then to subject application. During this period, deep learning enabled by technology, especially intelligent technology, has become an emerging research trend. In particular, the release of the Core Competences for Chinese Student's Development in 2016 added a powerful fuel for deep learning research. Given this situation, Chinese Scholar Kekang He (2018) asserted that deep learning has regained the widespread attention of academia and even the general public (according to the data, the first attention occurred during the Rapid Period).

2.2.The status of deep learning research

Figure 2 shows the research status of deep learning formed by the analysis of social network centrality. The larger the box, the higher the centrality, and the distance between the boxes reflects the close relationship between keywords.

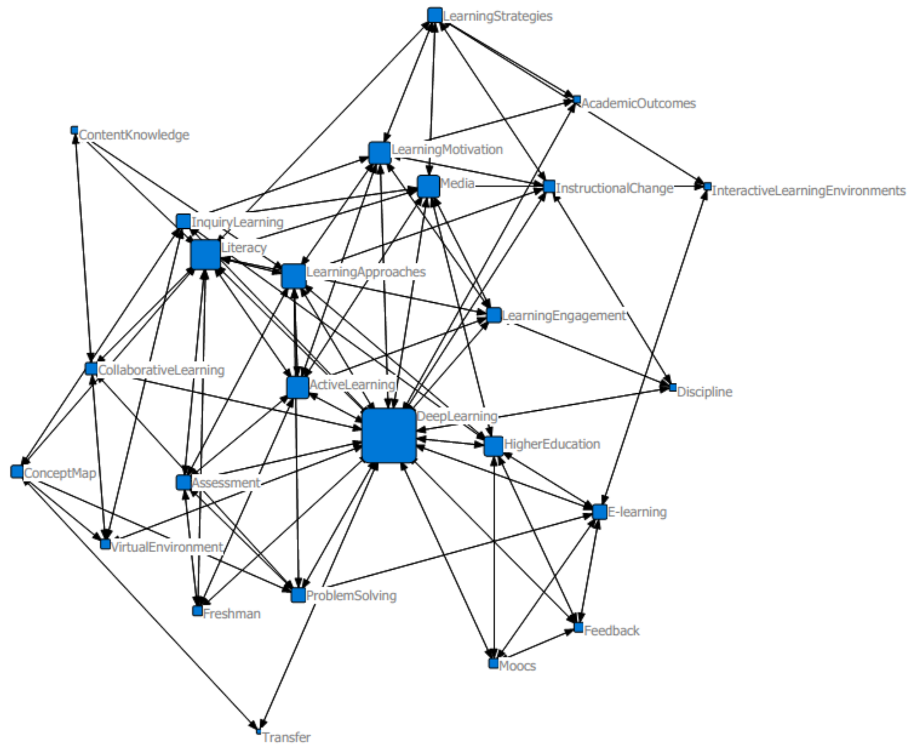

Figure 2 Community diagram of high-frequency keywords in deep learning literature

On the whole, the research of deep learning is biased towards promoting students' deep participation in learning and adopting advanced learning strategies. Specifically, In terms of deep participation learning, there is detailed research from the macro-participation culture to the micro-class participation (cognition, emotion, behavior) (Terrenghi et al., 2019; Gee et al., 2019). In terms of advanced learning strategies, scholars are committed to exploring various strategies to achieve deep learning, from peer teaching as a teacher to self-perception reflection (Nelson et al., 2014).. In terms of the development of high-level knowledge and skills, many literatures involve research on key compentencies such as creativity (Turvey, 2006) and critical thinking (Wang et al., 2015), while Figure 2 shows that it has a distant relationship with deep learning. In terms of transfer applications, there are few related studies, and the few existing mainly focus on the transfer of knowledge (Green et al., 2013; Nielsen, 2016): Figure 2 shows that transfer is on the edge of extreme remoteness confirms this conclusion.

3.The Concept Evolution of Deep Learning

At present, deep learning is more than a learning method used to understand basic knowledge, it usuallyrefers to learning strategies for obtaining advanced knowledge and its transfer.

3.1.The change of ideas

3.1.1.From pursuing understanding to pursuing transfer

In the early days, the deep learning proposed by Marton and Säljö (1976) aimed at learning approaches or strategies. Simply put, learning by understanding is deep learning, but learning by reproduction is shallow learning. Deep learning at this time is reflected at four aspects, they are seeking meaning, connecting ideas, using evidence, and being interested in opinions. Shallow learning is mainly embodied in three aspects: information is memorized irrelevantly, learning is limited to the syllabus, and adopting minimal effort to avoid failure (Tait, & Entwistle, 1996). This kind of learning only generates a limited understanding, little connection between concepts. On this account, the famous scholar Ramsden (2003) believed that shallow learning is at best a quantity without quality (quantitative change), while deep learning is a cumulative quantity of quality (qualitative change).

It is easy to find that the goal of deep learning at this time is to understand, and the goal of shallow learning is to reproduce the test materials. Although shallow learning can produce superficial understanding, it is not one of its learning goals.

Since deep learning starts in a way of understanding and constructing meaning, people soon realized that it can lead to better transfer of knowledge and concepts (Van, &Schenk, 1984). After entering the 21st century and facing the ever-changing new situation, how to transfer what has been learned in the classroom to enable students to succeed in future work and life has become a new education challenge. Therefore, the purpose of deep learning has changed from understanding to transfer (i.e. learning for transfer), and understanding becomes the basis for deep learning to realize migration. The National Research Council of the United States has set the tone of deep learning as the process through which an individual becomes capable of taking what was learned in one situation and applying it to new situations (i.e., transfer), and the product of deep learning is transferable knowledge (National Research Council, 2012). This kind of knowledge includes not only the content knowledge of a certain field in the traditional sense, but also the knowledge of how, why, and when to apply this knowledge to answer questions and solve problems.

3.1.2.From focusing on process to focusing on outcomes

Initially, deep learning was just a kind of learning strategies that Marton and Säljö advertised for students to pursue understanding. Later, this kind of strategies were refined into the deep strategies to maximize meaning and deep motivations such as intrinsic interest in the learning process(Biggs, 1987). According to Biggs, deep strategies describe the way students are deeply involved in tasks. As a prerequisite, this kind of participation has gradually become an integral part of the deep learning process (Biggs, Kember, &Leung, 2001). In deep learning, deep participation represents the extent to which students are actively pursuing deep learning, and it refers to actively participating wholeheartedly. Today, with the emphasis on “student-centered” teaching, participation plays an increasingly important role in deep learning. Chinese scholar Yunhuo Cui (2017) even directly quoted cognitive participation to define deep learning: it is a learning that shows high involvement, high cognitive participation and gains meaning in a complex environment.

Although, after the 1970s, the demand for talents' ability has changed, that deep learning did not shift its attention from process to result until the Hewlett Foundation initiated the deep learning strategic plan in 2010. Different from the previous deep learning that focuses on the deep understanding and basic knowledge transfer, the later deep learning pays more attention to the acquisition and transfer of middle-level and high-level abilities. Correspondingly, deep learning is also known as a comparative name: deeper learning.

Through analysis of the situation at the time, the Hewlett Foundation proposed six deep learning abilities that need to be transferred and applied (The William and Flora Hewlett Foundation, 2012), they are mastering core academic content, think critically and solve complex problems, work collaboratively, communicate effectively, learn how to learn, and develop academic mindsets. Soon after, in order to explore the blend of transferable knowledge and skills and 21st century competencies, the US National Research Council identified three broad domains of competence—cognitive, intrapersonal, and interpersonal, and regarded these three competence domains as the three dimensions of deep learning knowledge and skills (National Research Council, 2012). In fact, the six deep learning abilities proposed by the Hewlett Foundation correspond to the three competence domains defined by the US National Research Council, and they both are also homogeneous with the capabilities of smart talents, as shown in Table 1.

Talble 1. The relationship between deep learning abilities, 21st century competencies and smart talents capabilities

competence domains	six deep learning abilities proposed by the Hewlett Foundation	21st century competencies	smart talents capabilities
cognitive	mastering core academic content	- key academic subjects -3Rs （i.e., Reading, wRiting, and aRithmetic	-master the basic knowledge proficiently
	think critically and solve complex problems (including the effective use of professional tools and techniques, as well as the ability to solve problems creatively)	- critical thinking and problem solving - computing and digital proficiency - creativity and innovation	- good at solving complex problems - good at judgment and creation
interpersonal	work collaboratively	- collaboration and leadership	- good at collaboration - make good use of technology
	communicate effectively (written, oral)	- communication and media literacy	-good at communication
intrapersonal	learn how to learn	- learning self-direction	-good at learning
	develop academic mindsets	- career, civic	- ingenuity, good personality, pragmatic

3.2. Complete solution of deep learning concepts

To sum up, the goal of deep learning has evolved from seeking understanding to pursuing transfer. It not only pays attention to the deep participation of students and the strategies students adopted in the learning process, but also pays attention to the mastery and transfer of higher-level skills. Therefore, this study summarized an elaborate definition of deep learning: Deep learning is a meaningful learning method based on understanding and pursuing transfer applications. It promotes the development of high-level knowledge and abilities by encouraging students to be deeply involved in learning and appropriate use of advanced learning strategies, then realizes the application of this knowledge and abilities in new situations or the generation of new high-level knowledge and abilities.

The definition suggests the following features of deep learning, a) deeply involved in learning, b) adopting advanced learning strategies, c) focusing on the development of high-level knowledge and abilities, and d) based on understanding and pursuing transfer are the four major characteristics of deep learning. Among them, deeply involved in learning means fully and actively participating. It focuses on student's learning involvement and the state of students' flow. Advanced learning strategy can be judged by "whether it is based on understanding" and "whether it pursues transfer application". Considering that deep learning should embody the idea of "student-centered", whether the learning strategy is advanced or not also needs to be judged "whether it reflects the initiative of the students".

High-level knowledge and abilities are as shown in Table 1. From the perspective of Bloom's taxonomy, it focuses on implementing (i.e., applying what learned in new situations), analyzing, evaluating, and creating. The understanding in d) is mostly in-depth understanding. Since reflection has been proven to be an important means of in-depth understanding (Haller, Fisher, &Gapp, 2007), this understanding can start with deep and repetitive thinking from multiple perspectives. Regarding transfer, considering that classroom teaching cannot cultivate all the knowledge and abilities to solve unknown problems in the future, this study also takes the combination or comprehensive innovation of existing knowledge and abilities as a kind of transfer. In this way, the transfer includes both the application of knowledge and abilities in new situations and the generation of new high-level knowledge.

4.The Bottleneck of Deep Learning Research

Based on our review and analysis, the existing deep learning research basically covered four major characteristics of the concept of deep learning. In addition, though the existing studies almost regard deep learning as a stable structure-oriented activity process, its flexibility issue has not received enough attention.

4.1.Deep learning demands flexibility

Whether to encourage students to be deeply involved in learning or to guide them to adopt advanced strategies, the ultimate goal of deep learning is to promote the development of students' high-order knowledge and ability and its transfer and application. Research has shown that only deep understanding can realize transfer applications, and reflection is an important means and effective strategy to realize this understanding, what's more, some scholars even believe that reflection is the only mechanism for deep learning (Svensson, 1977). Reflection requires students to be able to review what they have learned, think repeatedly and revise existing ideas at any time. In addition, deep learning also needs students to be able to actively select suitable resources, tools, and carry out appropriate learning activities according to one's own needs. This personalization and initiative can help promote deep learning (Fullan, &Langworthy, 2014). Due to the uncertainty of the time for students to review what they have learned, the difference of review contents, and the unpredictability of their active choice of resource, tools and learning activities, the structure of deep learning activity progress should be diverse and flexible.

In the flexible progress structure, flexible and interactive self-inquiry guided by teachers is the key to the success of deep learning. Self-inquiry can make students believe that they have control over the content, methods, and time of learning, and can make them believe that their behavior is internally initiated. As a result, it leads to a greater preference for more challenging tasks and a greater willingness to put in more effort to understand (Grolnick, &Ryan, 1989), leading to deep learning. Research shows that cultivation and transfer applications of the high-level knowledge and abilities pursued by deep learning are very difficult for beginners, because they lack the schemas that experts use to solve new problems. This can easily lead to students' failure due to the lack of knowledge of self-inquiry without flexible interaction between students and teachers (Bransford, Brown, &Cocking, 2000). The failure case of deep learning of "learning while writing research papers" by Green et al. (2013) proves this point. The flexible interaction between students and teachers in self-inquiry are embodied in "individual needs, response whatever is requested, and fusion of request and its response", which is different from the teaching mode with clear distinction between student-led and teacher-led.

4.2.The challenge of flexibility

Flexibility is one of the six challenges of educational development and reform. Deep learning's demand for flexibility in the activity progress structure has touched on changes in the top-level framework structure, which further increases the difficulty of achieving flexibility.

In fact, the above flexibility is superficialn, what deep learning really needs is cognitive flexibility. This flexible feature is to organize teaching and teach knowledge in different ways, prompting students to repeatedly cross-learn (i.e., for the same content, repeated non-linear learning is carried out for many times from different perspective at different times and in different situations for different purposes). The process of repeatedly cross-learn is accompanied by the change of the context and the repetition of de-context and re-context. Context can bridge the world of knowledge and the world of life. In detail, de-context establishes a corridor from the world of life to the world of knowledge, prompting students to extract knowledge such as laws, trends, or common characteristics, and re-context establishes a corridor from the world of knowledge to the world of life: every time students solve a problem in a new situation, they will reassemble the extracted knowledge and construct the meaning of the current problem. In this way, students can form a rich and flexible understanding, and can flexibly apply or assemble relevant knowledge to solve problems in changing situations and realize transfer (Jacobson, 1996). This cognitive flexibility is a huge challenge in classroom teaching with limited time, heavy tasks and large numbers of people.

5.Solution Measures

As to the above flexibility bottleneck, learning architecture may be an effective approach, because its outstanding feature is flexibility (MCEETYA, 2003), and it can help understand the depth of learning (Scanlan, 2013).

5.1.Towards a learning architecture

Shen (2017) provided the idea of transforming pedagogical structure into learning structure, considering the existing problems of education and combining the demands of smart learning. According to his view, learning structure advocates that students take charge of their own learning behavior, which is a unique organizational form about the presentation of learning content, organizational sequence, time allocation, self-detection and other elements formed by them with the support of specific learning space in order to achieve corresponding learning goals. In the learning structure, the main tasks of teachers are to analyze the changes of students' preferences and needs, to form diverse resources that meet their individual cognitive habits and their ways of representation and presentation, and to construct the support of various learning strategies. It is true that the learning structure fully reflects the individuality and initiative of students, and helps to promote deep learning (Fullan, &Langworthy, 2014), but it requires too high a student's learning ability and is not suitable for the basic education of primary and secondary schools. More importantly, the unique form of learning organization it represents is still concerned with the stability of teaching and learning. Therefore, this study believes that teaching needs to move towards a learning architecture, so that teaching can not only focus on the individuality and initiative of students' learning like a learning structure, but also cater to the demands of deep learning: flexibility. The relationship among pedagogical structure, learning structure, and learning architecture are shown in Figure 3.

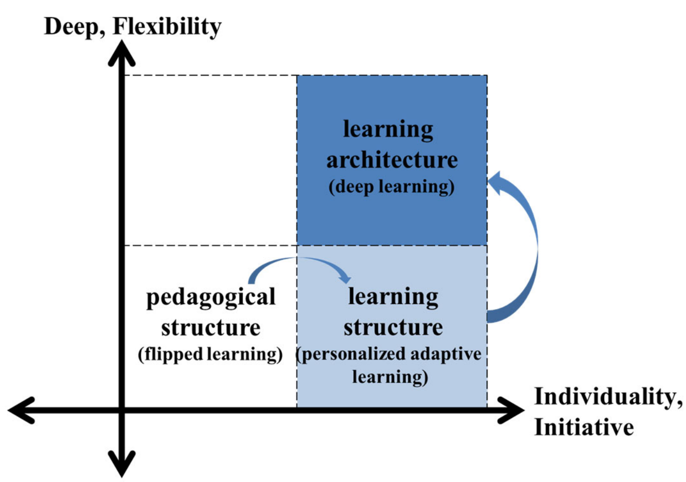

Figure 3 The relationship among teaching structure, learning structure and learning architecture

5.2. Smart classroom empowerment

Fundamentally, the shift to flexibility is driven by the development of technology. In theory, a smart classroom that integrates a variety of advanced IT technologies and media devices can empower the flexibility of deep learning. So far, although, it has not made deep learning happen as we expected.

As a paradigm of smart learning environment, smart classroom has all the functional characteristics of smart environment: seamless connection of learning space, keen perception of learning context, natural interaction of learning experience, precise adaptation of learning services, full recording of the learning process, and open and integrate of data resources (Zhu, Yu, &Riezebos, 2016). These functional characteristics give students more flexibility, effectiveness, adaptability, participation, motivation and feedback (Spector, 2014), and empower teachers and students to flexibly carry out in-depth teaching and learning. These functional characteristics give students more flexibility, effectiveness, efficiency, engagement, adaptivity,and reflectiveness (Spector, 2014), and empower teachers and students to flexibly carry out in-depth teaching and learning. Specifically, smart classrooms can flexibly create or connect context or real situations, and realize the arbitrary change of context required for cognitive flexibility;It can adaptively respond to the learning needs of students, and provide the appropriate learning support, personalized help and rich media-like learning resource ecology required for repeatedly cross-learning. Among them, the recommendation of personalized generative paths will lead to the diversity of the activity progress structure. This flexible progress can be fed back to teachers and students in real-time in a visual form.

In addition, smart classroom can pay attention to the learning status of each student, make teachers more capable of supervising, guiding and evaluating students, and feel more confident to give more initiative to students. This can also stimulate students' interest, motivation and creativity to achieve efficient and productive learning and achieve the goal of deep learning outcomes (Li, Kong, &Chen, 2015). Yu and Chen (2018) pointed out that smart classroom is a new type of classroom form that seamlessly supports deep learning with technology. However, the above research status diagram shows that the empowering role of the smart classroom has not been well explored: the smart classroom does not appear in Figure 2, and the smart learning environment as the upper concept of the smart classroom is only on the edge of extreme remoteness.

6.Conclusion

The analysis of this study shows that after more than 40 years of development, the research of deep learning has gone through dormant period, germination period, emerging period, and is now in the rapid development stage. At present, the research trend of deep learning is to promote students to be deeply involved in learning and the appropriate use of advanced learning strategies.

Two major changes of deep learning occurred in the past 40 years: a)from pursuing understanding to pursuing transfer, and b) from focusing on process to focusing on outcomes. Morover, deep learning is no longer just a learning approach to understand basic knowledge, it is more of a meaningful learning method based on understanding and pursuing transfer applications. It promotes the development of high-level knowledge and abilities by encouraging students to be deeply involved in learning and appropriate use of advanced learning strategies, then realizes the application of this knowledge and abilities in new situations or the generation of new high-level knowledge and abilities. Among them, the generation of new higher-order knowledge and abilities is a new aspect of transfer that we advocate.

However, the analysis revealed that the flexibility of deep learning is currently overlooked, while flexibility is the appeal of deep learning. This appeal involves the change of the top-level framework structure and requires cognitive flexibility which might be extremely challenging to achieve. In this regard, this study suggests that deep learning move towards a flexible architecture and try to solve this problem with the help of the enabling of a smart classroom.

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Teacher Made Videos: A Comparative Analysis of Two Approaches to the Creation and Use of Self-made Teacher Videos in the Secondary Classroom

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Abstract

The challenges of the 2020 global COVID-19 pandemic have thrust K-12 teachers into the world of online and hybrid learning. As a result, many teachers are looking for new and innovative ways to provide learning opportunities to students through online videos. The popular social media video streaming site YouTube provides a convenient resource for teachers to share video content as well as for researchers to observe teaching. This study provides an exploratory analysis of two differing approaches to creating and using teacher self-made videos in secondary classrooms. The study compares videos that were filmed in class, which document specific problem solving, with those made out of class to deliver direct instruction. Descriptive statistics provide insight into key comparisons of video length, number of views, and identify areas of interest; Distractions, Advertisements, Technology Troubles, Video Issus, and Audio Issues that were all found to influence delivery of instruction through online videos.

Key Words: Teacher Self-made Videos, K-12 Teacher Videos, YouTube, Secondary Education, Online Learning

Introduction

The COVID-19 pandemic has catapulted learning technology into the forefront of education (Bonafini & Lee, 2021; Fackler & Sexton, 2020; Smith & Colton, 2020). Teachers have been compelled through circumstances to adopt technology-based learning approaches that many were reluctant to accept and implement prior to the pandemic (Francom et al., 2021). Teachers are quickly moving to create rich learning opportunities to address the needs of their students and provide support to parents as at-home learning facilitators (Archambault & Borup, 2020). This includes the use of videos in both synchronous and asynchronous settings. Lowenthal and Covey (2021) observe that video is an effective instructional tool that is also well suited for conducting education research. The purpose of this study is to provide an objective review of these teacher-made videos to better understand the varied approaches to both creating videos and how they are used to deliver or support instruction in the K-12 secondary classroom.

Literature Review

Anecdotal observations of instructional videos used in the classroom prior to the pandemic were primarily limited to those produced for educational use by outside organizations. Videos used in the classroom were selected based on their relevance to the topic being taught and sometimes lessons were formed to fit around the video. As more teachers move to online and hybrid models of learning, it has become more difficult to utilize existing videos to meet the needs of all students. Innovative teachers have turned to creating their own instructional videos to deliver content to their students, which may be attributable to the extensive use of video in teacher preparation programs (Hollingsworth & Clarke, 2017). Lowenthal and Carvey (2021) observed that "despite the increased use of video in teacher education, questions remain about effective ways to use video in online video-based instructional modules" (p.225).

The Challenge of Rapid Transition

The sudden shutdown of schools and the government imposed at-home quarantines which necessitated the abrupt jump to distance learning revealed how unprepared many educators are to provide technology-based learning (An et al., 2021; Francom et al., 2021; Hodges et al., 2020). Despite the prevalence of technology in society and the classroom, many teachers and administrators continue to rely upon traditional models of instruction that are dependent upon location and presence (Smith & Colton, 2020). While online learning can offer many affordances, the transition from theory to practice can present unique challenges in normal times and even more so during a global pandemic (Hodges et al., 2020; Johnson et al., 2019; Tawfik, 2021). An et al. (2021) observed that "many schools and teachers were not well prepared for the sudden move to online teaching due to the pandemic" (para. 2). Using videos can help teachers draw students into the learning environment regardless of their physical location to facilitate learning (Di Paolo et al., 2020).

The use of videos in the K-12 classroom has been a common practice for decades (Aranya, 2020). Today more teachers are leaving textbooks behind in favor of digital resources that include high quality videos (Blomgren, 2018). Indeed, many teacher education programs now actively incorporate the use of videos in a variety of ways to prepare teachers for the classroom (De Voto & Thomas, 2020). The shutdown of schools due to the COVID-19 pandemic can be seen as "an unprecedented crisis and differs from other major school emergencies, such as school shootings and bomb threats" (An et al., 2021, para. 2). Hodges et al. (2020) noted that "well-planned online learning experiences are meaningfully different from courses offered online in response to a crisis or disaster" (para. 1).

YouTube: Working in a Familiar Space

YouTube is a global social media website where users share original videos. According to the YouTube website, "millions of people come to YouTube to be informed, inspired, or just plain delighted" (YouTube, n.d.). While YouTube is a popular media platform, Di Paolo et al. (2020) state that "technology alone does not motivate students to learn; however, instructors can use technology purposefully, effectively and efficiently to enhance learning (p.452). Lowenthal and Covey (2021) also identify video as a powerful media format that "can show things in ways that previously were not possible" (p.233). Teaching under what are considered normal conditions can be a complex process (Cuenca & Zaker, 2019). Because of the social restrictions created by the COVID-19 pandemic, both parents and education leaders have increased their demands on teachers to provide and promote effective technology-based learning opportunities

(Bonafini & Lee, 2021). Fackler and Sexton (2020) observe that the current climate creates a "complex nature of teaching in these uncertain times" (p. 11).

Lingering Questions Remain

Questions remain around what constitutes a good video and why teachers choose to use existing videos or make their own videos for their classrooms (Wijnker et al., 2019). More information is needed to help educators understand "details on how video is recorded and selected when developing video-based instructional interventions" (Lowenthal & Cavey, 2021, p.226). Di Paolo et al. (2020) identified four significant areas of consideration as "planning, development, delivery and reflection" in the meaningful use of online videos for distance education (p.459). Circumstances for learning and educational technology are continually changing and evolving, therefore repeated evaluation of ongoing efforts are needed to ensure that students continue to receive the education they both need and deserve.

Methodology

Purpose and Participants

The purpose of this study is to add to the understanding of how teachers are using self-made videos to teach students as a result of the COVID-19 pandemic's influence on education. Specifically, the study compares publicly available videos on YouTube from two secondary teachers with differing approaches to classroom video creation and use. This study utilizes a nonrandom, purposive sample of teacher self-made videos from two teachers who demonstrate differing approaches to creating and using video-based instruction in the classroom. Both teachers began posting videos regularly on YouTube in August 2020. This study reviews videos posted over the fall semester from August 2020 through December 2020.

Teacher 1 is a secondary math teacher from a rural school district with approximately 2,000 students. Teacher 1's primary approach to creating videos is through in-class recordings that are uploaded for students to review after class or at home asynchronously. Teacher 1's first YouTube video was a virtual open house that posted August 19, 2019 and was not part of the study. The next video posted by Teacher 1 was on August 19, 2020, when Teacher 1 began posting videos regularly that corresponded with work done in the classroom.

Teacher 2 is a secondary biology teacher in a district of approximately 5,000 students. Teacher 2's primary approach to creating videos is through prerecorded lectures that are uploaded for students to view before, during, and after class, or asynchronously for at-home students. Teacher 2's first YouTube video posted on September 14, 2020, followed by subsequent videos that were reviewed as part to the study.

Materials, Data Collection, and Procedures

This study utilized commercially available internet enabled computers with internet browsers to view online YouTube videos. Data was collected from both teachers on videos that were posted between August 2020 and December 2020. Videos were selected from each teachers YouTube channel by selecting the videos tab and then sorting the videos from oldest to newest.

Videos were watched in the order they were posted. Each video that was posted during the time frame of the study was selected and viewed from start to finish. The video play back speed for most videos was set between 1.5 to 2.0 to facilitate efficient review. Where clarification was needed, the video speed was adjusted to normal. Collected data was stored in a spread sheet and backed up on a portable storage drive. Built in formulas within the spreadsheet software were used to calculate descriptive statistics.

Results

Over the course of the study, both teachers posted videos regularly on YouTube. Teacher 1 posted more frequently, with 152 total videos, than Teacher 2, with 32 total videos. The total length of combined videos for Teacher 1 was 20 hours and 9 minutes. While Teacher 2 recorded and posted a total of 7 hours and 47 minutes. The average video length for Teacher 1 was 7.95 minutes and for teacher two it was 14.49 minutes (see Table 1).

Table 1

	Total Videos	Total Time of Videos	Average Video Length
Teacher 1	152	20 hours 9 minutes	7.95 minutes
Teacher 2	32	7 hours 47 minutes	14.49 minutes

The key difference to the creation of videos between Teacher 1 and Teacher 2 was whether the videos were made in class or out of class. In class videos are videos made with students present, and out of class videos are videos made without students present. Teacher 1 made 82.24% of videos in class and 17.76% of videos out of class. Teacher 2 made 6.25% of videos in class and 93.75% of videos out of class (see Table 2). There were also significant differences between the number of views each teacher received for their videos. Table 2 shows that Teacher 1 received 1,336 total views for an average of 8.78 per video while Teacher 2 received 5,719 total views for an average of 178.71 views per video.

Table 2

	In Class	Out of Class	Total View	Average Views
Teacher 1	82.24%	17.76%	1336	8.78
Teacher 2	6.25%	93.75%	5719	178.71

During the viewing of videos several important areas of interest emerged, specifically Distractions, Advertisements, Technology Troubles, Video Issus, and Audio Issues. Distractions were identified as anything that took away from the lesson or teaching being presented. Advertisements were separate from the video content and part of the YouTube streaming platform. Technology Troubles were any issues associated with technology devices not working correctly on camera. Video Issues were typically glitches in recording that could not be attributed to user error. Similarly, Audio issues were issues with audio feed that could not be attributed to user error. Table 3 shows the percentage of videos for each teacher according to these categories.

Table 3

	Distractions	Advertisements	Technology Troubles	Video Issues	Audio Issues
Teacher 1	26.32%	0.00%	37.50%	31.58%	36.84%
Teacher 2	21.88%	46.88%	3.13%	31.25%	31.25%

Discussion

An initial overview of the data collected for both teacher's reveals a large difference between the total number of videos posted by each. Teacher 1 posted nearly five times more videos than Teacher 2. This is explained through data collected from the videos and provides insight into why each teacher may have chosen their particular approach to creating videos. Teacher 1 created and posted videos for at least two classes and possibly a third. Because the videos were posted to YouTube and then linked to assignments in Google Classroom, it is not readily clear which videos went with which classes however, it is clear that Teacher 1 created videos for a Fundamentals of Math and a Geometry class. Teacher 2 created videos for a high school biology class, and as observed in the videos often recorded during the teacher conference period. Having one lesson to prepare is quite different than having two lessons to prepare which may explain why Teacher 2 chose to create videos prior to class and Teacher 1 out of necessity and a lack of time created videos in class. This may also help to explain why Teacher 1's videos were on average only about half as long as Teacher 2's videos. Whereas Teacher 1 focused on delivering direct examples of how to work problems, Teacher 2 used the video for direct instruction.

Considering the circumstances of each teacher also helps to explain the percentages of videos that were made in class vs out of class. Noticeably, Teacher 1's out of class videos were made while the teacher self-reported to be under personal quarantine or while the school was physically closed, and students participated in at-home remote learning. No clear explanation emerges for why Teacher 2 chose to create some videos in class with students present, though it should be noted that some of the out of class videos were made from home while the school was also closed, and students were switched to remote learning. Notably both schools, from different school districts, experienced physical closures and forced distance learning due to the COVID-19 pandemic during the study period.

When looking at the average number of views per video there is a dramatic difference between Teacher 1 and Teacher 2. Teacher 2 had nearly twenty times more average views than Teacher 1. This perhaps due to the way the videos were used in class, however without access to specific viewer data it cannot be clearly stated why Teacher 2 had so many more average views than Teacher 1. However, it is reasonable to conclude that their approaches to using the videos contributed to more views for Teacher 2. Teacher 2 used the videos as lectures for students, and also included comments to non-students, which may be partly why the general nature of the informational videos may have attracted a larger audience. Teacher 1, who used the videos to document working specific problems in class may have received fewer views because of the specific nature of the content as well as the redundancy for students that had already seen the problems worked in class.

The information gathered in Table 3 provides perhaps the greatest insight into a comparison of the two approaches to classroom video creation. Distractions ranged from classroom announcements during both teacher videos, to off task students, and the teacher engaging in sidebar conversations. Noticeably, the percentage of videos with distractions was closely similar with both teachers. Teacher 1 had no advertisements before, after, or during the posted videos so it came as somewhat of a surprise when almost half of Teacher 2's videos had at least one and often multiple advertisements associated with them. Further review revealed that Teacher 1's account was marked by YouTube as child related so comments were disabled and a link for YouTube kids was at the bottom of the page. Teacher 2's account was not marked for children, so the content was not limited. The presence of advertisements on required videos creates ethical questions and an opportunity for further research and discussion. Technology troubles were observed as both teachers struggled with their own issues. The increased number of Technology Troubles experienced by Teacher 1 is partially attributed to the fact that the videos were created during live class sessions and presented little opportunity for error. A simple glitch for Teacher 1 affected both the recordings and the real-time student instruction. Recording outside of class time may explain why Teacher 2 had significantly fewer Technology Troubles. Quality of the recording equipment became a factor for both teachers, as both experienced a similar percentage of issues. Video issues for Teacher 1 were related to incorrect orientation, failure to stop and start when intended, and video skips that created gaps in instruction. Video Issues for Teacher 2 were related to the quality of the camera and the lighting. Teacher 2 often lectured in front of a smartboard that created back lighting and shadows as well as issues of keeping the content on the smartboard in frame and clearly visible to students. Audio Issues for Teacher 1 were related to the difficulty of recording all of the audio in a classroom with a single microphone. Videos posted by Teacher 1 were filled with one sided conversations because most of the student's comments and questions could not be understood. This finding seems to support Ferdig and Kosko (2020) observation that the physical proximity to the camera can provide an advantage to those who are closer and a disadvantage to those who are further away. Audio Issues for Teacher 2 were attributed to movement by the teacher while lecturing as the audio would fade in and out as the teacher faced the board and then turned to face the camera.

Considerations for the Future and Conclusions

Understanding how these videos are created and used in a way that is both efficient for the teacher and effective for the student is critical. Additional research has concluded that teacher made videos may offer help in "understanding the complexity of classroom teaching but also builds spaces for reflective thinking and learning through practice" (Wetzel et al., 2017, p.535). As required changes begin to ease, it will fall more to education leaders to set a tone for the continued use of tools deemed essential during the pandemic (De Voto & Thomas, 2020). Farmer and West (2019) conclude that "as new online programs emerge and existing programs continue to develop, policies and practices at an organizational level should be established only after careful consideration of their impact on teachers" (p.116). The COVID-19 pandemic has forced the rapid creation of technology-based learning content. Helping teachers understand the pros and cons of various approaches to media creation will help them make more informed decisions about how to best serve their students. "Teacher educators must find real-world opportunities to develop technology-based instructional experiences for teachers to develop technology competencies" (Smith & Colton, 2020, p.454).

This study has sought to provide both current and future teachers with a better understanding of issues associated with two approaches to creating videos for classroom use. Teachers who create videos for classroom use must decide when and how they will create the video and how the video will be used to support learning. The shutdown and subsequent measured reopening of schools has forced teachers to consider new ways of educating students. As more teachers turn to creating their own video content consideration is naturally given to how these videos will be made and what purpose the videos will serve in the classroom. Lowenthal and Cavey (2021) observed that "as it becomes easier and easier to create, edit, and share video, educators, instructional designers and curriculum developers, and researchers will continue to experiment with ways to intentionally use video to improve teaching and learning" (p.233). Recording videos in a live classroom setting provides relevant examples for students to draw upon as they recall the experience. However live classroom recordings are also subject to disturbances and distractions that teachers may not have time to edit out. Recordings that are made ahead of time offer teachers a more thought-out opportunity to deliver direct teaching, yet it can be time consuming to prepare, create, and then post a video. Videos made prior to class however do offer greater flexibility when considering how they will be used. Teacher made videos offer more specific instruction to students from a relevant and reliable resource. One question that remains is whether technology practices that were implemented due to the extreme circumstances of the global pandemic will continue as part of the new normal or fade away into old habits (Tawfik, 2021).

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More Questions and Answers for the Flipped Classroom Approach: A Review of Reviews

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Abstract

In recent years, the educational strategy called the flipped classroom (FC) has gained notable publicity and popularity in education. A substantial number of articles related to FC have been published aimed to synthesizing this extensive body of research on the flipped classroom. Hereto, this paper examined 13 reviews aiming to identify the characteristics of review studies and the current state of knowledge on the flipped classroom as a pedagogy approach. Despite the methodological differences, the results of this review confirm that FC has positive impacts on students' learning experiences in general. This study revealed a need for increased support for research in FC design, implementations, and practices. More longitudinal analyses are necessary to better understand the best practices of FC implementation or whether the effectiveness of FC practices is influenced by contextual elements, such as disciplines, subject domains, the complexity of learning content, academic levels, and implementation duration.

Keywords: flipped classroom, inverted classroom, scope review, comparison study

Introduction

Flipped classroom (FC) is an instructional approach that extends traditional classroom-based learning through technology (Karabulut-Ilgu et al., 2018). FC is also referred to as inverted learning or flipped learning. The concept of FC emerged in 2000 when Lage, Platt, and Treglia proposed the idea of an "inverted classroom". In an inverted classroom, the students' first learning activity happens before the class and then uses the in-class time for more engaging activities like problem-solving (Lage et al., 2000). In 2007, FC gained its popularity after two high school teachers, Jonathan Bergmann and Aaron Sams, used video lectures as students' pre-class assignments for their chemistry classes (Lage et al., 2000; Tucker, 2012). Various models were proposed for FC implementation, such as the FLIP model (i.e., flexible environment, learning culture, intentional content, and professional educator) (Flipped Learning Network, 2014) and "FLIPPED" model, which extends the FLIP model by adding three more elements (i.e., progressive activities, engaging experiences, and diversified platforms (Chen et al., 2014). While there is no fixed model, the essential idea of FC is to have lectures and direct instruction delivered before class through online videos. And then, the actual class time is used for more engaging collaborative learning activities, such as hands-on activities, discussions, and interactions (Flipped Learning Network, 2014; Tucker, 2012). The instructional approach aims to transform students from passive learners to active learners, who can self-direct their learning to improve personal analytical, integration, and critical thinking skills for higher levels of learning (Hu et al., 2017).

Given the advancement of technology that provides tools for delivering flipped learning, FC has gained much popularity and scholarly attention in recent years (Akcayir & Akcayir, 2018; Bergmann & Sams, 2012). Various class activities, teaching tools, and techniques have been used to carry out the FC approach (Lundin et al., 2018; O'Flaherty & Phillips, 2015; Ward et al., 2018). Examples of the inside- Fand outside-of-class activities include reviewing case studies, playing games, role-playing, working on peer-reviewed assignments, watching video-recorded lectures, and working on post-class homework (Ward et al., 2018). The teaching techniques used in FC include prerecorded lectures, case-based presentations, team-based discussions, panel discussions, and debates (O'Flaherty & Phillips, 2015). Digital technology is also used to implement FC. For example, social media or networking sites like YouTube or blog posting is applied as platforms to share educational resources (Lundin et al., 2018). Additionally, the FC approach is widely implemented across different education levels, such as K-12 and higher education (Cheng et al., 2019), and disciplines, like engineering (Kerr, 2015), clinical pharmacy (See & Conry, 2014), chemistry (Baepler et al., 2014), and computer science (Giannakos et al., 2014).

The advantages of FC included better students' learning achievements, improvement on learning experiences, and increases students' motivation and satisfaction during the learning process are broadly indicated in previous research (Koo et al., 2016; Sergis et al., 2018). On the other hand, the challenges of FC included time limitation for pre-class activity preparation, time-consuming and less effective for learning (Koo et al., 2016; Roehling et al., 2017).

For a field to continuously progress, it is essential to be aware of its developmental patterns in the past to obtain insights for future implications (Dwivedi et al., 2011). As FC has progressively expanded over the years, a lot of research addressed the development of FC and its impacts. However, each review has its own focus, scopes, and comprehensiveness (Karabulut-Ilgu et al., 2018; Oliver & Luther, 2020). For instance, Cheng et al. (2019) reviewed the impacts of FC on students' learning outcomes. Liu and colleagues' (2019) review focused on the teaching effects of FC. Some research addressed FC and its impacts on both teaching and learning (Karabulut-Ilgu et al., 2018; Oliver & Luther, 2020).

Furthermore, mixed results were reported in the review studies with a focus on FC effectiveness. Researchers indicated that the positive impacts of FC on student learning, which included better learning performance, enhanced student engagement, increased student satisfaction, the development of problem-solving and cooperation skills, and improvement of theoretical knowledge (Akcayir & Akcayir, 2018; Hu et al., 2018; Karabulut-Lieu et al., 2018). On the other hand, although research results showed that FC in class seemed to produce positive learning outcomes, the effect is not long-lasting and not all course evaluations are positive (Betihavas et al., 2016; Presti, 2016).

With the different perspectives of examination of each review, different sets of studies might be selected, and, accordingly, different analysis results and conclusions would generate. Despite the contribution of these researchers, the diversity in selected information in existing review articles prompts a need to conduct a review of reviews study to provide a synopsis of the evidence of FC. Reviews of reviews are referred to as umbrella reviews, reviews of systematic reviews, overviews of reviews, a synthesis of reviews, and a summary of systematic reviews

(The Joanna Briggs Institute, 2014). This approach has been used to summarize the extensive scientific knowledge on widely explored research topics in nursing and medical fields (Egan et al., 2008; Mikton, & Butchart, 2009) and is becoming increasingly common in education and other fields (Chen et al., 2018; Pahlevan-Sharif et al., 2019). Reviews of reviews aim to summarize the existing research syntheses regarding a topic of interest (The Joanna Briggs Institute, 2014), which is compatible with the purpose of this current study.

The purpose of this study is to provide an overview of the features and impacts of FC from previously published FC reviews in the past decade. Through the lens of reviews of reviews, the close investigation of relevant FC reviews can provide vital insights into the expanding and popular trend of FC and to identify the insights to shed light for future research. This study is intended to capture the essence of the existing reviews in the area of FC to answer the following research questions:

1. What are the characteristics of review studies on the flipped classroom?
2. What are the findings of the FC reviews?

Methodology

Standard reviewing methods were applied in the current study to identify existing reviews, instead of primary research (Khan et al., 2001). The present study uses reviews as the unit of analysis, which differs from a conventional review that uses primary studies as the unit of analysis (Kache & Seuring 2014; Keller & Torre, 2015).

Search Strategy

Social Science Citation Index (SSCI) was the database used to identify the relevant reviews on flipped classrooms. SSCI was selected because it covers top-tier or highly ranked journals in social sciences based on the sophisticated selection process, specifically, the Web of Science Core Collection Journal Selection Process (Web of Science Group, 2019). The Web of Science (WoS) platform, one of the largest academic database search platforms, was applied to access SSCI.

In order to identify the largest possible number of articles in our initial search, the authors of this study used strategies that included a range of terms for their main research variables (e.g. flipped classroom, flipped approach, flipped instruction, flipped learning strategies, inverted classroom, systematic review, meta-analysis, scoping review, etc.). The Boolean operator “or” was used with related terms to broaden their search before narrowing down by the selection criteria. They also used truncation to include variation of words. For example, the authors used “flip*” to find items, including terms like “flip,” “flipping,” and “flipped” and “invert*” to search article items that contained “inverting” or “inverted.” After completing the above search process, they further applied selection criteria to screen out irrelevant results. The language restriction was English.

Inclusion and exclusion criteria

Criteria for inclusion of papers included (a) peer-reviewed journal articles; (b) articles classified as reviews, systematic reviews, or meta-analyses; (c) articles that reported on/about the flipped classroom; and (d) articles that were published in English. Studies were included if they reviewed any studies on the flipped classroom. Studies that did not meet these inclusion criteria were excluded, such as those that reviewed conference papers instead of published journal articles, studies that did not follow the systematic analysis procedure, and those that failed to report the process of literature selection. Restricting eligibility to publications in peer-reviewed journals enabled consistent quality across disciplines and databases covered in the literature search.

Selection process and data analysis

After completing the initial search process, all studies were examined by the two authors. After the initial database search, the two authors independently scrutinized the titles and abstracts from the electronic searches followed by the full text of all citations that definitely or possibly met the predefined selection criteria. If a disagreement occurred between the two authors, a third person would share their judgment. A discussion would follow among the three individuals until a consensus was reached. This exact process was also applied when a disagreement occurred during the coding stage.

After excluding duplicated records identified across SSCI searches, the titles and abstracts of 361 records were screened. After a full text review and discussion, a total of 13 unique reviews met the inclusion criteria. The two authors assessed the manuscripts independently and resolved any disagreements about inclusion by consensus after discussion. For each study included, information was obtained, such as bibliographical data, study purpose, study design, learning context, and primary results. Content analysis is the approach for data analysis. Both authors coded the qualitative data attained from the articles, respectively. Any discrepancies in the coded data between the two authors were discussed with a third reviewer until reaching a consensus of the coded data.

Results

Characteristics of the Included FC reviews

This section discusses the characteristics of retained FC reviewed, including background information (i.e., publication year, academic discipline, education level), research focus, and research methods.

Background information. Results show that one to two FC review research were published in 2015, 2016, 2017, and 2019. However, in 2018, the FC reviews publications peaked when seven articles were published that year. Additionally, authors of the 13 FC reviews came from a variety of regions, including North America (five articles from the U.S.), Asia (two from Hong Kong, one from China, and one from Taiwan), Europe (one article from Turkey and one article from Sweden) and Australia (two articles). All of the FC reviews focused on English-based FC studies. Nine of the 13 FC reviews examined FC studies within a single academic discipline, including nursing (4), health (2), engineering (1), mathematics (1), and education technology (1). Moreover, the majority of them examined the effectiveness of FC in the context of higher education.

Research focus. When examining the purpose study of the included FC reviews, four different research focuses emerged, including overall trends, effectiveness of FC on learning, current state of FC knowledge or practice, and benefits and challenges of FC implementation. It is worth noting that some of the included FC reviews may have had more than one study focus and/or was conducted in multiple stages. For example, the review of Lo et al. (2017) initially conducted a meta-analysis of 21 comparison studies about FC to examine the effects of FC for math education learning, following synthesized findings of 61 FC studies to identify the benefits and challenges of FC on students' learning.

Some features were found among the FC reviews with the same research focus. For example, the FC reviews that focused on FC current development situation frequently applied some aspects to present the developmental trend among the FC studies, such as publication trend (i.e., year, author, publication venue), keyword, and subject area. The FC reviews that focused on FC effectiveness examined the issues and factors related to the effect of FC approaches on teaching and learning, such as students' academic levels and duration of implementation. Furthermore, some of the FC reviews that addressed the current knowledge or practice status of FC also investigated the development or effectiveness of FC. For example, Ward's (2018) review integrated the application of FC in nursing education based on 14 related literatures. In addition to identifying main FC application themes in nursing education, students' academic learning outcomes and their measurements were also provided.

Research methods. Research methods of FC reviews can generally be categorized into qualitative and quantitative. The qualitative methods focused on content analysis to generate common themes among studies, and the quantitative methods studies focused on numerical data. However, some qualitative studies may have used quantitative data-analysis techniques, such as frequency or percentage analysis to describe the themes. Therefore, the authors broadly sorted FC reviews into three categories of research methods: qualitative review, quantitative review, and mix-method review. Among the thirteen FC reviews, one of them used a mixed method (8%), seven used a qualitative method (54%), and five of them used quantitative methods (38%) to analyze data. In terms of research approaches, there were meta-analyses, systematic review, literature reviews, and scoping review. All qualitative reviews utilized content analysis. Furthermore, FC reviews indicated that techniques and standard content analysis were used for qualitative data analysis, such as the coding protocol, rating scale, and framework. Some included studies that applied more than one research approach. For example, the study of Lo et al. (2017) stated that they applied two approaches, such as content analysis and meta-analysis. The content analysis was used to examine current FC practice, and the meta-analysis method was used to conduct the statistical data of the effect value by homogeneity studies.

Primary Findings of FC Reviews

Three overarching themes emerged from results of FC reviews, including overall trends, effectiveness of FC on learning, and benefits and challenges of FC implementation.

Research trends of FC studies. The top two main trends of FC studies in this FC reviews were (a) focused more on higher education and (b) small-scale research. Higher education was the development trend that was indicated most frequently in eight of the thirteen included FC reviews. For example, Akcayir and Akcayir (2018) pointed out a particular composition of FC studies participants. While the FC approach seemed suitable for courses in all learning levels, many study participants in existing FC studies are composed of students in higher education institutions. Moreover, Cheng et al. (2019) pointed out that accessibility of study participants is also one of the reasons for this, since FC researchers are mainly from higher education institutions. It might be easier for them to find access to student populations in higher education than in K-12 schools.

Small-scale research was also frequently used by FC studies, as it was indicated in half of the included FC reviews. Although the length of time of FC implementation varied considerably study-by-study, seven of the thirteen reviews revealed that many of the FC studies were small-scale research, such as small sample size, localized recruitment, and descriptive design. The duration of the implementation mostly ranged from one unit in a semester to one full semester. The tendency of localization in FC studies might result in the application of small-scale design. For example, 26 of the 31 FC articles that Lundin and colleagues (2018) reviewed were composed of experiences from a single course or classroom.

Effectiveness of FC on learning. Results showed that both qualitative and quantitative analysis methods were used to examine effectiveness of FC on learning. Table 1 summarizes the study findings regarding the effectiveness of FC that is indicated in the included FC reviews. To summarize, 12 of the 13 FC reviews concluded that FC had overall positive impacts on learning compared to in-class, lecture-based learning. It is also worth noting that Chen et al. (2018) found a progressive improvement tendency in the FC outcomes over time through a meta-regression analysis. In other words, FC studies published in recent years seemed to support the improved outcomes under FC conditions more. Moreover, the effectiveness of FC was usually evaluated through academic performance (n=4), satisfaction (n=5), engagement (n=4), motivation (n=1), and self-reported learning attitude (n=1).

Table 1
Summary of Findings Regarding the Effectiveness of FC

Category	n	Source of Review
Overall positive impact on student learning outcomes	12	S1, S2, S3, S4, S6, S7, S8, S9, S10, S11, S12, S13
Academic performance (e.g. test scores, course grade, knowledge score)	4	S2, S3, S4, S8
Satisfaction	5	S3, S9, S10, S11, S12
Engagement	4	S3, S6, S9, S11
Motivation	1	S3
Attitude	1	S3
Factors on the effectiveness of FC		
Type of content knowledge	5	S1, S8, S11, S12, S13

Subject areas/discipline	3	S1, S4, S13
Student levels (K-12, HE)	2	S1, S3
Duration of Implementation	2	S1, S3,

Some FC reviews further examined influential factors associated with the differences in the positive effects of FC on learning and found possible factors, including content knowledge (n=5), subject area (n=3), student academic level (n=2), and duration of implementation (n=2). In terms of knowledge content, many FC reviews concluded that FC had greater impacts on improving practical knowledge learning, such as design and experiment than theoretical knowledge learning (Hu et al., 2018).

Results also indicated that the variance of FC effectiveness in learning was within different subject areas. For example, Cheng et al. (2019) found a higher effect size of FC on learning subjects like art and humanities than social sciences, mathematics, health, etc. Chen et al. (2018) indicated that the FC approach had greater positive application impacts on medicine and pharmacy than nursing and other health-related professions. The difference may be reasonable, since the FC approach did not seem applicable to certain types of content knowledge. Therefore, it was necessary to consider the subject area's features when the FC approach was applied. Additionally, the effects of FC on learning outcomes among different student's academic levels were not conclusive. Akcayir and Akcayir (2018) indicated that the effects of FC on learning outcomes were higher in older learners. However, Cheng et al. (2019) found that the impact of FC approach outperformed the non-FC approach in higher education, but the effects on graduate students were overall negative. This means that postgraduate students learned better in non-FC conditions. The duration of FC implementation may result in differences in the FC effects, and a shorter implementation period seemed better. Cheng et al. (2019) found that overall, while students in FC were significantly outperformed students in non-FC conditions, the FC studies with a longer duration of FC implementation had smaller effect sizes than studies with a shorter period. Akcayir and Akcayir's (2018) study also indicated a similar conclusion that the effects of FC might not sustain over longer-term applications.

Benefits and challenges of FC implementation. The benefits of FC implementation commonly reported by both students and instructors were flexibility, it enabled individualized learning, and students were better prepared before class (Akcayir & Akcayir, 2018; Karabulut-Lieu et al., 2018). In addition to the benefits of FC implementation, challenges of FC implementation were noted in the FC reviews. For instance, there were concerns about the quality of the learning materials, the time-consuming nature of FC for course content preparation, technological issues, the need for out-of-class activity guidance, and the time required by instructors to integrate into their curriculum. Some FC reviews also indicated possible conditions that hindered instructors from adopting the FC approach. This was especially true regarding courses that involved large amounts of factual content and hand-on activities as well as the requirement of frequent interactions and collaborative group activities (Akcayir & Akcayir, 2018; Karabulut-Lieu et al., 2018; Lo et al., 2017).

Discussion & Conclusion

This review of reviews included 13 studies about FC that were published by SSCI-indexed journals in the last decade. The results of FC reviews raised some concerns about the existing FC studies from the following aspects, including the study design of FC studies, the definition of learning effects, and the analysis of FC effectiveness.

The Study Design of FC Needs to Be More Diverse

Regarding the study design in investigating FC practices and evaluating FC effectiveness, there were several concerns identified by FC reviews. First, the majority of FC studies focused on comparing FC and general non-FC conditions. However, as Lundin et al. (2018) indicated in their review, comparison studies' fundamental problem was in these kinds of studies. This means that the non-FC context, like the in-class, lecture-based teaching approach, was most likely to be treated as unsuccessful, and FC was seen as a solution. The effect of FC in improving student learning seemed to be taken for granted, commonly without explanation of the pedagogical design and implementation settings (Lundin et al., 2018). Therefore, future FC studies need to employ more alternative quantitative, qualitative, and mixed methods to understand the FC phenomena in depth.

Second, many FC studies evaluated influential factors based on small-size, local case, and short implementation period. For example, 26 of the 31 FC studies that Lundin et al. (2018) included in their review were locally situated in terms of the sample (commonly 20 to 40 students) or case (mostly in higher education) and focused on only one course. Such a small-scale design made the generalizability of these studies' results a likely issue. The fragmented knowledge contributions also showed that the development of FC's related field had yet to be stabilized (Lundin et al., 2018). Moreover, FC's positive effect at the beginning might not be sustained throughout the semester when students in non-FC conditions catch up by the end of the course (Evans et al., 2018). In order to see if the FC approach can be appropriately adapted in a broader-level implementation, higher quality studies focusing on longitudinal, large-scale, and numerous-courses designs are needed in the future (Akcayir & Akcayir, 2018; Karabulut-Ilgu et al., 2018; Lundin et al., 2018). Chen and colleges (2018) further proposed the critical potential of FC in education. It seems appropriate to further understand whether FC approaches work and, if so, in what types of situations and contexts.

Third, other issues might limit background information relevant to the implementation and practice of the FC approach. Some examples of this may include the difficulty of the content knowledge, instructors' teaching experiences with the pedagogy, or students' self-efficacy of using technology tools (Evans et al., 2018). However, the most recent FC studies failed to discuss these issues properly or provide sufficient related information. For example, since effective pre-class learning in FC has highly relied on students' self-regulation skills, it is an essential factor to be explored for the overall success of the FC practice (Cheng et al., 2019). Evans et al. (2018) also indicated the need to discuss faculty preparation issues for the FC approach. How to provide training to faculty in terms of technology usage, pedagogical design, and instructional supports may be important questions to answer as well as other factors in the success of FC.

The Definition of Learning Effects of FC Needs to Be Clarified

Results from the FC reviews raised a concern about the definition of learning effects used in FC studies to examine the FC effectiveness. For example, Evans et al. (2018) pointed out that inconsistency in terminology was a concern in the FC studies. Additionally, when discussing possible conceptual ideas related to the effectiveness of FC, most of the FC studies mentioned a mix of pedagogical strategies without providing a thorough explanation nor referring to the educational or learning theories framework. Blended learning and active learning were two of the ideas that were commonly brought up when examining factors associated with the effectiveness of FC (Lundin et al., 2018). While blended learning and active learning are considered effective strategies to support learning, few studies distinguish the impacts of FC from the effects of blended learning or active learning. It aligned with Akcayir and Akcayir (2018)'s argument that without identifying the definition of the conceptual terms, it is difficult to determine that the shown effect of FC was the result from FC or from other learning modalities.

In addition to the definition of learning effects, the type of indicators used to examine FC effects on learning could also be a potential issue. The retained FC reviews showed that academic performance (e.g., test scores and course grades) and self-reported data (e.g., participants' motivation and perceptions of the learning experience in FC situations) were the primarily common evaluation methods used in FC studies. However, Lundin et al. (2018) argued that most of the FC studies in their review chose inappropriate ways to examine the effects on student learning. They stated that survey data like pre-and post-test scores or course questionnaires could not provide an in-depth analysis of whether or what learning occurred in FC. Given that the purpose of FC was to promote higher-level cognitive skills like application, creation and behavioral change, lower-levels of assessment like recall in a test may not necessarily be considered as an appropriate way to evaluate the effects of the FC approach (Chen et al., 2018). To delineate FC's effectiveness, better sensitive indicators to measure the higher-level cognitive outcomes need to be developed (Chen et al., 2018).

Despite the Overall Positive Impact on Learning, the Varied Effects of FC should be Further Examined with Sufficient Qualitative and Quantitative Data

Most of the FC reviews discussing the effect of FC included in this study indicated that compared to the in-class or lecture-based approach, the positive impact of FC on students' learning outcomes had the effect sizes as small to medium (Chen et al., 2018; Cheng et al., 2019). Furthermore, lacking reviews that can evaluate the effectiveness of FC systematically may result from insufficient data or design information in previous FC studies. Hew and Lo (2018) indicated that scant FC studies provided the detailed and necessary information to conduct a qualitatively or quantitatively systematic review, which may be why only five FC reviews in the present study contained enough statistical data to conduct their studies using a software like Comprehensive Meta-Analysis (CMA). Besides the shortage of necessary data for statistical investigation from FC studies, the lack of information about the pedagogical design and implementation of FC makes it hard to perform qualitative analyses. Cheng et al. (2019) indicated that FC researchers seemed interested in reporting the effects of FC on students' learning outcomes, rather than examining the learning environment's actual design and implementation features (pedagogy). Without the essential information like the instructional strategies that applied the FC approach during the online and in-class time or the instructors' teaching experiences related to the FC approach, it would be difficult to know which factors contributed to the overall impacts of FC. The above results suggest that more information is needed to support the effects of FC on teaching and learning.

While most FC reviews agreed on the overall positive impact of FC on learning, compared to non-FC conditions, in general, the effect size varied. Also, its actual effectiveness on learning remains debatable. More detailed qualitative and quantitative data are needed for further systematic analysis to provide high-quality evidence to form policy decisions on how best to use FC to enhance learning. A more solid theoretical background to distinguish FC from other learning approaches like blended learning and self-regulated learning is needed to determine what contributes to the learning effect in FC conditions. A stronger focus on the planned studies about evaluation or assessment of FC and the development of evaluation tools could provide experimental evidence of the impact of FC on teaching and learning. A broader-level study design that focuses on longitudinal, large-scale, and multiple courses is needed, as well.

The authors acknowledge some inherent limitations in this study. In general, the discussions in this study are based on the information and findings from the included 13 FC reviews. In other words, their study heavily relied on the quality of these review studies. Possible problems from previous FC reviews, such as inadequate literature search or improper analysis of the findings, can impact the quality and results of this study. Furthermore, although they tried to locate high-quality reviews in the first place, it was inevitable to lose detailed information of the primary literature. They developed a search strategy to search for FC reviews that were published in a major database. However, there is still a possibility that they may have missed some relevant FC reviews. Studies that were published after the search date in this review were not included either. In addition, the authors did not check if the included reviews selected the same FC studies. Therefore, FC reviews that focused on similar research purposes might partially consist of the same FC studies.

As stated by many scholars, the FC approach holds much potential, including more hands-on time with students and opportunities for active and collaborative learning. The authors are looking forward to seeing more creative adoption of FC as a pedagogical tool that can be used with other strategies, rather than substituting or replacing another. They hope to promote more effective and engaging practices in teaching that ultimately create a highly positive impact on student learning. There needs to be additional research in a broader range of learning contexts, while combining FC approaches with other instructional innovations to achieve such goals.

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Effects of a Problem-solving Framework Based on Engineering Design of Japanese High School Students

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Abstract

Recently, the development of problem-solving ability is emphasized. We taught Japanese high school students a framework of problem-solving based on Engineering Design. As a result, we found that students' awareness of problem-solving ability and self-assessment of problem-solving activities were improved. The students are considered to be suitable for the problem-solving framework based on Engineering Design.

Keywords: Problem-solving, Engineering Design, Information

1. Introduction

There has been a lot of discussion about the qualities and abilities that should be developed for the children of the future. For example, ATC21s has defined 21st century skills. The 21st century skills are defined as ten skills in four areas that are considered necessary for living in the 21st century. One of them is the problem-solving skills (Griffin et al. 2012). In addition, the OECD tested problem-solving skills for the first time in PISA 2003. These indicate that attention is being paid to the development of problem-solving skills.

Problem-solving skills have been defined in many ways. The OECD (2012) defines problem-solving skills as the skills to understand and cognitively process problem situations where the solution is not immediately obvious, as well as a proactive attitude toward the problem. Thus, the problem-solving skills are widely considered to be the skills to find an answer to a situation where the answer is not yet known.

1.1 Problem-solving in Japan

In Japan, education is standardized throughout the country based on the contents of the Course of Study issued by the Ministry of Education, Culture, Sports, Science, and Technology. The Course of Study is revised about once every 10 years to improve the content of education. In the Courses of Study, problem-solving skills are listed as one of the qualities that form the basis of learning. Therefore, it indicates that problem-solving skills should be taught throughout the school to improve the quality of educational activities and increase the effectiveness of learning.

Problem-solving skills are intended to be cultivated throughout school education. In school education, information science has been cited as an important subject for developing problem-solving skills (MEXT 2016). In Information I, one of the goals stated in the Courses of Study is "to acquire knowledge and skills about how to find and solve problems" (MEXT 2018). Problem-solving skills have been treated with more emphasis over the years.

This problem-solving skills has been practiced in various ways in Japanese information science. The following are some of the issues that have arisen through the practice in Japan. These include teaching knowledge and skills related to problem-solving and the integration of lessons on problem-solving skills into the teaching plan.

1.2 Develop Problem-solving

To develop problem-solving skills, many studies have been conducted and challenges have been identified. First, it has been shown that explicitly presenting and teaching skills is effective in developing problem-solving abilities(Mathee and Turpin 2019). In addition, Schoenfeld (2013) showed that it is necessary to develop a framework for problem-solving. In addition, there is a need to assess problem-solving skills (Griffin et al. 2012). Happner and Peterson (1982) developed the PSI to assess individual behavior and attitudes.

From this, it is clear that there is a need for an explicit framework for problem-solving as a skill. Engineering design has shown promise as a framework for problem-solving.

1.3 Engineering Design

We focused on engineering design as a problem-solving framework that improves problem-solving skills. It is said that there is no unified definition of engineering design (Li et al. 2016). For example, NGSS (2013) defines three types of behaviors that students who have mastered engineering design can perform (A) Define the problem to be solved. (B) Generate several solutions. (C) Optimizing the solutions to improve their quality.

The effects of engineering design on the problem-solving process have been examined in previous studies. Problem definition and information retrieval can lead to better problem solving (Atman et al. 2007). Although the time spent on problem solving activities is longer, it led to better problem-solving activities(Atman and Bursic 1996). However, no conclusion has been reached that it improves problem-solving skills (Li et al. 2016).

2. Purpose

We suggest that Engineering Design is effective in developing problem-solving skills. However, there is a lack of research that examines whether engineering design improves problem-solving skills. The purpose of this study is to investigate the effect of teaching Engineering Design to high school students on their problem-solving skills.

3. Methods

3.1 Participants

In July of 2020, this study was conducted in 100 minutes at a private high school in Tokyo. The Participants were two classes of 82 third-year high school students, 54 (65.9%) boys and 28 (34.1%) girls, who were taking "Information".

3.2 Procedure

This practice was carried out according to the procedure shown in Figure 1. First, the participants answered a pre-questionnaire survey. The items of the pre-questionnaire were related to their perceptions of their problem-solving abilities. Next, the participants worked in groups of four or five on problem-solving activities. The problem-solving activity was conducted using a chat application on a smartphone. Afterward, the participants self-evaluated themselves and the group on the problem-solving activity. Then, we conducted a class to teach engineering design. In the class, we explained the framework of the problem-solving framework using PowerPoint and handouts. After the class, the students performed the same problem-solving activities as before and self-assessed the problem-solving activities in the same way. Finally, a post-questionnaire survey was conducted.

We prepared two types of group work topics. One was a problem-solving activity to think about what is needed to make life in a regular classroom more comfortable. I put a limit of 100,000 yen or less on the budget and asked them to think of something that could be installed in about two months. The second was a problem-solving activity in which students were asked to think of products that they would like to have in the school store. We put a limit on them to think of products within the range of what high school students can afford.

In teaching the problem-solving framework, the elements of the problem-solving framework based on engineering design were taught one by one. In addition, we taught the problem-solving framework by having the learners fill in the blanks on the handout that had blanks throughout the content. The framework of the problem-solving approach to be taught to the learners was developed based on Engineering Design (NGSS 2013, 2017) (Table 1). In teaching the problem-solving framework, the NGSS is written in English, it was translated into Japanese for teaching.

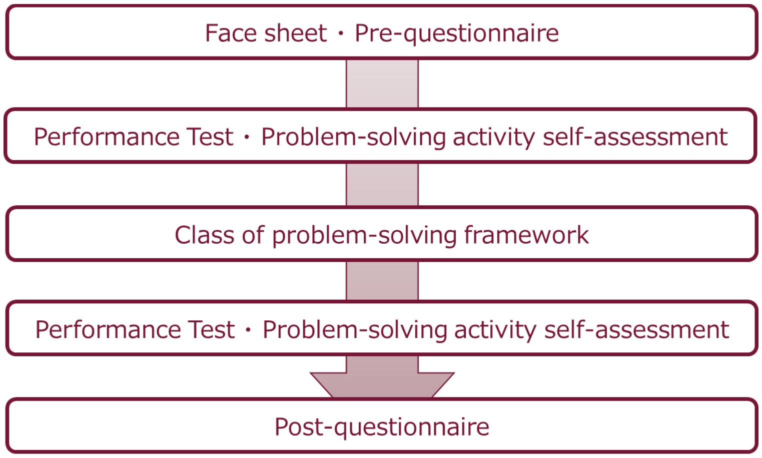

Figure 1. Procedure of research

Table 1. Framework for problem-solving based on Engineering Design

Define	Define a simple design problem that reflects the need, with specific success criteria and constraints on materials, time, and cost.
	・Understand what the problem is now. ・Understand what is required to solve the problem. ・Understand the conditions that must be considered when solving the problem.
Develop	Generate and compare multiple possible solutions to the problem based on how likely each solution is to meet the criteria and constraints of the problem.
	・To be able to generate multiple solutions ・Compare the degree to which each solution satisfies the problem. ・Share ideas to improve the solution.
Optimize	Plan and execute unbiased tests that control variables and account for failures in order to identify aspects of the prototype that can be improved.
	・Design tests to test solutions. ・Identify problems with the solution from test results. ・Collaborate to gather data for evidence.

3.3 Questionnaire

To investigate the changes in problem-solving skills, a questionnaire survey was conducted. First, a questionnaire survey on self-perception of problem-solving skills was conducted before and after the practice. In setting the items for the questionnaire, we selected 22 items out of a total of 47 items (32 items from the Problem-Solving Inventory (PSI) (Happner and Petersen 1982) and 15 items from the scale for measuring attitudes toward problem-solving (Emoto et al. 2005 in Japanese)).

In addition, self-evaluation of problem-solving activities was conducted. The self-assessment items included 9 items on the framework of problem-solving and 2 items on the self-confidence of the problem-solving activities. The students were asked to self-evaluate the degree to which they were able to perform problem-solving activities for their individual problem-solving activities and the problem-solving activities of the entire group.

In addition, a questionnaire survey was conducted after the practice to investigate the usefulness of the framework of the problem-solving approach. Five items were set as survey items to investigate the degree of usefulness through the problem-solving activities using the framework of the problem-solving approach.

4. Results

Based on the collected data, we investigated the impact of teaching the framework of problem-solving thinking on the learners. From the results of each questionnaire survey, those with missing values were excluded from the analysis, and data from 38 participants (46%) were used.

4.1. Problem-solving skills

The results of the pre- and post-questionnaires were used to measure changes in the perception of problem-solving ability. After processing the reversed items, Shapiro-Wilk's test for normality was conducted, but normality could not be confirmed. Therefore, Wilcoxon's signed-rank test was conducted on the pre- and post-questionnaires of self-perception of problem-solving ability (Table 2).

Table 2. Self-awareness of problem-solving skills

		Pre		Post		M_{post} - M_{pre}	Z		r
		M	SD	M	SD				
1.	I am able to look at a situation in different ways when solving problems. (R)	3.34	1.05	3.66	0.71	0.32	-1.87		0.35
2.	I am able to see things from different perspectives.	3.55	0.98	3.55	0.80	0.00	-0.02		0.00
3.	I try to think about the essence of things when I solve problems.	3.55	0.76	3.45	0.76	-0.11	-0.73		0.14
4.	Many of the problems I face are too complex for me to solve. (R)	3.03	0.79	3.26	0.95	0.24	-1.65	†	0.27
5.	When I make a plan to solve a problem, I am almost certain that I will succeed in doing so.	2.87	0.96	3.03	1.08	0.16	-0.92		0.15
6.	When I am faced with a problem, I am not sure that I can handle the situation. (R)	3.13	0.99	3.37	1.05	0.24	-1.52		0.23
7.	One of the first things I do when I notice a problem is to try to find out exactly what the problem is.	3.55	0.76	3.45	0.95	-0.11	-0.69		0.12
8.	When I am faced with a complex problem, I gather information so that I can define exactly what the problem is.	3.42	0.64	3.61	0.89	0.18	-1.29		0.24
9.	After I solve a problem, I do not analyze what went well and what did not go well. (R)	3.05	1.09	2.79	1.02	-0.26	-1.54		0.25
10.	When I am faced with a problem, I come up with as many ways as possible to handle it and think about them until I can't think of any more ideas. (R)	2.71	0.90	3.08	0.91	0.37	-2.38	*	0.41

11.	When I decide on an idea or possible solution to a problem, I do not take the time to consider the likelihood of success of each alternative. (R)	2.84	0.72	3.05	1.01	0.21	-1.28		0.24
12.	When I am faced with a problem, I stop and think before deciding on the next step. (R)	3.63	0.97	3.47	0.95	-0.16	-1.13		0.16
13.	I generally follow the first good idea that comes to mind. (R)	3.42	1.08	3.18	0.95	-0.24	-1.15		0.23
14.	When choosing a solution, I weigh the consequences of each alternative and compare them to each other. (R)	3.37	0.82	3.29	0.80	-0.08	-0.41		0.10
15.	I try to predict the overall outcome of implementing a particular solution.	3.18	0.77	3.50	0.80	0.32	-1.40		0.40
16.	When I try to think of possible solutions to a problem, I do not come up with too many alternatives. (R)	3.50	0.89	3.39	0.75	-0.11	-0.65		0.13
17.	I have a systematic way of comparing alternatives and making decisions. (R)	2.74	0.69	3.05	0.84	0.32	-2.00	*	0.41
18.	When confronted with a problem, I usually do not consider what external factors are contributing to the problem. (R)	2.79	0.66	3.18	0.73	0.39	-2.70	**	0.57
19.	When I am confused by a problem, one of the first things I do is to investigate the situation and consider all the relevant information.	3.11	0.73	3.42	0.76	0.32	-1.80	†	0.43
20.	Sometimes I don't stop to deal with my problems, I just mess around and move forward without taking the time to do so.	3.29	0.98	3.29	1.11	0.00	-0.04		0.00
21.	When I am working on a problem, sometimes I feel like I am groping or wandering and not getting to the real problem.	3.45	0.83	3.45	0.72	0.00	-0.07		0.00
22.	I sometimes make poor decisions and regret them later.	4.11	0.89	3.79	0.87	-0.32	-2.13	*	0.36

n=38, (R): Reverse score, 5-point Likert scale *†p<.100, *p<.050, **p<.010*

4.2. Problem-solving activities

Based on the results of self-evaluation of problem-solving activities, we measured the change in self-evaluation of problem-solving activities. As a result of Shapiro-Wilk's normality test, normality could not be confirmed. Therefore, Wilcoxon's signed-rank test was used for the pre- and post-questionnaires of self-perception of problem-solving skills (Table 3 for individual self-evaluation of problem-solving and Table 4 for group self-evaluation of problem-solving).

Table 3. Self-assessment of individual problem-solving activities

			Pre		Post		M_{post} - M_{pre}	Z		r
			M	SD	M	SD				
1.		I am satisfied with my problem solving.	3.21	1.06	3.55	1.02	0.34	-1.84		0.30
2.	Define	I was able to define a solvable problem that meets the needs of the problem conditions.	3.08	1.04	3.37	0.96	0.29	-2.07	*	0.34

3.		When defining the problem, I was able to identify what needs to be solved to be successful.	3.08	0.77	3.26	1.12	0.18	-1.79	†	0.29
4.		I was able to identify the constraints of the situation to be solved when defining it.	3.05	0.83	3.24	0.93	0.18	-2.64	**	0.43
5.		I can generate multiple solutions.	2.76	1.20	3.32	0.95	0.55	-0.83		0.14
6.	Develop	I can compare solutions in terms of success and constraints.	2.84	0.84	3.11	0.88	0.26	-2.03	*	0.33
7.		I can improve my solutions by sharing ideas.	3.03	1.09	3.37	0.98	0.34	-1.17		0.19
8.		I was able to discover improvements to the solution.	3.16	1.06	3.32	1.00	0.16	-0.26		0.04
9.	Optimize	I was able to improve the solution based on the improvement points	2.95	0.94	3.21	1.06	0.26	-3.41	†	0.55
10.		I was able to plan and execute surveys and other activities to discover improvements in solutions.	2.74	0.94	3.03	1.06	0.29	-2.11	*	0.34
11.		I think that my problem solving is better than others' problem solving.	2.58	1.14	2.92	1.09	0.34	-2.33	*	0.38

n=38, 5-point Likert scale *†p<.100, *p<.050, **p<.010*

Table 4. Self-assessment of the group's problem-solving activities

			Pre		Post		M_{post} - M_{pre}	Z		r
			M	SD	M	SD				
1.		We are satisfied with our problem solution	3.61	0.90	3.76	0.87	0.16	-1.24		0.20
2.		We were able to define a solvable problem that meets our needs for the problem conditions	3.47	0.94	3.61	0.87	0.13	-1.54		0.25
3.	Define	We have clarified what we need to solve to be successful in our definition	3.42	0.96	3.61	0.96	0.18	-1.22		0.20
4.		We were able to identify the constraints of the situation to be solved when we defined it	3.55	0.94	3.58	0.94	0.03	-2.45	*	0.40
5.		We were able to generate multiple solutions	2.92	1.11	3.24	1.06	0.32	-0.20		0.03
6.	Develop	We were able to compare solutions in terms of success and constraints	3.18	0.94	3.45	0.99	0.26	-2.06	*	0.33
7.		We were able to improve our solutions by sharing our ideas	3.24	1.01	3.63	0.96	0.39	-1.57		0.25
8.		We were able to discover improvements to the solution.	3.26	1.07	3.34	1.06	0.08	-0.06		0.01
9.	Optimize	We were able to improve the solution based on the improvements	3.47	1.04	3.39	1.01	-0.08	-1.17		0.19
10.		We were able to plan and carry out surveys and other activities that would enable us to discover improvements in our solutions.	3.11	1.07	3.34	1.06	0.24	-2.40	*	0.39
11.		We think that our problem solving is better than others' problem solving	3.05	1.02	3.29	0.94	0.24	-2.21	*	0.36

n=38, 5-point Likert scale **p<.050*

4.3. Usefulness of the framework

In the post-questionnaire survey, the evaluation of the problem-solving framework was conducted. The mean and variance of the results were calculated (Table 5).

Table 5. Usefulness of the problem-solving framework

		M	*SD*
1	I was able to understand the framework of problem-solving skills introduced.	3.76	0.85
2	I was able to solve problems using the introduced problem-solving framework.	3.42	0.89
3	The introduced problem-solving framework fits as a framework for problem solving.	3.61	0.82
4	I was able to solve problems easily by applying the framework of problem-solving skills introduced.	3.47	1.03
5	I was able to solve the problem better the second time than the first time.	3.79	1.12

n=38, 5-point Likert scale

5. Discussion

In this study, we investigated the impact of teaching a problem-solving framework based on Engineering Design on the students. From the results of the questionnaire survey, there was a change in the self-perception of problem-solving skills. It showed that the students' self-perception of their problem-solving skills changed, and they began to think that they were able to solve problems systematically after being taught the framework of problem-solving framework. In addition, they have come to believe that it is important to come up with multiple ideas for solutions when conducting problem-solving activities. They started to think about my own situation first when they started problem-solving activities. This was probably because they recognized the importance of defining the problem and developing ideas from the framework of problem-solving.

Self-evaluation of problem-solving activities also changed. In particular, the self-evaluation of problem-solving behavior related to define increased significantly. However, many items did not change in the self-evaluation of problem-solving behavior related to Optimize. Insufficient time for problem-solving activities and not being able to optimize problem-solving activities may have influenced the results. There was also a difference between the self-evaluations of individual and group problem-solving behaviors. This may be because they were not able to utilize the problem-solving behaviors that they were able to perform individually in their group problem-solving behaviors.

We found that the learners felt that the problem-solving framework was useful. However, they did not give it a high rating, indicating that it needs to be improved. The self-evaluation of the Optimize problem-solving activity also did not improve, indicating the need to improve the Optimize part in particular.

Several issues were found in this practice. First, there was no improvement in any of the problem-solving activities. In the framework of the current problem-solving approach, it was found that the "definition" problem-solving activity had a certain effect. However, the results for "generation" and "optimization" were not sufficient to say that they were effective. Therefore, the framework of problem-solving and its teaching methods need to be improved.

The fact that the individual problem-solving activities could not be applied to the group problem-solving activities indicates that there is a need for consideration when conducting group problem-solving activities. In this study, we used smartphones, and we felt the need to provide support so that discussions using smartphones could be conducted smoothly.

In addition, there were some problems in the subject matter and time setting of the problem-solving activities. In addition, there were some comments from the chat logs that there was not enough time for the problem-solving activities, which suggests that there was not enough time for the problem-solving activities. In this practice, the time for each problem-solving activity was short because we had to conduct two problem-solving activities and a lesson on the framework of problem-solving in a short time. To give learners enough time for problem-solving activities, it is necessary to clarify the time required for the activities by conducting preliminary experiments.

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Faculty Perceived Barriers of Online Education at a Midwestern University in Ohio

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Many institutions have adopted best practices in the design of online education programs. However, the literature indicates that there is a need for continued research in the area of evaluating and examining online faculty satisfaction levels and self-perceived barriers in relation to online education. This study extended research conducted by Lloyd et al. (2012) and investigated faculty perceived (interpersonal, institutional, training/technology, and cost/benefit) barriers to online education. Statistical analysis revealed three major items: (1) faculty continues to experience barriers to online education; (2) faculty is receiving training and guidance in order to become more comfortable, and knowledgeable in online settings; and, (3) as faculty online experience increases, the perceived barriers decrease. Additionally, faculty provided detailed comments validating ongoing interpersonal, institutional, training/technology, and cost/benefit analysis barriers in online education. Higher education's online programs will benefit from intense professional development, training, as well as, open conversations including focus groups, composed of administration, faculty, and students.

Introduction

According to the *Condition of Education 2019* report*,* (McFarland et al., 2019) online enrollment in higher education continues to escalate with 5.5 million students participating in online education in fall 2017. Additionally, 2.2 million of those students, or 13 percent of the total undergraduate enrollment, were taking courses completely online. Between 2017 and 2028, the overall undergraduate enrollment is projected to increase to 17.2 million students. Additionally, from fall 1999 to fall 2017, faculty in higher education had an increase of 49 percent, from 1.0 to 1.5 million.

The *Condition of Education 2019* report is an annual verification, mandated by Congress to summarize the latest data on education in the United States. Local, state, and national governments continue to implement a host of initiatives, such as, improving student retention and completion rates, cultivating educational programs, increasing professional development activities, advancing technology, and development of academic leadership, etc. (Jolley et al., 2014). The exponential demand for online options in higher education directly affects faculty. Therefore, this current research will focus on understanding faculty perceived barriers to online education in an effort to advance research is this area.

This study expands on the research conducted by Lloyd et al. (2012), which stated that major factors affecting faculty's perceptions of online learning include: (1) interpersonal barriers; (2) institutional barriers; (3) training/technology barriers; and (4) cost/benefit analysis barriers. As online learning continues to be demanded by students, colleges have constantly increased online offerings due to the advancement of computer technologies. Faculty are tasked to accept new challenges via online education. Higher education would benefit from understanding major factors affecting faculty perceptions to online learning. A major benefit would include innovative guidance, and new opportunites for improvement in online education programs. "The advancement of online education has transformed the availability of higher education. Technology and adaptable curricula formats have expanded the speed, methods, and approaches in both traditonal and non-traditional education environments" (Fogle et al., n.d.), higher education continues to face changes.

As described by Windes and Lesht (2014), the dramatic changes which have been faced by higher education can be explained within the framework of Disruptive Innovation Theory. This theory suggests two types of technological change: supporting technological changes and disruptive technological changes. The authors note that a supporting or sustaining innovation serves the needs of existing customers, provides some enhancements; however, it does not result in major changes to the market or its audience. In contrast, a disruptive innovation, ultimately replaces services or products because they are more accessible to a population of customers, enabling new companies to develop and then dominate the industry. Therefore, as emphasized by Windes and Lesht (2014):

> Many have pointed to online education as a disruptive innovation within higher education. Students that were not well served by traditional colleges have seen their options increase as the number of online courses and programs has grown. While initially resistant, many institutions of higher education are now attempting to compete with early adopters by developing online programs in order to reach this underserved market. (p. 1)

The Ohio Faculty Council (OFC) which represents all of the faculty at all of the four-year public universities in the state of Ohio, advised that higher education in Ohio is at a crossroad, and must make it easier for students to attend college and earn quality and affordable degrees. “Today, 45% or more of working age adults in other states like Massachusetts, Maryland and Virginia have two- or four-year degrees compared to only 36% of working age adults in Ohio” (Ohio Faculty Council [OFC], 2014, para. 2).

A major strategy for Ohio, as noted by OFC includes a personalized academic program of study, which will ideally include the option of courses from Ohio Public institutions delivered in the online learning format. However, throughout the literature, it is noted that faculty continue to resist online education.

Statement of Problem

Faculty continue to express fears and concern about online education (Davis & Jacobsen, 2014; Eickholt, 2016; Fogle et al., (n.d.); Gillett-Swan, 2017; Glass, 2017; Reid, 2014), and they are reluctant to teach in the online format. Online education which has been recognized as an emergent and profitable field, has developed into a permanent fixture in mainstream higher education (Luongo, 2018). Students and employers continue to laud online education due to the fact that location and scheduling issues are expunged. Higher education administrators continue to examine cost effectiveness and surges in enrollment due to evolving technologies. As reported by Seaman et al. 2018:

> The proportion of the higher education student body taking advantage of distance education courses has increased each of the last four years. It stood at 25.9% in 2012, at 27.1% in 2013, 28.3% in 2014, and 29.7% in 2015. (p. 11)

Even after a decade of significant growth in the number of universities with online offerings and students taking these courses, the level of uncertainty in relation to online learning amongst faculty continues to remain high (Allen & Seaman, 2016).

Wingo et al. (2017) states that in the United States, faculty are being tasked to teach online at an outstanding rate. Faculty are hesitant and reluctant to embrace online teaching due to: (1) interpersonal barriers; (2) institutional barriers; (3) faculty training/technology barriers; and (4) cost/benefit analysis barriers (Lloyd et al., 2012). There are numerous policy items and issues that administrators and faculty need to discuss in relation to online environments. Obstacles faced at various stages of online education noted by Berge and Muilenburg (as cited in Reid, 2014) include: administrative structure, legal issues, organizational change, technical expertise support, student support services, access, threatened by technology, faculty compensation and time, social interaction and quality, evaluation/effectiveness (p. 384)

Faculty are increasingly challenged to rethink their underlying assumptions about teaching and learning online, and the roles they take as instructors (Luongo, 2018). Luonogo also reminds us that perceived lack of institutional and departmental support is one of the biggest deterrents to teaching online. In the meantime, the competition has created other avenues such as edx and coursea. Understanding faculty perceived barriers to online education might assist in reducing barriers in this environment.

Purpose of the Study

The purpose of this study is to understand if, and why faculty members have perceived barriers to online education. Based on a review of faculty perceived barriers in higher education (Allen & Seaman, 2016; Capra, 2011; King & Arnold, 2012; Lloyd et al., 2012) more research is needed to comprehend this topic. This descriptive quantitative study intended to use the results to assist institutions as they cultivate training programs, and faculty recruitment policies for online education, in order to meet the growing demand for this type of instruction. The findings of this study contributed to the body of knowledge in the fields of faculty development, online learning, and higher education administration.

Methodology

Some researchers use the term survey research to denote almost any form of descriptive, quantitative research (Leedy & Ormrod, 2013). This current study intended to use survey research to acquire information about one or more groups of university faculty and their characteristics, opinions, attitudes and previous experience with online education by asking questions and tabulating their answers. This study also intends to investigate the relationship between faculty members' demographic characteristics and interpersonal, institutional, training/technology, and cost/benefit analysis barriers. Questions will be answered by the use of an online self-report survey instrument and the responses will be analyzed quantitatively.

Research Questions

The study attempts to answer the following research questions:

1. Is there a significant difference in faculty perceived institutional barriers for online education based on full-time status?
2. Is there a significant difference between faculty perceived institutional barriers for online education and years of online teaching?
3. Is there a significant relationship between faculty perceived institutional barriers for online education and age?
4. Is there a significant difference between faculty perceived interpersonal barriers and gender?
5. Is there a significant difference in faculty perceived technology barriers and previous online courses taken related to online teaching?

Instrument

The survey instrument proposed as the foundation for this study was created by Lloyd et al. (2012) for a study of faculty perceived barriers of online education at North Georgia College & State University. "There are advantages to using existing instruments, particularly if they have already been validated and reported to be reliable. Reusing an existing survey may also allow for an additional point of reference and comparison" (Eickholt, 2016, p. 3). The noted survey instrument was "pilot tested twice in order to assess the face validity and clarity of the questions (pilot test #1) as well as the ease of use of the web-based survey tool and reporting formats (pilot test #2)" (Lloyd et al., 2012, pgs. 3-4). Lloyd et al. (2012) sent three email requests for participation to faculty members, an informed consent, and a URL to access the online survey. It was also noted that all procedures were conducted in accordance with, and approved by the North Georgia College & State University's Institutional Review Board.

This present-day research study will augment the 37-item questionnaire that was constructed, distributed, and used in the online survey at North Georgia College & State University by the above noted researchers. This researcher received an email confirmation to use the North Georgia College & State University's online survey (S. Lloyd, personal communication, September 1, 2014).

The instrument for this present study was a self-report questionnaire with four sections. The first section of the questionnaire contained seven questions that measured online faculty members experience and perception of online education. The second section contained 21 questions that measured faculty perceptions of barriers to online education on a Likert scale. The Likert scale asked the participants to rate the extent that they strongly disagree, disagree, agree, or strongly agree with the various statements in relation to barriers towards online teaching and learning. The third section was an open-ended question, which asked the participant to list their experience with other barriers to online education. Finally, section four was the demographics area, which contained six questions.

The population for this study included faculty teaching at least one face-to-face or online course during the academic year 2019/2020 semester at a four-year degree-granting public Midwestern University. This included those teaching undergraduate and graduate degree programs, approximately 800 participants.

Data collection

During the academic year 2019/2020, the Midwestern University's Office of Institutional Research sent the recruitment email via the university's e-mail system (online) to all faculty teaching at least one face-to-face or online course and invited them to participate in the study. The email contained a consent letter informing the faculty members of their rights as participants. If the faculty member elected to participate, they clicked a link to Qualtrics that was available for them to complete the anonymous questionnaire.

Data analysis

The statistical tests used included the following:

One-way ANOVA – this exploration includes only one independent variable with more than two levels.
Independent samples *t*-test – Compares two sample means to determine whether the population means are significantly different.
Pearson correlation – an analysis of the linear relationship between two variables, called the Pearson *r*.

Results

During the academic year 2019/2020, the Midwestern University's Office of Institutional Research sent a recruitment email via the university's email system (online) to faculty teaching at least one face-to-face or online course, and invited them to participate in the study.

Listed are the colleges within the Midwestern University, which were sent an invitation to participate in the study: Arts and Letters, Business Innovation, Education, Engineering, Health and Human Services, Law, Natural Sciences and Mathematics, Nursing, and Pharmacy and Pharmaceutical Sciences. Of the 792 faculty members who were sent an email invitation, 115 faculty members completed the survey from October 29, 2019 until December 4, 2019. A response rate of (14.5%) was the result. The demographic characteristics of the participants are illustrated in Table 1, which include gender, faculty status, academic rank, experience with online education, perceived level of comfort and proficiency with technology for online teaching, and years of online teaching.

Table 1
Demographic Characteristics of Respondents

Demographic	N	% of Sample
Gender		
Male	39	33.9%
Female	58	50.4%
Prefer not to answer	9	7.8%
Missing	9	7.8%
Faculty Status		
Full-time	78	67.8%
Part-time	24	20.9%
Missing	13	11.3%
Academic Rank		
Professor	22	19.1%
Associate Professor	18	15.7%
Assistant Professor	14	12.2%

Demographic		N	% of Sample
	Lecturer	23	20.0%
	Visiting Instructor	1	0.9%
	Other	28	24.3%
	Missing	9	7.8%
Experience with Online Education			
	No Experience	40	34.8%
	Taught Online Course	69	60.0%
	Missing	6	5.2%
Perceived Level of Comfort and Proficiency with technology for online teaching			
	Not Comfortable	13	11.3%
	Sort of Comfortable	47	40.9%
	Very Comfortable	47	40.9%
	Missing	8	7.0%

Demographic Characteristics of Respondents (continued).

Years of Online Teaching			
	Never	39	33.9%
	1-4 Years	28	24.3%
	5-8 Years	14	12.2%
	8+ Years	24	20.9%
	Missing	10	8.7%

Research questions. In addition to providing data analysis for the research questions, respondents provided rich qualitative data in the open-ended question in the survey.

Research question #1: Is there a significant difference in faculty perceived institutional barriers for online education based on full-time status? As shown in Table 2, an independent samples t-test was used to determine whether differences existed in the mean score for perceived institutional barriers based on full-time and part-time faculty rank. As shown in Table 2, there were no statistically significant differences in the score ($p<.05$) for any perceived institutional barriers.

Table 2
Independent Samples t-test by Institutional Barriers Full/Part-time

	Full-time		Part-time			
	M	SD	M	SD	t(99)	p
Perceived Institutional Barriers	26.8	5.5	26.7	4.3	0.11	>.05

Comment from a part-time instructor:

> I am a part-time instructor with full-time (50+ hours) administrative job. I teach a mixed class of in-class and distance learners. My method of teaching involves several hands-on, team workshops. It is very difficult to give the DL's the same experience with the hands-on exercises. I did try to take a course in on-line teaching but it involved more time than I could dedicate due to full-time responsibilities and it seemed to start at a level above my starting point.

Comment regarding academic support: "If a Chair is not supportive of online course development, they don't encourage their faculty to design courses."

Research question #2: Is there a significant difference between faculty perceived institutional barriers for online education and years of online teaching? As shown in Table 3, a One-way ANOVA test was used to determine the difference amongst the four groups (never taught online, 1-4 years, 5-8 years, and 8+ years). There were no statistically significant differences; however, the 8+ years group had a lower mean, as compared to the other groups.

Table 3
ANOVA Institutional Barriers Based on Years of Teaching Online

	Never taught online		Taught online 1-4 years		Taught online 5-8 years		Taught online 8+ years			
	M	SD	M	SD	M	SD	M	SD	F (3, 100)	p
Perceived Institutional Barriers	28.1	4.9	28.6	4.6	26	3.5	22.7	5.4	8.19	0.001

One respondent has been teaching since 2002:

> The Online Learning division should be marketing our programs. Many UToledo online programs are certified through Quality Matters. UToledo online courses offer direct access to the instructor, usually within 24-48 hours, as is not the case with on campus courses.

One respondent commented on the benefits of online education:

> Online courses help students beyond the expected coursework in that scheduling/planning, time management and project management are learned, providing enhancement of skills for undergrads and graduate students.
> Online learning provides help lines, tutorials, and a myriad of other support materials for students. This also improves student communication skills, both verbal and written. I see no down side to online teaching, other than an instructor who does not put in the time and energy to fully transform their on-campus course into a quality online course. I have been teaching online since 2002. I have used WebCT and Blackboard, but I am also familiar with Canvas, Moodle and many others.

On the other hand, a respondent with no online teaching experience proclaimed:

> I would like to teach, but getting over the first hump is a little scary. If I had more hands on support from other faculty who have taught online or modules that could improve my online skills, I think that would help.

Additionally, some respondents did not have any barriers: None. In fact, I get far more participation in online classes than I do face-to-face.
This respondent favored face-to-face instruction: There is empirical evidence that face-to-face instruction results in better learning than the disembodied online experience.

*Research question 3: Is there a significant relationship between faculty perceived institutional barriers for online education and age? A*s shown in Table 4, a Pearson correlation was used to determine whether there was a relationship amongst age and perceived institutional barriers. The test showed that a negative relationship existed. As age increased, perceived institutional barriers decreased. Or, as age decreased, perceived institutional barriers increased.

Table 4
Pearson Correlation by Institutional Barriers Based on Age

Measure	1	2
1. Age	-	
2. Perceived Institutional Barriers	-0.15	-

Research question 4: Is there a significant difference between faculty perceived interpersonal barriers and gender? As shown in Table 5, an independent samples *t*-test was used to determine whether differences existed in the mean score for perceived interpersonal barriers based on gender. As shown in Table 5, there were no statistically significant differences in the score ($p<.05$) for any perceived institutional barriers.

Table 5
Independent Samples t-test by Interpersonal Barriers and Gender

	Male		Female			
	M	SD	M	SD	t(94)	p
Perceived Interpersonal Barriers	14.2	3.5	14	3.7	0.83	>.05

Faculty illustrate some of the perceived interpersonal barriers that exist based on gender:

> As a Black female professor, students are less respectful to me than their white and male counterparts. They either plead for me to change their grades and if I maintain the integrity of my grading policy, they retaliate by writing negative evaluations. They do address me by my first name and or attempt to question the integrity of my expertise in the subject.

This comment discussed difficulties of online environments:

> I am resistant to online teaching because I feel strongly that the most valuable parts of college are meeting your classmates and professors, having to show up on time, and the dialogue that happens in class. I associate online-heavy curricula with unaccredited, for-profit universities, not with legitimate institutions. I enjoy students and want to get to know them which is difficult in an online setting . I also sense that the emotional labor component of teaching is extremely limited for online-only faculty. They don't have to stand in front of students or develop relationships with students, so they don't get asked for letters of recommendations, advice on job interviews, questions, etc. that face-to-face faculty do. My sense is that students don't take online courses as seriously as their face-to-face classes. Students will freely admit even to faculty that they take online classes because they are "easy" or because they can use the book during tests. That is highly problematic.

This respondent commented on instructor creativity, morale, and motivation:

> I think that some of the barriers listed about being impersonal can be true, but it is up to the instructor to ensure that the online class is finding ways to make it more personable. However, this also makes it a much more time consuming class to teach. It is definitely harder to engage students who are only taking an online class so they don't have to "show up" to a physical class. That mindset can be a barrier for instructors. Adjunct instructors might also feel less connected to the department and other instructors if they are not physically present. Having a connection with other faculty in the department can help with creativity, morale, and motivation.

Research question 5: Is there a significant difference in faculty perceived technology barriers and previous online courses taken related to online teaching? As shown in Table 6, an independent samples *t*-test was used to determine whether differences existed in the mean score for perceived technology barriers based on if the respondent has taken previous online courses in relation to online teaching (yes or no). As shown in Table 5, there were no statistically significant differences in the score ($p<.05$) for any perceived institutional barriers.

Table 6
Independent Samples t-test by Technology Barriers and Previous Courses

	Yes		No			
	M	SD	M	SD	t(103)	p
Perceived Technology Barriers	4.1	1.4	4.3	1.2	-0.69	>.05

This respondent discussed technology barriers:

> It sometimes feels more difficult to create meaningful, active discussions or activities to engage students. There are always options to use discussion boards, and have students create short videos, however, it feels to me there is always a challenge in engaging students online, when compared to in-classroom.

Comments below state optional forms of technology:

> If you have a good platform like Zoom where you can see each other and divide into virtual small discussion groups, share your screen, and do the class in real time it is a really great way to teach and learn. It's more inclusive for distance learners. I do think that there is something different that happens in a face to face situation that is in person that is different from the online. I am not sure if it's different enough that the lack of face to face is a barrier. It might be for better to have blended classes some online class times and some in person especially for health and human services were dealing with people in person is part of the profession.

Other technology concerns: Poor support of computer hardware and software from university needed for effective course development and monitoring and availability of training to use online system.

Conclusions

The purpose of this study was to understand if, and why faculty members have perceived barriers to online education. Results indicated that faculty continues to experience various barriers online. However, faculty report being comfortable in the online environment, and continue to embrace this form of educational delivery.

Faculty in this study, based on the specific research questions, do not have perceived institutional barriers based on full-time status. Results also revealed that as faculty online experience increases, faculty perceived institutional barriers decrease. Additionally, there are no perceived interpersonal barriers based on gender; and, no perceived technology barriers based on previous online classes taken in relation to online teaching. There is a relationship amongst age, and perceived institutional barriers; as age increased, perceived institutional barriers decreased.

On the other hand, faculty comments provided rich, practical, and extensive documentation of ongoing interpersonal, institutional, training/technology, and cost/benefit analysis barriers. The study also highlighted additional critical barriers experienced by faculty, which included the lack of student preparation in the online environment, issues with learning management systems, and questionable support of academic leaders towards online education. The online environment has become even more integral to scholarship based on the pandemic health concerns throughout the world.

Online education is no longer, just a preference. Administrators, faculty, and students are on notice as to the urgency, and significance of this form of educational delivery. Planning must also include transformation of face-to-face courses to online delivery. Additionally, faculty will benefit from intense professional development, training, as well as, open conversations including focus groups, composed of administration, faculty, and students. Online education continues to evolve, and higher education continues to advance, and embrace this challenge.

In summary, this research study sought to understand why faculty continue to express fears and concerns in online environments. The data provided generous examples of current interpersonal, institutional, training/technology, and cost/benefit analysis barriers. The significance of the study provides administrators with guidance, and opportunites to improve current practices in the development of online education. Guidance includes understanding the technology acceptance model, online education, pedagogy, and tackling the critical barriers from question #29. The domain of education has changed forever; and, it continues to face new challenges worldwide. This research provides evidence that it is imperative to address faculty perceived barriers in the "everchanging digital world" called online education.

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TraceMe + Pedagogical Agent = Morgan: Personalized Learning With AI

Fatimah Wirth, Ph.D.

Abstract

Online courses are often structured using a cookie cutter approach and even when they are personalized, they are done based on instructor/instructional designer experience. In this research study, the learners' paths was traced throughout the online course. Georgia Tech Professional Education (GTPE) collaborated with Professor Alain Mille from the French National Center for Scientific Research and France's Universite Numerique and Pierre-Antoine Champin from Claude Bernard Lyon 1 University in France and the LIRIS research center and used their proprietary software called TraceMe to collect data in a Georgia Tech Professional Education (GTPE) course. The research question addressed was how learners navigate through an online course. The findings from this research study will help identify trends/paths that can be used to restructure curriculum and presentation of content. Understanding the learner's navigational and interactivity patterns will inform effective course design (Stein, 2014). The findings will also help create an artificial intelligent pedagogical agent that provides a personalized path. The AI pedagogical agent will pop up at the point where the learner is frustrated or stuck.

Introduction

The Covid-19 pandemic has forced everyone to learn in new ways. It has ripped us from the traditional classroom environment and forced us to think of education and learning in new and novel ways which may have been unthinkable pre-Covid-19.

Although this research study predates the Covid-19 pandemic, it even more relevant now. Once the research data had been analyzed, the Georgia Tech Professional Education (GTPE) researchers will be able to determine how the learners navigate through a course based on the trace data collected. This will help identify trends/paths that can be used to restructure curriculum and presentation of content. Understanding the learner's navigational and interactivity patterns will inform effective course design (Stein, 2014). Georgia Tech Professional Education collaborated with Professor Alain Mille from the French National Center for Scientific Research and France's Universite Numerique and Pierre-Antoine Champin from Claude Bernard Lyon 1 University in France and the LIRIS research center and used their proprietary software called TraceMe to collect data in a GTPE course.

The aim of this research project was to trace the path that a learner takes during an online course session using javascript applied to each course page within the Learning Management System. The path that is traced includes how the student peruses the course menu and the content within a course. The data collected from the trace of the learner's path through the online course can be beneficial in that the researchers will be able to find out where learners have issues within the course. The issues may be due to navigation, instructions or course content. As a result, the researchers will be able to discover trends or themes when the data is coded. These trends or themes will lead to better online course structure, course content and course navigation. This will then improve the quality of the online courses so that participants get a more positive and beneficial online course experience.

Research Questions

The aim of this research project is to trace the path that a learner takes during an online course session using javascript applied to each course page within the Moodle Learning Management System (LMS). The path that is traced includes how the student peruses the course menu and the content within a course. This will allow us to identify areas within the course that need improvement.

The research questions investigated in this research study were as follows:

- Identify where and when learner engagement drops off
- Identify where content needs to be clearer or re-emphasized

An IRB protocol was submitted and approved before research and data collection started.

Literature Review

New challenges in information technology has forced institutions of higher learning to rethink education. Many institutions have turned to Artificial Intelligence (AI) to improve education. According to Yolvi, et al.:

> The formats based on artificial intelligence promise a very substantial improvement in education for all the different levels, with an unprecedented qualitative improvement: providing the student with an accurate personalization of their learning tailored to their requirements, managing to integrate the various forms of interaction human and information and communication technologies.
>
> (Yolvi, et al., 2019, p.536)

Artificial Intelligence creates computing systems that have the ability to learn from information in its environment and provide adaptive behaviors to assist learning. For the past 30 years, many institutions of highly learning have focused on creating AI based systems to mimic human tutoring. These systems are highly autonomous, interactive and adaptable (Qin, et al., 2020).

AI can also assist those with intellectual disabilities. These learners need a wide range of learning needs and do not learn in a linear or hierarchical way. The use of artificial intelligence tools for education can help move a student from a negative state to a positive state of learning. Students who are frustrated or stuck at a certain place in a course can be nudged to move into a more positive state of engagement. (Standen, et al., 2020)

However, so far, even though there may be intelligent tutors powered by AI, there is yet not a single one that provides just-in-time assistance where the AI pedagogical agent actually pops up at the time of frustration or being stuck in one place in a course and lets the learner know that there are other pathways that they can follow in order to get unstuck. This research study aims to do just that.

Methodology

The instructional designer reached out to at least three instructors teaching Georgia Tech Professional Education online courses in Fall 2017. An instructor was chosen based on the interest of the professor to participate and the ease of navigation of the course. The duration of the subject participation would be the duration of the course.

A week before the start of the course, the students in the course were sent a Qualtrics survey asking for voluntary participation in the research study. The students had to enter their first name, their last name and their email addresses. A consent form was attached to the email. In addition, before taking the background or end of course survey, the participants in the research study were provided with verbiage that said that if they took the survey, then they were consenting to taking part in the research.

The students first name, last name and their email address were asked so that the sample population would be identified. Once this population has been identified, their actual trace data will be anonymous. Their names will not be attached to the trace data in any way. The system will generate a random ID for each student based on CAS authentication. So each time the student logs into the course, the same random ID will be used for the student. There will not be a key or any document that will link the names to the random ID generated at any point during the study.

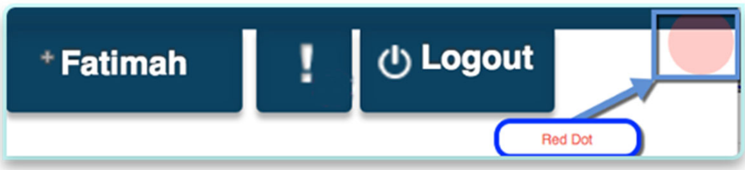
A new role called "Non Participant" was created for all those who did not fill out the survey or who did not want to participate in the research study. The new role was manually added to each student who did not want to participate. By adding this role, these students would not be tracked. These students would therefore have two roles, namely the Student role and the Non Participant role. This exclusion from participation in the study was created via the use of an HTML block in the Moodle Learning Management System used by Georgia Tech Professional Education. The HTML block would be called KTBS. The Non Participant role will ensure that the students who do not wish to participate will not see the KTBS HTML block when they logged into their course. This would mean that they will not participate in the study. The students who agreed to participate in the research study will see the KTBS HTML block when they log into their course. In addition, they will see a large red dot on the top right of the page.

When the students who had agreed to participate in the research study logged into the course, their every action in the course would be traced. This was an automatic process and the students would not have to do anything to initiate the process. If the students who had agreed to take part in the study did not want their actions traced, they can click on the red dot. The green dot will then become a red dot. This will mean that their actions in the course are not being tracked. If they log out of the course and then log back in, then the green dot will automatically appear again. This means that they will have to uncheck the check box again if they do not want to be tracked. The tracing of the data will not impact or change the normal user navigation or course setup in terms of activities and assessments.

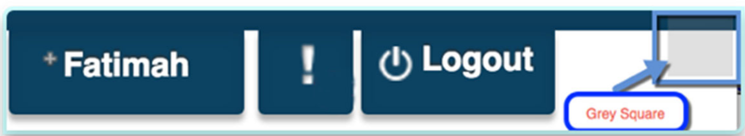
The students were informed that there were no known risks for participating in the study. All student information would be kept confidential. All records would be kept under a code number and not by student name. However, students were warned that data may exist on backups or server logs after the end of the research project. All data would be deleted three years after the completion of the study.

The students were also informed that the trace data would be on the Amazon Cloud server. The data collected would be anonymous and only the researchers would have access to this server. Only the researchers would be able to download the data as a CSV file.

The students who agreed to participate in the course were identified through the response to the survey and given access to a consent form. In the consent form, students were notified that the software called “TraceMe” would be activated when they logged into the course. They would see a red dot next to their names on the top right and that signified that their actions in the course was being traced (see image below).



These students were also informed that if they wished not to be traced on a certain day or if they no longer wished to have their actions in the course traced, then they could click on the red dot next to their names on the top right. The red dot would then turn into a grey square and this would denote that they were no longer being traced (see image below).



The students who did not wish to participate would not have access to the software and hence would not see a red dot next to their names on the top right. They would participate in the course as any other student in an online course would.

In addition, the participants will have to fill out a background survey and an end of course survey. The background survey will collect demographic information of the participants. The end of course survey will ask questions about the course design and navigation.

The background data will be collected once at the beginning of the course through the background survey. The end of course survey data will be collected once at the end of the course through the end of course survey. The end of course survey will determine the difficulty level of the content and the navigational ease of the course. The data collected from the background and end of course surveys will be correlated to the trace data. For example, the trace data and the background data can be correlated to show how younger participants navigate versus how older participants navigate through the course. There may also be other correlations in terms of navigation through the course such as gender, educational background, reason for taking the course, etc. The trace will be continuously sending data on student navigation of the online course to the server. This data will be captured for the entire duration of the course. The data collected will assist the Georgia Tech Professional Education instructional designers to figure out where students get stuck within a course and what can be done to alleviate that. There could be follow up interviews with each student who had difficulties to find out why they got stuck and what would have made either the navigation or the content better meet their needs.

Course Design

The Learning Management System at Georgia Tech Professional Education at the time of the research was Moodle hosted by Moodlerooms. The course chosen for the research project was VET^2: Military Transitions to the Workforce. The course was chosen based on the fact that it had a clean interface and was easy to navigate. The course was also designed based on the

Standards from the Quality Matters Higher Education Rubric, Sixth Edition and had enough activities to make the course engaging.

The tracing software that we piloted was developed by Dr. Alain Mille from Liris (Trace-Based System - a project of the TWEAK Team) and Pierre-Antoine Champin from Claude Bernard Lyon 1 University in France. The trace engine was installed on a server and javascript code was appended to each course page in Moodle. The trace would be automatically activated as soon as the learners who had agreed to participate in the research study logged into their course. The tracing software then would record and archive all paths taken by the learners. The tracing of the data will not impact or change the normal user navigation or course setup in terms of activities and assessments.

The data collected from the trace of the learner's path through the online course can be beneficial in that the researchers will be able to find out where learners have issues within the course. The issues may be due to navigation, instructions or course content. As a result, the researchers will be able to discover trends or themes when the data is coded. These trends or themes will lead to better online course structure, course content and course navigation. This will then improve the quality of the online courses so that participants get a more positive and beneficial online course experience.

Data Collection

Data was collected from the background survey, the end of course survey and the trace from the TraceMe software. Data from the background survey and the end of course survey will be analyzed quantitatively and/or qualitatively. These data may also be exported to qualitative and/or quantitative software packages.

Dr. Champin created a Pilot HTML block in the course, to host the script that would collect the data when the student who had agreed to participate in the research project logged into the course. The student would see the red dot on the top right of the page when data was being collected.

The trace data collected from the Amazon Cloud server would be analyzed qualitatively and/or quantitatively. The data is anonymous and only the researchers have access to this server. In addition, the trace data would be exported to qualitative and/or quantitative software packages. Open coding would be used to discover trends, themes or confounding variables within the qualitative data collected. The data may also be cross-tabbed across multiple data sources (e.g. background survey, end of course survey and trace data from plugin) in order to discover trends, themes or confounding variables. The tracing of the data will not impact or change the normal user navigation or course setup in terms of activities and assessments.

The data collected from the participants of the research study will be kept confidential to the extent allowed by law. Participant records will be kept under a code number and not by name. Participant records will be kept in a locked file if printed and on a secure desktop or laptop if electronic. The data on the desktop or laptop will be kept secure by locking the desktop or laptop screen with a user login and password. When the desktop or laptop computer is not in use the screen will be locked. Only the researchers will have access to these files - printed and/or electronic. Participants in the research study will only be identified by number. Data correlation will use this number to match data from various sources to the participant. Researchers will share data and collaborate on a private Office 365 site. The site will only be available to the researchers. All data (printed and electronic) will be destroyed three years after the completion of the study.

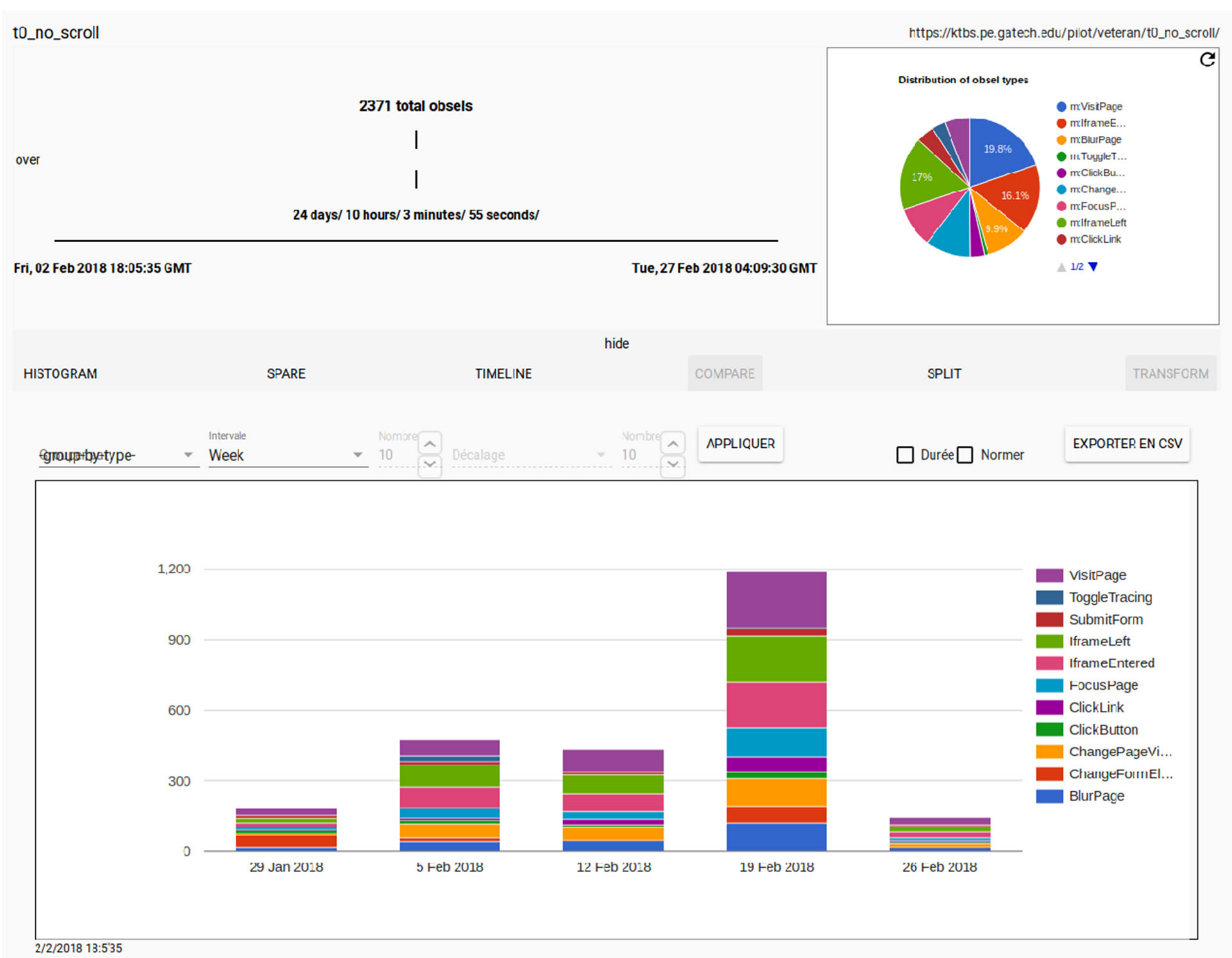
Data Analysis

Data collection took place in Spring of 2018. The chosen course, VET^2: Military Transitions to the Workforce, went live on February 5, 2018. There were 26 students in the chosen course and all 26 students agreed to take part in the research study. The students were given 6 weeks to complete the course which had 4 modules, 4 end of module quizzes, 5 assignments and 7 videos to watch. Data was collected on an AWS server. The Amazon Cloud external server only collected anonymous data. The researchers had access to this server and were able to download this data as a CSV file.

In just 24 days, 2371 pieces of data was collected. The data collected included visiting a page, submitting an assignment, clicking a link, clicking a button, changing page view.

Figure 1

Preliminary data obtained from VET^2: Military Transitions to the Workforce course.



Of more interest however, was how the students were making their way through the course and where they got stuck or spent the most amount of time. However, data collection and data analysis had to stop before the GDPR rules went into effect on May 28, 2018 as the researcher collecting the data was Pierre Anton Champin who resided in France. Pierre handed over the data to the researcher in the United States and data analysis has stalled since then because of the new GDPR rules.

Work in Progress

After data collection ceased due to GDPR restrictions, data analysis also ceased. This is due to the fact that the researchers who would be analyzing the data were from France. Currently there are more than 40,000 bits of data waiting to be analyzed.

The aim of the project has also changed from identifying two research problems to the creation of an AI pedagogical agent that would address the two research problems. The first research problem was to identify where and when the learner engagement drops off. The second research problem was to identify where content needs to be clearer or reemphasized. The pedagogical agent, named Morgan, would pop up at the point when engagement drops off. The pedagogical agent will provide either encouragement, explanation or a new path for the learner to follow so that the learner can complete the task. In addition, research partners will need to be identified to assist in the process of the AI creation based on the current data collected.

However, since Georgia Tech Professional Education now uses Canvas as the Learning Management platform instead of Moodle, replication of research needs to be conducted in the same course in Canvas.

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The Moderating Effects of E-learning Experience and Employment Status on Students' Satisfaction and Perceived Learning within an e-Learning Environment

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Abstract

Students' satisfaction and perceived learning outcomes are critical determinants of the effectiveness of a learning system and provide the needed competitive edge at the end of the learning experience. While studies are bound that examined these factors within e-Learning systems in disparate contexts, there are few literatures that investigated the variability within the population based on the e-Learning experiences and the employment status of the students. Therefore, in this study, we developed an integrated model and utilized it to investigate the critical predictive factors (CPFs) that promote students' satisfaction and perceived learning outcome within an e-Learning environment in a developing context, specifically Nigeria. In addition, the study examined the moderating effects of e-Learning experience and employment status on students' satisfaction and perceived learning within the e-Learning system. 267 responses were received from a Google form shared link together with a physically administered questionnaire survey instrument and was analysed using the Partial Least Squares Structural Equation Modelling (PLS-SEM) multigroup analysis technique (MGA). From the 21 Paths evaluated, results show that e-Learning experience and the employment status of the students moderated 11 relationships within the model, thus, confirming the relevant hypotheses, while 10 hypotheses were not supported. The discernment made and the implication for theory and practice for the institutional management of the ODL system in Nigeria were discussed.

Keywords: *e-Learning, Distance Learning, Digital Technologies, Internet, Satisfaction, Perceived Learning*

Introduction

Technology and the internet have become intricately woven and intertwined into the fabrics of society, in particular, institutional managers within the educational sector have come to terms with the realities of technology as a major driver, catalyser, an accelerator and a multiplier of the opportunities within the different facets of the sector. However, these affordances are made possible on account of the growth of the internet and internet technologies. Recognising these immense factors, institutions across the globe are investing in these technologies to multiply and scale-up access and provide opportunities for more citizens to advance their education, hone their skills, and contribute to national economic growth and development (Mtebe, 2020). In addition, the deployment of technology enhances the institutional reputation and increases its coverage, consequently attracting research interests and advancing knowledge and academic development.

These transformations in the distance education spectrum have evolved from paper based correspondence education to modern day electronic Learning (e-Learning) model(Dick, Akbulut, & Matta, 2020). Consequently, disparate pedagogical approaches have emerged, terms such as online learning, hybrid learning. blended learning, virtual learning, e-Learning have continued to dominate the education space. Recently, the Corona virus pandemic (COVID-19) challenge birthed the emergency remote learning model leading to the escalation in the application of e-Learning resources for learning (Aboagye et al., 2020).One common feature of the digital learning models is the centrality of digital technologies as the delivery medium and the eclipse of time, space, and location inhibitions. A situation Moore, (2013) described as the transactional distance which is characterized by the dialogue that happen between the learner and the instructor, or facilitator. A scenario that has significantly shifted the burden of learning on to the students. Researchers such as Moore, Dickson-Deane, & Galyen,(2011) have pointed out the inconsistencies in the conceptualizations of e-Learning.

These researchers argued that stake holders tend to conflate the diverse models in their definitions. In that respect, Tulinayo, Ssentume, and Najjuma, (2018) defined Digital Technologies as a broad range of tools, services and applications in the form of software and hardware that are used to facilitate services and activities through electronic medium. They are used for creating, storing, processing transmitting and displaying information. When deployed for educational/pedagogical purposes they are often referred to as e-Learning resources. Over the years, researchers have variously defined the concepts of e-Learning. For instance, Stefanovic, Nikolic, Drapsin et al., (2011) described e-Learning as learning via internet enabled by digital technology and it is a major phenomenon adopted by institutions to improve the teaching and learning process. In alignment, Hussein, Daoud, Alrabaiah, and Badawi, 2020); Binyamin, Rutter, and Smith, (2020) describes e-Learning as an all-encompassing concept that includes all forms of teaching and learning that occur partially or completely using digital technologies. In this study, we considered the Open and Distance Learning process at the National Open University of Nigeria (NOUN) as an e-Learning given that (90% of the delivery process is conducted online within the integrated learning management system called NOUNiLearn. (www.nounonline.net). Also, because e-Learning success can be measured through multiple perspective and tools (Serdyukov, 2020; Stefanovic et al., 2011;Authors, 2020), we considered students' satisfaction and perception of learning as appropriate measures of the NOUNiLearn system effectiveness. Customer satisfaction is a widely accepted measure of the acceptance of a product in business research and economics. In e-Learning and education by extension, it may be the reflection of the success of the learning experience. Hence, this study considers students' satisfaction and the perceptive fulfilment of their learning expectations as a plausible measure of the effectiveness of NOUNiLearn.

Many factors have been advanced as critical predictive factors of students' satisfaction with the e-Learning system; student factors, instructor factors, interaction factors, motivational factors, quality factors, learning environment, as well as the resources deployed for the learning experience play important roles in students' satisfaction within the e-Learning system (Yunusa & Umar, 2021; Alhabeeb & Rowley, 2018)). Therefore, these factors must be considered to ensure successful learning process within the system (Stefanovic et al., 2011). The National Open University of Nigeria (NOUN) was established in the mode of the Open University UK, Allamal Iqbal Open University Pakistan and many others across the world. However, there is limited empirical evidence on students' perspectives of the effectiveness of the system measured through the lens of students' satisfaction and perceived learning based on their learning experiences. Therefore, this study is pertinent, moreover, as Serdyukov, (2020) asserted, though, e-Learning offers the benefits in terms of access, inclusiveness, and multiplying the spaces for learning, It also harbours some challenges to the students that affects them in different ways that leads to their withdrawal, dropout and poor learning motivation and outcomes (Carr, 2000 as cited in (Aboagye, Yawson, & Appiah, 2020). Serdyukov argues that the e-Learning environment tend to exert some influence on the learners cognitively, behaviourally, and learning expectations. Nonetheless, the need for career advancement, improved skills, and certification among others, has increased the support for online learning among adult citizens in different contexts (Bolliger & Halupa, 2018; Bolliger, & Martindale, 2004; Allen et al., 2016). Therefore, we considered it plausible to measure the effectiveness of the e-Learning platform from the perspectives of the learners' satisfaction with their learning experiences. The study is significant as it provides students' perspectives of the system that might help to improve critical sectors of the system, provide additional empirical grounding on the effectiveness of the e-Learning system in Nigeria and inform effective curriculum design and development within the e-Learning system in Nigerian context.

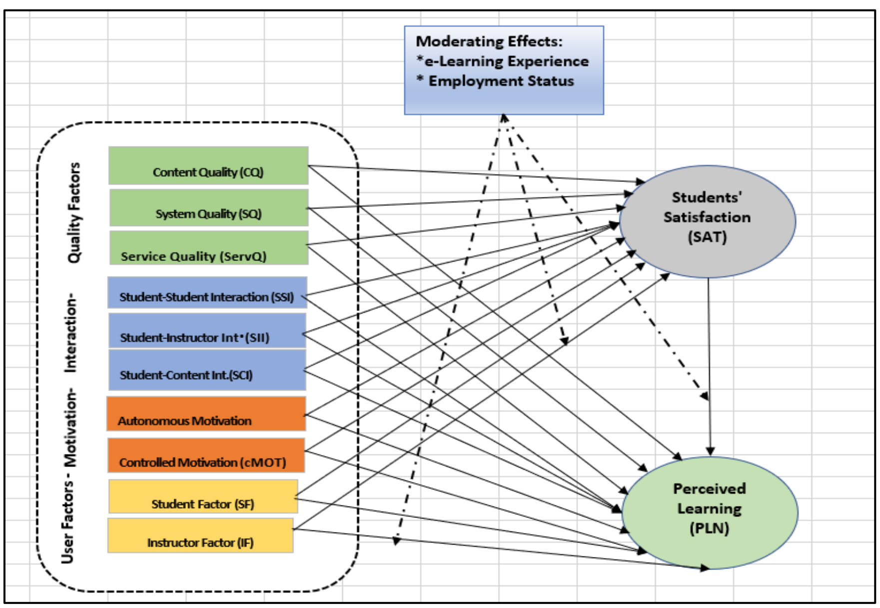

Figure 1. Conceptual Framework of the study

Hypotheses development

Based on review of literature, an integrated framework was conceived, and it comprised of the critical predictive factors (CPFs) of satisfaction and perceived learning (Yunusa & Umar, 2020). As conceptualized in Figure 1. The framework was developed from the quality factors of the DeLone & McLean Information System Success model (D&MISS) (DeLone & McLean, 2003), Theory of Transactional Distance (TTD) (M. G. Moore, 2013), Self-Determination Theory (SDT) (Deci & Ryan, 2015) and the User Characteristics factors (Ozkan & Koseler, 2009; Sun, Tsai, Finger, Chen, & Yeh, 2008) ; Sun et al., 2008). The framework was formed because a single model may not be sufficient to explain the phenomenon under investigation. Hence, since a nomological framework might lead us to the desired study outcome, it is considered plausible. Consequently, demographic variables (e-Learning experience and Employment Status were added to the fray since they improve the explanatory power within the model based on the recommendation by Venkatesh, Morris, & Davis, (2003).We draw on previous studies that adopted the use of integrated models to answer to pertinent e-learning questions and provide better understanding of various concepts such as behavioural intention and continuance intention to use of MOOCs (Zhou, 2016), examination of relationships among students self-determination, technology acceptance, and satisfaction to use MOOCs (Joo, So, & Kim, 2018), willingness to develop sport tourism (Lin, Chen, Tan, Lee, & Yang, 2018), university students level of satisfaction and readiness for e-learning (Topal, 2016), as well as measuring technology acceptance level of teachers (Koral Gümüşoğlu, 2017), studies that were predominantly in the context of developed countries.

The following hypotheses were formulated based on the research objectives.

E-learning Experience Moderating Effects

Researchers; Lu & Chiou, (2010); Yukselturk, (2009) reported conflicting outcomes in their study. While Lu & Chiou (2010) identified job status as a moderating factor in the linkage between system quality and satisfaction, Yukselturk, (2009) could not establish any significant moderating effect of age, gender, educational level and previous online experience on the students' satisfaction with online learning experience. Consequently, more research is required to better understand these phenomena, though, there are argument regarding the justification for including moderation analysis in model formation (Holland, Shore, & Cortina, 2017) . Nonetheless, we hypothesize that:

H1: (a, b, c, d, e, f, g, h, i, j): e-Learning experience moderates the effects of (CQ, SQ, SVQ, cMOT, aMOT, IF, SF, SSI, SII, SCI) on students' satisfaction (SAT) within the e-Learning environment.

H2: (a, b, c, d, e, f, g, h, i, j): e-Learning experience moderates the effects of (CQ, SQ, SVQ, cMOT, aMOT, IF, SF, SSI, SII, SCI) on students' perceived learning (PLN) within the e-Learning environment.

H3: e-Learning experience moderates the effect of students' satisfaction (SAT) with the e-Learning system on perceived learning outcome.

Employment Status Moderating Effects

Over the years, researchers have investigated the effects of demographic factors on e-Learning effectiveness in higher education at different contexts (Islam, Abdul Rahim, Liang, & Momtaz, 2011;).(Tarhini, Hone, & Liu, 2014b; Wang et al., 2009) results show that conflicts exist regarding the moderating effect factors within the system thus, warranting further research in that regard. Islam et al., 2011 reported significant moderating effects of age, program of study, and level of education on e-Learning effectiveness. Against this backdrop, we hypothesize that:

H4: (a, b, c, d, e, f, g, h, i, j): Employment Status moderates the effects of (CQ, SQ, SVQ, cMOT, aMOT, IF, SF, SSI, SII, SCI) on students' satisfaction within the e-Learning environment.

H5: (a, b, c, d, e, f, g, h, i, j): Employment Status moderates the effects of (CQ, SQ, SVQ, cMOT, aMOT, IF, SF, SSI, SII, SCI) on students' satisfaction within the e-Learning environment.

H6: e-Learning experience moderates the effect of students' satisfaction (SAT) with the e-Learning system on perceived learning outcome.

Purpose and Method

The study sought to answer the following research questions:

(i) What are the critical predictive factors of e-Learning satisfaction and perceived learning within the e-Learning environment?

(ii) How do e-Learning experience and Employment Status moderate students' satisfaction and perceived learning within the e-Learning environment?

The study adopted the quantitative research design approach (Clark & Creswell, 2015) A Google form online link was shared on the WhatsApp platforms of the target respondents and the questionnaire was physically administered to gather the data. The respondents are Bachelor of Education undergraduate students who had enrolled in the ODL e-Learning programme for at least four semesters. This category of students was targeted because they have used and garnered enough experience to report on their satisfaction and learning expectations of the system. Researchers have argued that students are better placed to define the effectiveness of the e-Learning environment because they are the target clientele and the most users of the system (Sher, 2009). The survey instrument included questions with items drawn from previous research instruments with established validity and internal consistency reliability. And based on quality factors, interaction, motivation as well as user characteristic factor items. The students are expected to respond to the five-point Likert scale statement (*ranging from 1-Strongly Disagree (SD) to Agree 5-Strongly (SA*) to reflect their perceptions with the e-Learning system predicated upon their prior learning experiences.

Findings and Discussion

Responses were gathered from 285 students whose age range between 18 to 55 years, 64% (n-171) are *male* and 36% (n-96 are *female*). Also,64.4%(n-172) are *employed* while 35.6% (n-95) are *not-employed.* Meanwhile, 85% (n-228) of the respondents have significant e-Learning experience. Consequently, 267 responses were found useable for analysis using the Partial Least Squares Structural Equation Modelling (PLS-SEM). PLS-SEM was chosen because it is widely accepted as a useful tool for investigating causal model relationships (regressions) and moderating effects. PLS-SEM is preferred for its relative advantages over first generation statistical analysis techniques especially been amenable to all kinds of data (normal and non-normal) (Ghasemy, Teeroovengadum, Becker, & Ringle, 2020; Sarstedt & Ringle, 2020). PLS-SEM can simultaneously test the plausibility of an entire collection of propositions of a causal theory, can model multiple independent variables (IVs) and multiple dependent variables (DVs)(Lowry & Gaskin, 2014).

The analysis was conducted using the SmartPLS version 3.2.8 (Ringle, Wende and Becker, 2015) after data cleaning and ensuring that basic statistical assumptions were met. As noted by Trochim, (2006) data analysis encompasses three fundamental steps viz: Data preparation, data description and Hypotheses testing. Thus, based on the recommendations by Hair, Sarstedt, & Ringle, (2019); Sarstedt, Ringle, & Hair, (2017) a two-step approach was followed to determine the convergent validity and the composite reliability indices as quality criteria, while the discriminant validity and collinearity issues were also assessed followed by the structural model analysis to test for relationships. The results for the path coefficients and differences in terms of Employment status and e-Learning experience between the groups is presented in Tables 1 and 2.`

Table 1: Significant values for the moderating effects of e-Learning experience

Relationship	Beta value More experience -Less experience	t-value More experience -Less experience	p-value More experience vs Less experience
CQ → PLGN	0.697	3.053	0.001
CQ → SAT	-0.439	3.469	0.000
IF → PLGN	-0.284	0.970	0.167
IF → SAT	0.932	6.684	0.000
SAT → PLGN	-0.204	0.880	0.190
SCI → PLGN	0.399	2.374	0.010
SCI → SAT	0.037	0.264	0.396
SF → PLGN	0.735	4.168	0.000
SF → SAT	-0.334	2.673	0.004
SII → PLGN	0.275	1.418	0.079
SII → SAT	-0.286	2.715	0.004
SQ → PLGN	-0.563	3.241	0.001
SQ → SAT	0.366	3.492	0.000
SSI → PLGN	-0.269	1.223	0.112
SSI → SAT	-0.268	2.257	0.013
SVQ → PLGN	-0.234	0.986	0.163
SVQ → SAT	-0.038	0.320	0.375
aMOT → PLGN	-0.712	3.846	0.000
aMOT → SAT	-0.142	1.140	0.128
cMOT → PLGN	0.487	4.501	0.000
cMOT → SAT	-0.134	1.898	0.030

Key:CQ: content quality; SQ: system quality, SVQ:service quality, IF: instructor factor. SF: student factor, aMOT:autonomous motivation, cMOT: controlled motivation, SII:student-instructor interaction, SSI:student-student interaction; SCI: student-content interaction.

Table 1 shows the summary of the moderating effects (path coefficient differences) of e-Learning experience among the relationships within the model. There were significant moderating effects of e-Learning experience in 13 of the 21 linkages with six skewed towards the more experienced students thus, supporting the hypotheses in the following paths/linkages: (CQ→PLGN:β-diff=0.697,p<.005);(IF→SAT:β-diff=0.932,p<0.00);(SCI→PLGN:β-diff=0.399, p < 0.010); (SF→PLGN:β-dif= 0.0.735; p<0.00); (SQ→SAT: β-diff=0.932, p< 0.00) and (cMOT→ PLGN: β-diff = 0.487; p < 0.00). On the other hand, the moderating effects of e-Learning experience was stronger among less experienced students in the following paths (CQ→SAT: β-diff= -0.286, p= 0.004); (SF→SAT: β-diff=-0.334,p=0.004); (SSI→SAT: β-diff=-0.268,p=0.13); (SII→SAT:β-diff=-0.286,p=0.004); (SQ→PLGN:β-diff=-0.563,p=0.00); (aMOT→PLGN: β-diff=-0.712, p=0.00); (cMOT→SAT: β-diff=-0.134,p=0.34).

These results suggest that in terms of motivation more experienced students appreciate the role of controlled motivation more importantly. Also, that low experienced students placed more importance on the contents than the technology. This may be ascribed to the maturity of more experienced students and longevity of system usage. It may be deduced that the more experienced students appreciate more the roles of the instructor, the efficiency of the technology, the quality of the materials and interaction with course mates as important factors in e-Learning environments.

Additionally, results align with the assertion by Stoel and Hye Lee (2003) regarding the significance of longevity of usage to increased appreciation of ease of use and positive attitude to technology. Therefore, more attention should be given to the new users of the system to help them in actualizing their expectations of the e-Learning environment. More studies are required to better understand the role of e-Learning experience in students' satisfaction.

Table 2: Results for the significant moderating effects of employment status

Relationships	Beta value diff Employed – Not Employed	t-value Employed vs Not Employed	p-value Employed vs Not Employed
CQ →PLGN	0.320	2.217	0.014
CQ → SAT	0.139	0.735	0.232
IF → PLGN	0.259	1.196	0.117
IF →SAT	-0.145	0.432	0.333
SAT → PLGN	-0.978	5.115	0.000
SCI → PLGN	-0.025	0.158	0.437
SCI →SAT	-0.453	2.089	0.020
SF →PLGN	-0.243	1.456	0.074
SF →SAT	1.120	4.554	0.000
SII → PLGN	-0.750	2.838	0.003
SII → SAT	1.127	2.569	0.006
SQ →PLGN	-0.102	0.572	0.284
SQ → SAT	-0.532	1.968	0.026
SSI → PLGN	0.279	1.603	0.056
SSI → SAT	-0.177	0.705	0.241
SVQ → PLGN	0.052	0.303	0.381
SVQ → SAT	-0.124	0.442	0.330
aMOT →PLGN	0.481	2.538	0.006
aMOT → SAT	-0.116	0.575	0.283
cMOT→PLGN	0.260	1.870	0.032
cMOT → SAT	-0.189	0.970	0.167

Key: CQ: content quality; SQ: system quality, SVQ: service quality, IF: instructor factor. SF: student factor, aMOT: autonomous motivation, cMOT: controlled motivation, SII: student-instructor interaction, SSI: student-student interaction; SCI: student-content interaction.

From Table 2: It can be seen that there were significant moderating effects of employment status with *the employed students* recording higher path coefficients in the paths: (CQ→PLGN: β-diff= 0.32, p= 0.014); (SF→SAT: β-diff= 1.120, p< 0.000); (SII→SAT: β-diff= 1.127, p= 0.006); aMOT→PLGN: β-diff= 0.481, p= 0.006); and cMOT→PLGN: β-diff= 0.260, p= 0.032).There were also significantly negative moderating effects of employment status in the paths: (SAT→PLGN: β-diff=-0.978, p< 0.000); (SCI→SAT: β-diff=-0.453, p=0.020); (SII→PLGN: β-diff=-0.750, p= 0.003); (SQ→SAT: β-diff=-0.532, p=0.026). These results suggest that the "Not employed students" had a more significant perception of the system within those relationships. And employment students failed to moderate students' perceived quality towards e-learning satisfaction. The findings paralleled the study by Yuselturk (2009) but conflicted that by Lu and Chiou (2010) who reported job status as a moderating factor in interface friendliness and e-learning satisfaction. Based on the findings, it may be concluded that the universality of the e-Learning environment was emphasised in the study as a system that is open to diverse form of learners. Whether experienced, in-experienced, employed, or un-employed.

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Understanding students' pre-existing computational thinking skills and its relationship with their block programming performance

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computational thinking, block programming, prior experience, learner analysis

Introduction

Computational thinking (CT) skills have been specified in many state standards of computer science (CS) education (*Promote computer science*, 2019). They are a set of skills utilizing abstraction, algorithmic thinking, decomposition, pattern generalization, and evaluation to solve problems (Selby & Woollard, 2013). Educators and researchers have proposed that CT is not only used in CS-related fields but also frequently applied in other areas even in our daily lives (Barr et al., 2011; Wing, 2006, 2011).

As a result, investigations have been conducted in recent years regarding CT skill development without computers. Researchers deployed non-programming activities in K-12 classrooms (Ballard & Haroldson, 2021; Lambert & Guiffre, 2009; Thomas et al., 2019). Those activities include games, simulations, picture book reading, or story creation. Results of those studies showed a significant improvement of students' CS/CT skills, especially their basic coding skills, such as the definition of variables and use of simple loops and conditionals (Ballard & Haroldson, 2021; Grover et al., 2019; Lambert & Guiffre, 2009).

These findings not only supported the efficacy of non-programming activities in improving young students' CT skills but also encouraged us to further explore young students' development of CT skills prior to coding or robotics programs.

This study was a part of the learner analysis in the design of a robotics program. In this study, we examined the CT skills of middle school students from an underrepresented minority group. Our research questions were: 1) did the students' CT skills in solving gaming problems predict their performance of block programming? 2) What other factors, such as gender and prior coding or robotics learning experiences, contributed to students' performance of block programming?

Methods

Participants

Forty-eight students from three classes at a local middle school participated in this study. A convenient sampling method was used as the participating students were from the classes where the instructors collaborated with the authors in the robotics program. 42% were girls, and 56% were boys. 81% self-identified themselves as African Americans. 4% were Latinos and Caucasian, respectively. 67% were in Grade 8, and the rest were from Grade 7.

Instrument

We collected and analyzed data from a survey and a quiz, which were delivered at one time in a class session. The survey included questions asking students demographic information. The quiz included 16 questions from the CTt instrument validated by Román-González et al. (Román-González et al., 2016; Román-González et al., 2018). Among them, eight measured students' algorithmic thinking and pattern recognition skills in gaming problems, and 8 measured the same skills in block programming problems. Students had 40 minutes to complete the survey and quiz.

Analysis & Results

We conducted a multiple regression to identify the predictability of students' CT skills in solving non-programming problems, their prior coding and robotics learning experiences, and their gender on their CT skills in solving block programming problems.

The dependent variable was students' CT skills in solving block programming problems. It was the average of 8 quiz questions measuring CT skills in solving block programming programs. Students' CT skills in solving non-programming problems, their prior coding and robotics learning experiences, and their gender were the predictors. Among them, students' CT skills in solving non-programming problems were the average of 8 quiz questions measuring students' CT skills in solving non-programming problems. Students' prior coding and robotics experiences were dummy coded, with 1 meaning Yes and 0 meaning No. Students' gender was coded as 1 being boys and 2 being girls. Results of the descriptive statistics of these variables are shown in Table 1.

Table 1.
Descriptive Statistics

	Mean	*SD*	*N*
CT in Block Programming Problems	1.11	1.14	48
CT in Non-programming Problems	2.57	1.14	48
Prior Programming Experience	.17	.38	48
Prior Robotics Experience	.17	.38	48
Gender	.65	.48	48

Results of the multiple regression showed that students' CT skills in solving non-programming problems and their prior robotics learning experience significantly predicted and explained 44% variation of their CT skills in solving block programming problems ($F(4,43)=8.52$, $p<.01$).

$$CT_{block\text{-}programming}=.45*CT_{non\text{-}programming}+.91*Experience_{robotics}$$

We did not find a significant impact of students' prior programming experience and gender on their CT skills in solving block programming problems.

Discussions

Results of our study showed a significant relationship between students' CT skills in solving gaming and block programming problems. From the instructional design perspective, it supports the use of non-programming methods to improve students' CT skills. At the same time, it suggests that students may have developed some CT skills prior to any coding or robotics programs. Those skills may be developed from their interactions with real-world problems or in prior learning experiences. Therefore, it will benefit students' understanding of coding if we activate their prior knowledge and skills and use the real work examples or their prior knowledge to explain the coding algorithms.

We also found that students' prior robotics learning experience had a significant impact on their CT skills in solving block-programming experiences, but their prior programming learning experience did not. We think it may be because robotics provides tangible and visual aids for students at young ages to develop an abstract understanding of CT skills. However, studies with a large sample size are needed to verify this finding.

African American students have been reported as underrepresented in secondary CS education (Code.org, 2020). In addition, the gender disparity within the underrepresented minority group was found to aggravate this inequity (*Current perspectives and continuing challenges in cs education for u.S. K-12 schools 2020 report*, 2020). Results of our post-hoc analysis did not show a gender difference in students' CT skills in solving gaming problems when their prior robotics learning experience was taken into account. It could be because only boys were found to have prior robotics experiences. This finding endorses the results in the national report. In addition, it underscores the necessity to broaden participation for underrepresented minority students, especially the female students from that group. We suggest future studies consider the impact of students' prior experiences when examining the gender difference.

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Analysis of Data-based Learner Characteristics – Taking Fourth-grade Students in a Certain School as an Example

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Abstract: With the development of education information, a new round of scientific and technological changes and challenges have set new goals for talent cultivation and education innovation and put forward new requirements for the analysis of learners' characteristics. The use of user portrait technology in education can help teachers to keep pace with the development of learners and provides a way to promote the future development of students' learning. And data collected by electronic schoolbags in real time make data-based analysis feasible. This paper mainly uses data-based learning analysis method to analyze and mine the data of a fourth-grade elementary school. Firstly, the pre-processed data is descriptively tested to see if it conforms to the normal distribution. After that, the student's grades are standardized and clustered. Secondly, the processed data is used to map the student's comprehensive situation radar map. Based on the results of radar map and cluster analysis, targeted suggestions are put forward for learning and teaching. This study provides a reference model and a new thinking dimension for data-based learner feature analysis and the research results have theoretical value and practical significance.
Keywords: Analysis of learner characteristics; User portrait; Electronic schoolbag

1 Introduction

Since the 21st century, education information reform has been unanimously recognized in the education field. Subsequently, the "Bring Your Own Device (BYOD)" campaign, which allows every student to obtain and use a mobile device, began to be promoted (Liu Bin et al., 2016). Through these portable mobile devices, students can read various electronic textbooks and online courses and other resources needed for learning, which is conducive to the development of one-to-one digital learning. The electronic schoolbag is a new technological product born with the development of science and technology since the 21st century. E-schoolbags have been experimenting in the field of foreign education a long time ago. However, for various reasons, the development of e-schoolbags in China has not kept pace with foreign countries and started late (Tong Hui et al., 2016). It was not until 2013 that e-schoolbags finally started to be tested in China (Wang Yujie, 2018). At present, due to the characteristics of the e-schoolbag itself, its scope of application is not wide. E-bookbag trials have been conducted almost only in schools and areas with better educational resources and higher quality of teaching. The electronic schoolbag uses an electronic terminal to integrate the students' books. It can change the traditional classroom format, not only the carrier of teaching, but also the teaching model to a certain extent (Fan Minsheng et al., 2017). Electronic schoolbags are an important means of communicating traditional school education and education informatization. It creates conditions for the collection of learner data, which in turn provides strong support for the development of data-based learning analysis (Zheng Liqing, 2014).

This research is mainly devoted to the analysis of learner characteristics based on data, and at the same time, it provides a reference model and some new thinking dimensions for the analysis of learner characteristics based on data in the background of information technology. Therefore, this research uses a series of data from e-schoolbags to analyze the characteristics of learners and make suggestions.

2 Literature Review

2.1 Learning Analysis

As an emerging field of learning analysis, its development is closely related to information technology and educational intelligence. Learning analysis uses data and models to predict the future state of learners and discover potential problems through analysis (Liu Qingtang et al., 2017). Learning analysis reports can help to better understand learners' learning styles, learning habits, and cognitive structure, and other information, so it helps teachers to prescribe the right medicine and develop personalized learning plans for students (He Kekang, 2016). In addition, through learning analysis, a comprehensive observation and recording of the entire learning process of learners can be used to grasp the learning situation of students in real time, which can help teachers make timely adjustments to their own teaching plans and teaching strategies. Nowadays, to measure, collect and analyze learners and learning environment, and get corresponding reports, and then use these reports to optimize the learning process of learners and the learning environment in which they are located. It is a technology for learning analysis. Accepted definition (Wu Yonghe et al., 2013; Siemens, 2011).

Learning analysis has attracted the attention of domestic scholars since the Horizon Report released in 2011. Gu Xiaoqing and others define learning analysis as: using different analysis methods and data models to explain the data related to learner information, and then explore the learning process and laws of learners; or interpret learners' learning performance based on data and provide them with corresponding feedback Thereby promoting more effective learning (Gu Xiaoqing et al., 2012). Learning analysis is based on the massive omni-directional data generated by students in the learning process to carry out data analysis and mining, using visual means to present the results of data analysis and mining, and then teachers and teaching administrators can carry out data analysis and mining based on the obtained predictive model The prediction of students' various learning behaviors. In this way, it is helpful to find risk learners and intervene in time. In addition, it can also push personalized learning resources and design personalized learning paths for students. Therefore, learning analysis can be regarded as achieving teaching students in accordance with their aptitude. Technical support for the purpose.

2.2 Learner Characteristics Analysis

The new round of technological changes and challenges has put forward new goals for talent training and educational innovation and has also put forward new requirements for the analysis of learner characteristics. "Taking the learner as the center" is a major purpose of the new situation classroom under the guidance of current constructivism (Yu Jiajun, 2015). Compared with the traditional classroom, the role of teacher and student are changed, so that the learner can change from a passive position to an active position and become a meaning builder. At the same time, teachers have also changed their previous roles, becoming instructors and facilitators of learning. Therefore, students are extremely important for the ability to clearly understand their own original cognitive structure and to actively construct the meaning of relevant knowledge based on their own experience. Learner analysis has become an important part of it. Based on this background, many scholars and researchers have conducted in-depth explorations on learning analysis in the new educational information environment (Xu Qi et al., 2021; Chen Changsheng et al., 2020; Sabine Seufert et al., 2019). With the development of the education field, the content and dimensions of learning analysis are also constantly changing. On online learning platforms (such as the MOOC platform), thanks to the comprehensiveness and convenience of platform data acquisition, many meaningful research results have emerged, which has promoted the development of these platforms. However, due to the inconvenience of the acquisition and collection of offline course data, there are still problems in applying similar learning analysis techniques to traditional classrooms (Huang Qin, 2017).

Data mining on the acquired education data through learning analysis technology can provide strong support for the development of education and teaching. Learning analysis can cover the entire process from diagnostic evaluation to formative evaluation to summative evaluation, providing powerful support for schools, teachers, students, and parents to learn about teaching, learning, and results, thereby providing guidance for promoting learning and improving performance. Therefore, how to use the existing experience in traditional school education to carry out the analysis of learning that meets the new requirements of today, to promote the development of classroom education, is a problem worthy of consideration and exploration.

2.3 Learner Portrait

As far as the current situation is concerned, at the practical level of the education field, the big data user profile technology has not been tested in the true sense (Xu Yan, 2017). Learner portrait is the multi-dimensional quantification of learner's internal or external characteristics. It is an abstract student model obtained based on data analysis and mining. Learner portraits outline the image of learners through the modeling of related data, restore students' various characteristics, motivation levels and other potential attributes, and then understand learners' behavioral tendencies and needs, and derive learning laws hidden in many learners. Carrying out the analysis of learner characteristics in different dimensions for different learning scenarios can improve the design of learning platform, improve the learning recommendation system and teaching strategies (Xiao Jun et at., 2019). Most of the foreign researchers carry out research by dividing the roles of learners by certain characteristics, which include learners' learning motivation, cognitive level, and learning attitude. Scholars such as Wataru Takahashi provide corresponding services to different learners based on the motivation composition, self-efficacy cycle, and service incentive effects of different roles. Takahashi et al., 2014). Foreign scholars have also conducted in-depth research on how to build learner portraits. The goal of establishing a learner's profile is to focus on the implementation of learning needs, motivations, preferences, etc., and present the main characteristics of learners. Scholars such as Debbie Holley divide students into different risk levels, predict the learners' use of risk models, and then implement corresponding interventions. Therefore, accurately describing learning ability, providing guidance for teachers to carry out teaching, and promoting the improvement of professional skills are the important values of establishing learner profile.

With the continuous in-depth development of the concept of learner portraits, domestic scholars have gradually begun corresponding research. Through research, some scholars believe that the establishment of learner profile in a ubiquitous learning environment is an important part of the design of MOOC resources, and the evaluation of learning effects can also be achieved through learner profile (Wang Xiaofang et al., 2019). The significance of learner profile technology in personalized teaching has also been confirmed by many empirical studies conducted by domestic scholars based on experiments (Chen Haijian et al., 2017; Tang Yewei et al., 2019).

In summary, as the application of user portrait technology in education, learner portrait technology plays an important role. The learner profile technology can not only make precise positioning according to the different characteristics of learners, but also can be further used in the optimization link of teaching design to provide targeted support for learning, to better serve personalized learning. However, at present, the research on learner profile technology still focuses on how to build models and how to apply them, and there has not been an overall description of the process of learner profile building.

3 Method

3.1 Research Path

In this research, EXCEL, RStudio, and SPSS are used to model with learner characteristics analysis method based on data. First, the obtained student performance data is standardized, and then various indicators are used for cluster analysis. Then, the standardized student performance is non-linearly transformed, and a radar chart is drawn based on the standardized student performance, and the radar chart is used to perform a single Analysis of student performance to promote the overall development of students.

3.2 Data Sources

A certain elementary school aims to promote the application of information technology in education and has carried out a long period of in-depth exploration in the use of electronic schoolbags to carry out teaching. The "electronic schoolbag" used by the fourth-grade students in this elementary school has many special functions, which can enhance classroom interaction and produce better teaching results. The emergence of electronic schoolbags has created conditions for the development of data-based learning analysis in school education, and the use of electronic schoolbags in the fourth grade of a primary school is providing a good case study for data-based learning analysis in school education. Thus, this research started. The daily teaching activities in the fourth grade of a primary school are basically carried out using electronic schoolbags. Through the electronic schoolbag, teachers use the online course platform to present teaching content, collect teaching materials, interact with students, publish assignments, and test information, and carry out evaluation activities; students use the online course platform to conduct group interactive discussions, communicate with teachers, and obtain teaching Activities such as content, completion of homework and quizzes. In this process, a large amount of student data was generated. These data include student PAD usage, classroom interaction, evaluation activities, evaluation results statistics, knowledge mastery, statistics on the number of teacher lectures, etc. Among them, some data about the evaluation activities are incompletely recorded, students' knowledge mastery in some time periods, and individual student data are missing.

The data selected in this study comes from the data in an electronic schoolbag used by 29 fourth-grade students in a primary school. The daily teaching tasks of this elementary school are basically carried out through electronic schoolbags. It can be considered that the acquired electronic schoolbag data is a good and comprehensive record of the situation of the fourth-grade students in a certain elementary school.

3.3 Data Processing

3.3.1 Standard Score

The standard score is a relative status measure, which is derived based on the original score. The standard score can represent the relative position of the original score in all the scores in which it is located. The standard score is based on the standard deviation of a group of scores, and the average of the number of components is used as a reference. It can show that the original score is several standard deviations away from the overall average in the whole, and then it reflects the relative position of this original score in the overall data. Compared with the original score, the standard score can more intuitively reflect the meaning of the obtained data. The standard score can reflect the position of the student in the overall. As a result, the same standard score can still be regarded as equivalent even if the test is different. This also provides a method for visually comparing scores in different test contexts. From this, after converting the learner's raw scores into standard scores, it will be more comparable, especially in different times, different subjects, and different types of tests. It will be more reasonable and fairer to use standardized student scores in learner analysis.

3.3.2 Cluster Analysis

Cluster analysis is a process of classifying and combining individual abstract individuals in a whole and combining individuals with similar characteristics to form classes. Cluster analysis is an important analysis method. The clustering effect depends on two factors: the method of measuring the distance and the clustering algorithm. K-means clustering algorithm is a commonly used method of clustering analysis. Its approach can be expressed as selecting K initial centroids at the beginning. The so-called centroid is the average vector of all observations in a class. The initial centroid can be selected randomly, each centroid is a class, then each observation is assigned to the centroid closest to it, and a new class is formed with the centroid, and finally the centroid of each class is recalculated and repeated until the centroid does not occur. When changing or reaching the maximum number of iterations. This research mainly uses K-means clustering algorithm to analyze student data.

3.3.3 Non-linear transformation

The student's standard score z obtained after conversion is a standard normal distribution N(1, 0). In order to facilitate the use of the obtained standard scores in subsequent analysis, non-linear conversion processing is performed on them.

The nonlinear conversion formula used is $z' = \frac{1}{\pi}\tan^{-1} z + 0.5$.

The transformation has the following characteristics:

(1) Convert the infinite interval from negative infinity to positive infinity into a finite interval from 0 to 1;

(2) Convert the original average value of the standard score (z) from 0 to an average value of 0.5;

(3) The function obtained after transformation has good linearity near the average value, and the more it deviates from the average value, the stronger its compressibility.

3.3.4 Radar chart

The radar chart is a graphical method of displaying multivariate data in the form of a two-dimensional chart of three or more variables on an axis starting from the same point. The radar chart is composed of a series of equidistant concentric circles. Each of the concentric circles corresponds to a different value, the closer to the center of the circle, the smaller the value, and the greater the deviation from the center of the circle, the larger the value. The evaluation index of the radar chart is represented by multiple axes drawn from the center of the circle. The value corresponding to each index obtained is processed and marked on the index axis according to a certain ratio, and then the marked points obtained by these marks are aligned. If you are connected to each other, you can get a radar chart that reflects each evaluation index of the sampled book.Radar chart plays a very good role in both qualitative analysis and quantitative analysis.

4 Results

4.1 Overall Characteristic of Learners

Use SPSS to explore the PAD use time and reading time in the obtained student data, and judge whether it obeys the normal distribution. The results are shown in Table 1. The absolute values of the skewness coefficient and kurtosis coefficient of the two indicators are both less than 1, which can be regarded as approximately obeying a normal distribution.

Table 1. Statistical results of PAD use time and Reading time

		Statistics		Standard Error	
		PAD use time	**Reading time**	**PAD use time**	**Reading time**
Mean		1157.497	39.735	131.4139	6.2917
95% confidence interval of the mean	Lower limit	889.114	26.886		
	Upper limit	1425.880	52.585		
5% trimmed mean		1109.367	37.654		
Median		827.000	28.000		
Variance		535358.163	1227.140		
Standard deviation		731.6817	35.0306		
Minimum		340.0	2.4		
Maximum		2889.7	115.6		
Scope		2549.7	113.2		
Interquartile range		1061.0	59.5		
Skewness		.894	.904	.421	.421
Kurtosis		-.156	-.478	.821	.821

After sorting out the obtained student's original scores, select the entire class of students in a certain test, and standardize the student scores in the following way.

(1) Obtain the scores of n students in the test in order of x_1, $x_2 ... x_n$, calculate the average score of the whole class of students who participated in the test μ: $\mu = \frac{\sum_{i=0}^{n} x_i}{n}$;

(2) Calculate the standard deviation σ of the obtained scores of n students in the test: $\sigma = \sqrt{\frac{\sum_1^n (x_i-\mu)^2}{n}}$;

(3) According to the standard score conversion formula, the original scores obtained by each student in the test are converted into standard scores for easy comparison by calculation. The formula is $z = \frac{x-\mu}{\sigma}$.

Some of the final processing results are shown in Table 2.

Table 2. Standardization

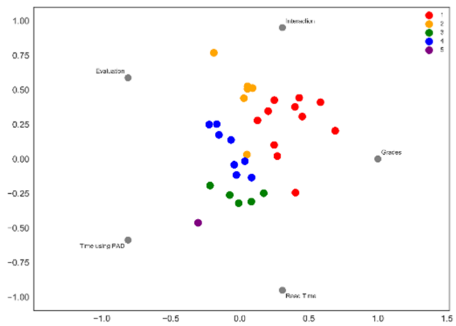
Student	Chinese	Math	English
Chen	0.104	0.482	-0.009
Dai	0.297	-0.184	-0.460
Du	0.406	0.251	0.298
Feng1	-0.445	0.372	0.138
Zhang3	0.288	0.149	0.298

Standardize students' classroom performance, teacher evaluation, pad use time, and reading time data. Select five indicators: performance indicators, evaluation indicators, interaction indicators, PAD use time, and reading time, and use SPSS to perform cluster analysis. It is divided into 5 categories, Table 3 shows the cluster analysis results.

Table 3. Cluster center

	Cluster				
	1	**2**	**3**	**4**	**5**
performance	.1212	-.1421	-.0464	.1117	-.2021
interaction	-.0923	.0337	-.1015	.1630	-.4146
evaluation	-.1005	.1645	-.1369	.1143	-.4125
PAD use time	-.2390	-.2416	.1967	.2334	.2457
reading time	-.1174	-.1465	.2163	-.0561	-.1798

RadViz radar chart can complete multi-dimensional data visualization tasks and is suitable for visualization of cluster analysis results. It is based on the basic spring pressure minimization algorithm often used in complex network analysis. The spring algorithm puts a series of nodes in the same plane, and then assumes that each data set uses a spring to connect to each node. Therefore, these nodes will move due to the existence of springs and stop when all the elastic potential energy of the entire system reaches a minimum. In the RadViz radar chart, different



colors are used to identify different classes. Figure 1 shows the drawing result.

Figure1. RadViz radar chart

The first category of cluster analysis results contains 11 students. These 11 students have good performance in performance indicators, but most of them do not perform well in classroom interaction, teacher evaluation, PAD use time and reading time indicators. Through analysis, we can clearly know that they are all able to achieve good results, but they do not tend to use PAD as a learning tool and prefer traditional book learning, nor do they like to interact with teachers in the classroom. From a long-term perspective, although such students can better complete their academic tasks through independent learning, they should still interact and communicate more with teachers, to help them discover new problems in their communication with teachers. At the same time, even if such students use less e-bookbags, they can still achieve better results. Teachers can still guide these students to use modern tools to help them learn, so that students can realize the power of the new learning tool of e-bookbags. The convenience provided for their study.

The second category of cluster analysis results includes 6 students. These 6 students have good performance in classroom interaction and teacher evaluation indicators, but most of them do not perform well in performance indicators, PAD use time and reading time indicators. This shows that although they actively participate in the interaction in the classroom, they can also get good evaluations from the teachers in the classroom, but they still cannot achieve satisfactory results. This kind of students are also more common in the classroom. Although they are active in the classroom, they may not get a good grade due to inappropriate learning methods and methods. Therefore, helping such students find a learning method that suits them is one of the key points to improve their academic performance. In addition, teachers can also consider starting from the use of PAD and consider whether these students are unable to achieve the expected results compared with other students, whether it is because they did not maximize the help effect of e-schoolbags on learning. Correct guidance to improve student performance.

The third category of cluster analysis results includes 5 students. These 5 students have outstanding performance in PAD use time and reading time indicators, but most of their performance indicators, classroom interaction indicators and teacher evaluation indicators are not optimistic. For such students, it should be considered whether they have not properly played the role of PAD, an e-schoolbag. When these students use e-schoolbags, they are likely to use it as an entertainment tool and fail to achieve the purpose of e-schoolbags to help and promote learning. These students should be guided in a timely manner, and they should be guided to use e-schoolbags to help their learning, instead of using them as a novel pastime and play tool. The real significance of introducing e-schoolbags is to use the value of e-schoolbags.

The fourth category of cluster analysis results contains 8 students, these 8 students have a good performance in other aspects except for the lower PAD reading time indicator. This shows that these 8 students can better promote their own learning through the interaction with the teacher in the classroom, can also get a better evaluation from the teacher, and can also use the electronic schoolbag to complete the learning task better. In addition, these 8 students can consider using e-bookbags to read more, study textbooks, content outside the classroom, enrich their knowledge content, and achieve better performance.

The fifth category of cluster analysis results includes 1 student. This student has outstanding performance on the PAD usage time indicator, but the performance on other indicators is not optimistic. This student is like the 5 students in the third category, and it should be determined in a timely manner whether he has correctly played the role of the e-schoolbag and actively guided.

From the above analysis, different students have different attitudes and situations towards learning with electronic schoolbags. However, it is not difficult to find from the results that the current students' acceptance and use of e-schoolbags need to be improved, and e-schoolbags still do not fully exert their value in helping to learn to a certain extent.

Through cluster analysis, 31 students are divided into 5 categories according to the five dimensions of performance indicators, evaluation indicators, interaction indicators, PAD usage indicators, and PAD reading time indicators, which helps to intuitively and clearly grasp the various Dimensional performance, and promptly discover possible problems in the learning process of students, so as to help teachers to carry out personalized teaching and prescribe the right medicine, so as to guide students to better aspects and promote the overall development of students. In addition, clustering analysis based on data can not only improve the efficiency of teachers in understanding the situation of students, but also more scientifically obtain the situation of students from the observation and feeling of teachers in traditional classroom teaching and has a good guidance for the development of teaching. significance.

4.2 Individual Characteristic of Learners

Table 4 shows some of the processing result after non-linear transformation.

Table 4. Processing result after non-linear transformation

Student	Chinese	Math	English
Chen	0.533	0.643	0.497
Dai	0.592	0.442	0.363
Du	0.623	0.578	0.592
Feng1	0.367	0.613	0.544
Dai	0.589	0.547	0.592

Do the same processing with the obtained data of student classroom performance, teacher evaluation, pad use time, and reading time, and select indicators Chinese score, Chinese evaluation, Chinese interaction, math score, math evaluation, math interaction, English score, English evaluation, English interaction, PAD use time, reading time 11 indicators, use RStudio to draw a radar chart.

When drawing, convert the 11 selected indicators into 11 corresponding dimensions in the radar chart. According to the results of data processing, the more the indicator point deviates from the central origin, the better the student's performance on the indicator. From the perspective of the area of the closed figure enclosed by each indicator point of the radar chart, if the area of the closed figure is larger, the overall situation of the students is better.

4.2.1 Case Study 1

Figure 2 is a radar chart of Zhang's comprehensive situation. From the figure, we can see that Zhang's mathematics performance indicators, mathematics evaluation indicators, English performance indicators, English interaction indicators, and PAD use time indicators are all close to the maximum value of the class. Reading time indicators, language interaction indicators, and English evaluation indicators It is higher than the average of the whole class, the Chinese performance index and the Chinese evaluation index are close to the average of the whole class, and the mathematics interaction index is lower than the average of the whole class.

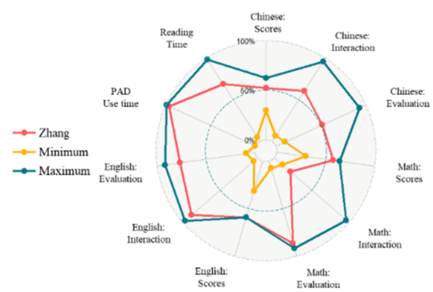


Figure2. RadViz radar chart of Zhang's comprehensive situation

(1) Teaching interaction. By observing the three interactive indicators of Zhang's Chinese, Mathematics, and English, we can find that Zhang can interact well with teachers in Chinese and English classes, but he did not interact with teachers to a similar degree in math class. This shows that in terms of teaching interaction, Zhang's situation is better, but he still needs to pay attention to his interaction in the mathematics class and find the reasons for his low mathematics interaction indicators, such as the tendency to teaching methods.

(2) Technical application. From the two technical application indicators of Zhang (PAD use time and reading situation), we can find that Zhang's PAD use time indicator is close to the highest value of the class, and his reading time indicator is also higher than the average of the class. This shows that Student Zhang can use the electronic schoolbag to study well and complete the tasks assigned by the teacher.

(3) Subject analysis. From the radar chart of Zhang's comprehensive situation, we can find that Zhang's English scores and math scores are close to the highest value in the class, indicating that Zhang has a good performance in these two subjects. In contrast, Zhang's Chinese performance is a bit weak, and his Chinese performance indicators are only close to the average Chinese performance of the whole class. As a Chinese teacher, he should pay more attention to its internal reasons, such as whether the learning method is inappropriate, the learner Zhang himself can also improve his language performance through self-reflection.

(4) Teacher evaluation. Among the three teacher evaluation indicators of Zhang, the mathematics evaluation index tends to be the highest in the class, and the English evaluation index is also higher than the average of the class, indicating that Zhang can be highly recognized by the teachers in these two subjects. However, Zhang's language evaluation index is only near the average of the class. Based on the analysis of Zhang's language performance indicators and language interaction indicators above, there is still a lot of room for improvement in Zhang's performance in language subjects.

4.2.2 Case Study 2

Figure 3 is a radar chart of Teng's comprehensive situation. From the radar chart, we can understand that Teng’s PAD usage time and English performance indicators tend to be the highest in the class. In addition, Teng’s Chinese performance indicators, language interaction indicators, language evaluation indicators, and mathematics scores the indicators, mathematical interaction indicators, mathematics evaluation indicators, English interaction indicators, English evaluation indicators and PAD reading time indicators all reach the average of the class or even tend to the lowest value of the class.

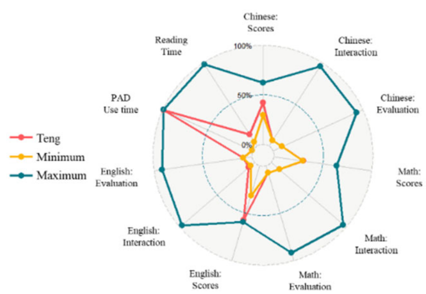


Figure3. RadViz radar chart of Teng's comprehensive situation

(1) Teaching interaction. Observing and analyzing the interactive indicators of Teng's three subjects, it can be found that these three interactive indicators of Teng are close to the lowest value of the whole class. From this we can infer that student Teng does not like to participate in learning by interacting with teachers in class. In this regard, teachers may consider guiding Teng. When considering Teng, it is for reasons of character to guide him to participate more actively in the classroom.

(2) Technical application. From the use of Teng’s PAD and reading time indicators, we can find that Teng’s PAD is used more frequently, and it is understood that most of Teng’s other indicators are basically the lowest in the class, indicating that Teng Although students often use the electronic schoolbag as a tool, they may not give full play to the value and function of the electronic schoolbag. Based on this problem, the teacher should provide timely guidance to achieve the purpose of the electronic schoolbag to promote learning.

(3) Subject analysis. Observing Teng's Chinese, math, and English performance indicators, we can find that, except for the English performance indicators tending to the highest value of the class, the other two indicators are close to the lowest value of the class. This shows that Teng can achieve good results in English subjects, but his performance in Chinese and mathematics subjects is not good. This may be due to Teng's preference for English subjects. In this regard, teachers should start from the perspective of the content of each subject to help Teng understand the meaning of each subject to himself, to stimulate Teng's inner motivation for learning other subjects and promote the overall development of his various subjects.

(4) Teacher evaluation. Analyzing the teacher evaluation indicators of Teng in the three subjects of Chinese, mathematics, and English, we can find that Teng has not been able to get a good evaluation of the teachers in these subjects. Comparing and analyzing Teng's teaching interaction indicators and subject performance indicators, we found that they are almost corresponding. Therefore, teachers need to consider whether this is caused by Teng's learning interest or lack of learning motivation. After investigating and clarifying the reasons, they will prescribe the right medicine to help Teng become a better learner.

4.2.3 Comparative Analysis of Two Cases

By observing the radar chart of the two students, we can also observe the overall situation of the students through the area of the closed figure, that is, the larger the area of the closed figure, the better the overall situation of the students. Comparing the radar charts of the two students, we can easily find that the two students performed similarly on the English performance indicators and the PAD usage time indicator.

Judging from the three performance indicators alone, Zhang's performance in each subject has achieved a more balanced development, while Teng's performance in Chinese and mathematics is still very lacking in addition to English. This is easily reminiscent of the law of short boards. The amount of water that a wooden barrel can hold depends on the shortest wooden board of the wooden barrel, not the longest wooden board of the wooden barrel. Each of us is like a wooden barrel, with its own length and shortness. The longer plank can naturally help us to have some outstanding performance, but in the end our development will be largely determined by the shortest plank, so We should work hard to make up for the shortcomings. As a student, you should also achieve a balanced development of all subjects to promote your own outstanding development. Through the radar chart, students can clearly and intuitively find their shortcomings and try to make up for them.

5 Discussion

By drawing and analyzing the radar chart of the overall situation of students, it is helpful for teachers to grasp the situation of all students from the overall situation and formulate teaching strategies in the general direction. Analyzing the radar chart of a single student will help teachers better carry out personalized teaching, understand the strengths and weaknesses of students, and prescribe the right medicine to promote the all-round development of students. By observing their own data analysis radar chart, students can intuitively understand their own development in various aspects, more immediately understand their own strengths and deficiencies, guide students to learn to check for missing vacancies, and promote students to form a self-reflection, self-promotion, and self-improvement Virtuous circle.

Using the large amount of student data generated in real time during the use of the electronic schoolbag to perform corresponding learning analysis and generate student characteristic analysis is of broad significance for the development of further teaching and the progress of student learning. From a practical point of view, the analysis of learner characteristics based on data has the following significance. First, for students, obtaining learner characteristics analysis based on data analysis will help students to understand their real-time strengths and weaknesses more intuitively in time, forming a virtuous circle of self-reflection and self-promotion. Second, as far as teachers are concerned, obtaining real-time characteristics analysis results of students can help teachers better meet the needs of providing personalized teaching, grasp the strengths and weaknesses of students, and then set personalized development goals to guide students toward complete and comprehensive development. Third, for parents, compared to simply knowing the learning results of students through test scores, feature analysis based on student learning data can provide parents with a measure of measurement. From a theoretical point of view, this research can provide a reference model for data-based learner characteristics analysis under the background of information technology. This research involves the use of a series of data including statistics on students' classroom performance, statistics on the mastery of students' knowledge points, statistics on the use of students' electronic schoolbags, statistics on student performance trends, completion time and completion statistics of student homework and tests, etc., to analyze and generate a series of data. Series learner characteristics. This data-based learner characteristic analysis mode can provide a reference for the development of learning analysis, and it also provides some new thinking dimensions about learner characteristic analysis.

There are still shortcomings in this research. Due to the large and complex data obtained, there is not much data left after actual screening, especially the data of some individual students have serious lacks, and some subjects and knowledge points cannot be determined, so students cannot be determined. The individual performance in each period is compared longitudinally. In addition, the originally obtained student performance data is not only Chinese, mathematics, and English, but also student science and other subjects. However, due to the small number of these subjects and the large time interval, they are not suitable for analysis. Therefore, this study only analyzed the three subjects of Chinese, Mathematics, and English.

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Volume 2

Selected Papers On the Practice of Educational Communications and Technology

Flipping the Course Evaluation Process:
Using Student Feedback Up Front (and Throughout)

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Keywords: *student evaluation of teaching (SET), student engagement*

Faculty are engaged in ensuring students learn. If students fail, instructors have failed. One way to ensure student success is to ask the students themselves. Asking at the beginning of the course is additionally a way to communicate to the students that the instructor wants them to be successful. Sometimes simply knowing that the professor cares can be a significant bump to student motivation and all they need to fuel their success for the rest of the term. Concern for and interest in the student is a key facet students expect in superior college teachers (Feldman, 1976). Asking for student feedback routinely during a course is an excellent way to show concern for student success and make modifications to improve student success.

Project Questions

Due to the continuation of the Pandemic enforced changes at the university level, and the clear direction for graduate programs to remain in online environments, it seemed essential to determine the best methods of obtaining student feedback to improve the student experiences in online courses. There were two primary questions to be answered:

Question 1: Did soliciting student input earlier than the end of course SET surveys result in higher student response rates?

Question 2: Did initial and mid-course student feedback surveys result in actionable data to improve instruction?

This SoTL project was limited to fully online courses as part of graduate educational leadership programs at two midwestern universities.

Background

As the cost of higher education is continuing to rise and universities are competing for a shrinking pool of students, it seems essential to ensure student success. Taking student feedback into consideration is a key element to designing effective instruction (Pate & Hunt, 2015). Frequent, timely, and constructive feedback is considered a key element of the American Association of Colleges and Universities' (AAC&U) High Impact Practices (HIPs) (Lee, Wilkum, Immel, & Fisher, 2021). Fink (2005) includes feedback and assessment as one of the three core pillars of that instructional design model. Keiler, Diotti, Hudon, & Ransom (2020) found that structured feedback from multiple sources including students could have a positive impact on improving teaching. Their study was a mentoring model with high school teachers, but the results should generalize to higher education instructors in a variety of input formats.

Often, the traditional student evaluation of teaching (SET) at the end of the course is not taken seriously by the instructor and/or institutional stakeholders. According to Wong and Moni (2014), the evidence shows instructors were “moderately receptive” to student feedback. Research by Kember, Leung, & Kwan (2002) showed that in reviewing 25 sets of student feedback gathered by departments over three or four year periods, only one significant positive change was seen. Kember, Leung, & Kwan also found that the SET end of course evaluations were too focused on the teacher and not necessarily on the student experience within a course. In three other areas, student evaluations saw negative trends. Therefore, instructors and institutions do not seem to be gathering appropriate actionable feedback or they are not taking action based on SET data. (Wong & Moni, 2014). Both Hadad, Keren & Neveh (2020) and Deale (2020) question the overall validity of SET data and claim the validity of such end of course evaluations Deale articulated gender and age bias can also impact SET data.

Wong & Moni (2014) identify that the purpose of SET is not necessarily clear. If it is primarily to improve the student experience, the timing at the end of the course is not conductive for the students completing the survey. As they have generally completed the course, instead of providing feedback to improve the student experience, they are more likely to be an evaluation of the instructor. Berezval, Lukáts & Molontay (2021) identify that SET evaluations can be significantly manipulated based on such non-instructional things as passing out chocolate to students prior to completing the end of course evaluations. They state students’ anticipated or actual grade also has an impact on SET scores and grade inflation can play a part in raising instructor scores on SET evaluations. Steyn, Davies, & Sambo (2018) identify non-response error as a concern in SET evaluations as well since low response rates are common in end of course evaluations. However, Wurf & Povey (2020) found that students as young as those in primary grades can provide useful perceptions and feedback for instructors willing to integrate student feedback and consider student perspectives.

Lee, Wilkum, Immel, & Fisher (2021) do not go far enough in their advocacy for feedback to better engage students. They focus on the instructor *providing frequent, timely, and constructive feedback* (p. 192) to the student, but they do not go to the next step and elicit feedback from the students about their perspectives about the course content, materials, and instructor. Mandouit’s (2017) study showed that gathering regular collaborative feedback from students and allowing instructors access to appropriate professional development and guided reflection can have a positive impact on instructional effectiveness. Pate & Hunt (2015) focused on the need to provide regular feedback to students in order to develop the necessary habitus to make use of the feedback being provided by the instructor.

Hortsch's (2019) work identified that student feedback showed instructors that students used instructional materials and resources in unexpected ways and by gathering feedback, the instructors were able to utilize that information to provide more efficient instructional materials within the course. Gathering such information during the course itself would potentially allow an instructor to make modifications to the course in progress. Steyn, Davies, & Sambo (2018) pointed out that collaborative feedback opportunities generated slightly more recommendations than individual feedback opportunities. Awidi, Paynter, & Vujosevic (2019) found that students found social media outside the learning management system (LMS) such as Facebook a more engaging tool than the LMS's discussion tools. However, using tools outside the LMS or the larger digital learning environment (DLE) seems to be unwise when addressing student perceptions of courses and instructors.

Tormey, Hardebolle, Pinto, & Jermann, (2020) identified that the existing learning analytics in most LMSs are not yet aligned to any theoretical frameworks. In most cases, the analytics are simply off the shelf. Tormey, Hardebolle, Pinto, & Jermann identified that most LMS analytics are pragmatically based on available or east to obtain data and not currently aligned to pedagogical needs.

Methodology

According to Mandouit (2017), one of the most practical and effective methods of obtaining student feedback was to use a survey with both structured and open-ended questions. Based on that consideration, surveys were determined to be the best method for this project. Previously, the author used occasional mid-term surveys to gather input on a specific aspect of the course beyond the required SET end of course surveys. For instance, the following questions were included in a mid-term survey to an asynchronous accelerated graduate course:

1. Do you feel you are learning enough in the course at this time?
   a. Yes (100%)
   b. No (0%)
2. Do you think the instructor is participating or moderating the discussion questions?
   a. Too actively (not allowing enough student discussion) (0%)
   b. About the right amount (100%)
   c. Not enough interaction (0%)
3. Would you prefer to have a couple of questions to select from or continue to have everyone in the class respond to the same questions?
   a. Choice would be good (48%)
   b. Keep everyone focused on the same questions (31%)
   c. It doesn't matter to me (23%)

The parenthetical numbers show the results of that survey. Since the answer to the Question # 3 was the prime consideration in that survey, the students in the next iteration of the course were again asked if they preferred choice among the discussion questions (DQs) to which they were being asked to respond. In that case, the question was *Do you prefer to have a couple of questions to select from in the discussion threads or would you prefer less choice in the discussion prompts?* Ninety-four percent of the students responded choice is good and six percent said they didn't have a preference. No one preferred to have everyone focus on a single set of DQs after they had experienced choice. After the success of these pilot surveys, the instructor decided to make feedback surveys a more regular part of the instructional process in most courses.

Surveys

This informal scholarship of teaching and learning (SoTL) project encouraged student feedback throughout five online graduate courses. The students were provided with an initial survey after the first synchronous class session for semester long synchronous courses (Courses A & B) to ask students what the instructor could do to assist them in being successful. Those students were given a mid-term survey to provide feedback to the instructor as well as the traditional end of course survey. For the students in accelerated (seven or eight week) asynchronous courses (Courses C, D & E), the students were given either an initial or a mid-term course survey and then a traditional end of course survey. Courses A, B, & C were taught at a university that did not require a SET end of course exam. Courses D & E were taught at a university where all students were sent a SET survey for each course. As all of the courses were taught in an online environment, the surveys were conducted online as well. The instructor posted a direct link to the survey in the announcement section of the learning management system a week before the end of the course as well as sending an institutional email to each student with a link to the survey and a request to provide constructive feedback to the instructor. The announcement generally followed the example below:

Thanks again for all of your efforts this semester. I would like to ask you to take about 5 minutes to complete a brief end-of-course evaluation. It will remain open until after I turn in grades. It is anonymous and you will not be asked for any identifying information. Of course, you can always provide feedback directly as well. URL included here.

A reminder announcement was posted on the last day of the course following the example below:

Don't forget the end of course evaluation available at URL included here. Thanks again for an excellent semester and let me know if you need anything. Best of luck going forward!

The emails to each student followed a similar format. Approximately two-thirds of the responses were received prior to the reminder for the end of course surveys.

Collaborative Feedback via Discussion Threads

Beyond the individual surveys, an "extra credit" or bonus discussion thread was added to the end of each course with discussion threads as part of the core coursework following the example below:

Can you provide any suggestions for improving the course?

Can you provide any suggestions to make any of the assignments or the syllabus clearer and easier to understand? Or remove any bias?

Students were able to post and respond to the posts of other students to provide a collaborative opportunity for feedback beyond the individual opportunities provided through the surveys. Courses A, C, D, & E all included discussion thread requirements within the course, so a bonus thread was added to each as the example above to allow for a more collaborative feedback opportunity.

Results

Below in Table 1, the response rates for each survey are provided. The return rate of initial surveys was the highest. The initial survey response rate for Course A was due to the fact that a student dropped the course between the first class session and the official enrollment date. In all other cases, the enrollment of each course remained stable. For later calculations, Course A's initial survey was considered to have a 100% return rate (see Table 1).

Table 1

Return Rates for Course Surveys

Course	A	B	C	D	E
Initial Survey	105.3%	69.0%	83.3%	N/A	N/A
Mid-Term Survey	78.9%	44.8%	N/A	81.3%	72.2%
End of Course Survey	84.2%	65.5%	66.7%	18.8%	33.3%

Student response rates were much higher for the initial surveys than for the final surveys. Those students who were used to an institutional SET survey automatically being sent had the lowest response rates at an average of 26% in comparison to the return rate of 72% for the end of course surveys where they were not institutionally required. The completion rates of the initial feedback surveys were 81% on average with a range of 69% to 100%.

The initial and mid-term surveys were not entirely uniform but were based upon specific instructional concerns. For instance, in one case, the survey was administered directly after the mid-term exam and two of the questions asked the students which of the study materials, they found useful, a review video and/or a study guide. This helped to guide the development of study materials for future exams. The final question was generally an open question asking for suggestions to improve the course for the mid-term surveys. For the initial surveys, the final question was always *What are three things I can do this semester to help build your confidence and ensure your success?*

The key phrases from that initial survey question to date have been to provide timely communications, constructive feedback and provide clear expectations and examples for assignments. Providing flexibility was often raised as a concern as well. Students also wanted to be able to revise assignments if they didn't hit the mark on the first iteration. The student who asked for "gentle feedback" stands out as a particularly memorable response as instructors need to make sure that they provide constructive feedback but do not provide an overwhelming amount of feedback. As mentioned by McDonald, Rich, and Gubler (2019), occasionally feedback can border on the cruel or hurtful. The instructor generally tries to focus on no more than a couple of areas for improvement on any assignment. This allows students to build their confidence and does not overwhelm them early in the course.

For comparison, the students in courses with a regular discussion thread as part of their course were given a bonus discussion thread as mentioned in the methodology. This allowed them to collaborative identify feedback for course improvement. The participation rate in those discussions ranged between 47% to 100% across the four courses. The median for the four courses was 83% participation in the end of course discussions (see Table 2).

Table 2

Participation in End of Course Feedback Discussion Thread

Course	A	C	D	E
Participants	47.4%	83.3%	100.0%	100.0%
Average # of Posts per Respondent	2.1	1.1	2.6	2.5

There does not appear to be a clear reason for why Courses D & E had both higher participation rates and more active participation rates (shown by number of posts). It is possible, since those two courses had the lowest SET survey response rates, students felt more engaged with the collaborative discussion threads.

A few of the students seemed to evidence a lack of comfort in sharing feedback in the discussion threads as if they were not able to voice their opinions freely. Though that is only conjecture. No follow up was conducted at the time of those comments.

Obtaining feedback from students during the course instead of waiting until the course was completed has been beneficial. Waiting until the traditional SET surveys at the end of the course may not engage students in part due to the fact any of their recommendations will not have a positive impact on their learning as the course in question is over. Initial and mid-term feedback surveys seemed to be a better way to engage more students. The response rate for surveys at the beginning of the course was much higher than those only offered at the end of the course. The midterm survey response rates were also higher on average than the end of survey results.

The particularly low rate of survey responses for those end of course surveys where there was an institutional requirement for SET surveys may encourage those institutions to consider better data gathering methods. Particularly as the non-response loss mentioned by Steyn, Davies, & Sambo (2018) could be significant and lead to skewed results which are neither helpful for the institution nor the individual instructor. At the same time, one issue for institutions at the department and program levels is the lack of comparative data for instructors, particularly new instructors, to gauge their effectiveness in comparison with their peers. Some type of basic summary data to assist, at least non-tenured faculty, to be able to bring context to their SET data would be useful.

Surveys should provide some level of open ended or unstructured prompts as well as the traditional Likert type items. McDonald, Rich, & Gubler (2019) point out that feedback is not always a good thing and in fact can be overly negative or even cruel at times in academic settings. The potential positives to improve the student experience should outweigh the potential negatives in most cases. For new faculty or those with thinner skins or other histories that might make them more susceptible to negative feedback, potentially, they could have a trusted peer filter the results and remove any non-constructive or cruel responses. This could provide an additional level of anonymity for students who might also feel comfortable with an additional level of filter

Themes that emerged from the open-ended responses in the study surveys align to the fact students appreciate clear, timely and kind communications from instructors. Clear instructions on assignments, the opportunity to address areas of concern, obtain a review of an assignment prior to submission are all among the concepts raised by students. Students appreciate choice and prefer to feel some level of control over the instructional environment.

Recommendations

Recommendations for Further Study

The study was conducted over two universities and a range of graduate courses including both aspiring K-12 administrators and traditional graduate students a few years or less out of undergraduate programs. Additionally, both traditional and accelerated length courses were included along with both synchronous and asynchronous delivery methods. Those variables might account for some of the apparent spread in response rates. Similar studies should be conducted with more homogenous student populations including undergraduate populations as well as with more homogenous courses or multiple sections of the same course. Hujala, Knutas, Hynninen, & Arminen (2020) suggest using Latent Dirichlet Allocation (LDA) topic and cluster models to manage large scale open ended SET data and extract useful information for course improvement. Studies with large student populations should consider this option to balance allow for unstructured student responses even with those larger groups.

Another potential untapped source of useful feedback are recent alumni. Contacting students after they have completed their programs of study may provide some of the best feedback about the practical viability of a course's content. Another option would be to provide students the opportunity for feedback through an echo box or similar widget embedded within the course LMS or DLE to allow for ongoing anonymous student feedback.

Recommendations for Practitioners

Instructors should strongly consider initial course surveys to hear from students to learn more about their concerns and how to ensure student success. Mid-course surveys can also be helpful particularly after key assessments in order to obtain feedback on particular assignments and materials. Due to the particularly low return rates and the concerns raised about non-response bias by Steyn, Davies, & Sambo (2018) and others, institutions may wish to reconsider the high value that some put on SET data. It appears that there are better methods available for obtaining feedback to assist in the improvement of instruction. Developers and IT staff need to build out tools that can assist instructors in gathering more real time feedback. Tools to allow full analysis of discussion threads would be a key item in reviewing discussion based student feedback.

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Job Search in the Time of the Pandemic:

Advice and Reflection Amidst the Challenges

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Introduction

Looking for a full-time job in academia is challenging for both first-timers and those with multiple job hunt experiences due to the highly competitive job market. Especially, tenure-track faculty positions have always been competitive: Only 10% to 30% of Ph.D. holders get a tenure-track professor job (Effective Altruism Forum, 2020). The current COVID-19 pandemic and the declined economy make finding tenure-track faculty positions in educational or instructional technology fields harder than ever. The U.S. Department of Labor reported that state and local education employment dropped in both public and private sectors in almost all states due to funding cutbacks during the pandemic (Rosewicz & Maciag, 2020). As a result of the pandemic, faculty of all types, especially adjunct faculty, were faced with job losses or salary changes across all institutional classifications (Sziron, 2021). International students who need H1B and Green Card sponsorships face additional challenges in finding academic jobs at this time due to the increasing number of universities that decline the immigration sponsorship because of the financial difficulties as well as the political climate

This article provides advice and reflections to those engaging in a tenure-track faculty job search in the field of educational and instructional technology. Although the paper's focus is geared more towards international students in America who seek tenure-track faculty positions, the advice provided will undoubtedly apply to other job-seeking students. The authors, tenured or tenure-track faculty members, and former international students in American universities bring together experiences looking for tenure-track positions in instructional technology and evaluating candidates for tenure-track positions as faculty members. The authors identified four strategic areas for consideration and discussion when students apply for tenure-track and other types of jobs in academia: reading job advertisements, creating documentation, preparing for interviews, and making online or campus presentations. Further, they discussed critical strategies and shared insights in managing the challenges of the job search.

Reading the Job Ads

A careful reading of the job advertisement or job description is the first crucial step in job hunting. The job advertisement describes what kind of person the organization is looking for, including the required and preferred qualifications. An example of a typical required qualification in educational technology is a K-12 teaching experience due to a focus on K-12 teacher education. Another significant type of program in the field focuses on corporate training. For such programs, work experiences in industry or the private sector could ensure getting a tenure-track job. If your capabilities are significantly different from the description in the job advertisement, this may not be an opportunity for you. Again, only 10% to 30% of Ph.D. holders get a tenure-track professor job (Effective Altruism Forum, 2020), which shows that the job market is highly competitive. If the job description does not make you feel "this sounds like me," then the chance of you getting the job will be slim. There are plenty of candidates in the market, and some candidates would certainly have qualifications that match the job descriptions.

However, you should always apply for the job even if it does not entirely match your qualifications as long as you have some capabilities that match the job description. In many cases, you would find yourself meeting parts of the required and preferred qualifications. It is a difficult decision to make, choosing if you give up or try. However, due to the competitive job market of tenure-track positions, it is probably better to apply for more jobs than fewer. Another reason for the encouragement to apply is that the job description is about an ideal candidate. In reality, the institutes rarely find a perfect match in their searching efforts. Each candidate is unique, and so are you. You might have some qualifications that are not listed in the job descriptions but are helpful in the department.

Once you decide to apply for the position, you want to make every effort to show your match to the advertised work. The Search Committee, who selects and recommends the candidate to hire, will evaluate your job application based on how close you are to the job description. You are not allowed to lie in your job application. You cannot list experiences that you do not have. However, you can strategically highlight your knowledge and expertise that are pertinent to the job description.

Documentation: Letter, CV, and References

As discussed in the previous section, showing your match to the job description is what you need to accomplish for your successful job hunt. The first step to show this match is to tailor your job documents to each position. In typical universities, tenure-track faculty members are evaluated based on their research, teaching, and service accomplishments, so you want to list and discuss your experiences in terms of the three areas. Research accomplishments include peer-reviewed journal publications and external and internal grant experiences. The best teaching experience would be your experience teaching a class as a solo teacher in the field of instructional design. However, other types of teaching experiences count, such as a solo teaching experience in another area or experience working as a teaching assistant in the field. Since the job market is very competitive, the key to your success is how many publications and teaching experiences you accumulate before the job hunt. While service experiences tend to be less emphasized than research and teaching experiences, you certainly want to have some service experiences inside and outside your school. Services for academic organizations, such as Association for Educational Communications and Technology (AECT), will look strong in your job application. Such experiences at an academic organization will help your networking with faculty members in the field, too. The following sections discuss specific advice for each application material.

Cover letters

It would be best to describe what you have accomplished in your cover letter or letter of intent. Typically, the letter opened up a narrative about your interest in the position and followed by your academic credentials. A good cover letter should provide what the institution is looking for, and thus, it should vary according to the job descriptions. Suppose you are applying for a research-focused job. In that case, your cover letter will talk mainly about your research accomplishments, such as peer-reviewed journal publications and external and internal grants that you have received, and the relevant research experiences you have had.

Meanwhile, suppose the position is more teaching-focused, such as a tenure-track position at a teaching institution or a clinical professor job in a research university. In that case, you want to spend more time talking about your teaching experience in the cover letter. While most tenure-track positions require strong qualifications both in research and teaching, some universities also emphasize service experience more.

In general, your letter should highlight the required qualifications based on your past and current experiences. Also, you may try your best to address the preferred qualifications. For example, working as a research or teaching assistant could extend your presentation as long as possible, well-aligned with the preferred capabilities.

In addition to the cover letters, some universities ask for research or service statements and teaching philosophies. The content of such a write-up would overlap with the cover letter content, but it would provide you with more space to discuss your experience. Many books and online articles are available on how to write a cover letter and other job documents for an academic job search, so you should consult such resources. Additionally, you could ask for feedback from your professor on your job documents. If your professor has experience serving on a search committee, they would have some insights into preparing robust job applications.

Resume or Curriculum Vitae (CV)

CV is the factual list of your accomplishments, experiences, and competencies, and capabilities, including your educational degrees, professional experiences, research and scholarly achievement, and service work you have done. Career counselors suggest tailoring each CV when applying for different jobs. Suppose you are applying for a tenure-track assistant professor job in a research one university. Your CV's content should highlight more about your research accomplishment and relevant research experiences according to the job description. In this case, your research accomplishment usually comes before your teaching experiences in the CV.

Other knowledge and skills you could highlight in your CV could be related to research tools and applications. For example, being proficient in using the SPSS program to conduct quantitative analysis, experienced in using NVivo to conduct qualitative data analysis, skillful in visualizing both quantitative and qualitative data, and proficient in analyzing video data are highly appreciated research skills. Finding a way to present these essential competencies you have in your CV is vital too. Your CV should reflect what you have done and demonstrate your commitment to and passion for the field of professional service. Like your educational background, research accomplishment, and teaching experiences, your professional assistance in your CV represents who you are and what you have done as a professional.

To be successful at a tenure-track job search, you would want to have at least three or more articles published in peer-reviewed journals. Although having a first-authored paper would make your profile significantly stronger, co-authored publications also count, primarily if published in peer-reviewed journals. The CV must be factual and does not have many places to "tailor" it to match each job description. You can still tailor your CV to be research-focused by having the list of publications and grants at the beginning of the CV or make it more teaching-focused by listing your teaching experiences first.

Letter of Reference

Finally, reference letters also should demonstrate the match between your qualifications and job descriptions. Although your references decide the content of your recommendation letter, you can communicate with them individually about the nature of the jobs you are applying for and what kind of experiences you wish them to emphasize in their recommendation letters. It is also advisable to provide your references with your cover letter or letter of intent for the job application and your updated CV, both of which would provide your contacts with more focused information about the job you are applying for.

Interview Preparation: Phone, Zoom, and One-Way Video Recording

Once you successfully pass the search committee members' document review, you could move to the next step --- an interview. Usually, there are two interview phases: the initial and the campus interviews. Before the pandemic, search committee members interview candidates by phone. Then, with new technologies, they started interviewing using web conferencing applications such as Zoom, Google Meet, or Webex. The same rule of showing your match to the job description persists in your interviews. Additionally, due to the stressful nature of job interviews, your preparation will be critical for achieving positive results.

The first round of interviews usually happens remotely, either by a voice-only traditional phone call or by a video call using Zoom, Skype, and so on. In either case, you want to prepare an environment without distraction. You want to be in a quiet place so that the search committee will hear your voice, and you can listen to their voices.

Initial Interview

Format. The search committee chair facilitates the interview meeting with each member, asking at least a specific question. Sometimes, the search committee will ask permission to record the interview session to share with non-attending members. In the end, you are allowed to ask questions about the search.

However, do not be surprised if the search committee asks you to video record yourself answering interview questions. Not many colleges or universities are conducting this one-way online interview, but some places do. Your computer camera is activated to record your answers to specific questions given a time limit without the search committee members. You have an opportunity to redo your recorded response once or twice if not satisfied.

Preparation. If you are going for a phone interview, you will face another type of difficulty. It would be best if you talked to multiple people on the phone. Since, in most cases, you don't know the voices of everyone in the search committee, you would have a hard time identifying who is speaking. If you can learn the names of the search committee before the interview, find their information online and print out their photos. Seeing their pictures while talking on the phone could make you feel less stressed in this awkward setting of talking to multiple people at a time.

In the case of video interviews, be sure that you have a secure and robust internet connection. Internet interruption will result in a stressful interview and will not help your success. Make sure to dress business casual to show your respect as well as commonsense. If you are not sure of what "business casual" means, ask for advice from your professors and store staff. Check how the environment would look through the camera, too. The background must be clean so that you would look professional. The light probably does not want to be so dark, so you do not look creepy, either!

Campus Interview

Format. At the initial interview, the search committee will use the output to decide whether to invite you or not as a candidate for a campus or onsite interview. While waiting for an invitation, it is a good practice to send a thank-you note via email to the search committee chair for the opportunity to interview.

Once you pass the phone or the video interviews, the next step would be an invitation for the on-campus interview. Most candidates cannot come this far, so you must be very proud of yourself if you get to this final stage of the job hunt. However, you should also be ready that this last step would be the most stressful, tiring, and scary part of the job hunting journey.

The on-campus interview would consist of interviews with the search committee, the department chair, and the Dean. Sometimes students in the department will interview you as well. Hopefully, by now, you already know about the Search Committee members. Still, you will also need to do your homework to learn about the Department Chair and Dean and the missions, agendas, and initiatives in the Department, School, and the University.

Preparation. The on-campus interview could be a stressful experience at the get-go. But interviews are not the only tasks during the campus visit. If you happen to receive an invitation to interview in another state, the campus visit starts as soon as you arrive at the nearby airport.

Typically, the search committee chair or member will come to the airport to pick you up and offer you a ride to the campus, restaurant, and hotel. Yes, you would most likely have a two-day visit. You will fly in at the end of the first day and interview and fly out the following day.

On-campus interviews are essential because everyone evaluates or judges if you are the right fit for the position and the department, college, and university. The search committee chair or members gather as much information about you at every opportunity, such as airport pick-up/drop-off, dinner, or campus tour. You can only relax when you are in the hotel by yourself or in the restroom! Many consider the campus visit as the most tiring and stressful step in the job search.

Presentation Preparation

Additionally, in the cases of research-focused universities, you would be asked to provide a Job Talk where you present your research in front of the Search Committee and other faculty members in the department. The Job Talk looks very similar to your dissertation defense if this helps you visualize how it looks.

Finally, in most cases, except for some research-focus universities, you will have another challenging task to complete, i.e., teaching demonstration. You will provide a lesson, typically about 45 minutes, in front of the search committee and other faculty members. Sometimes, the teaching demonstration happens before a group of students in the department. All groups evaluate your potential as a teacher in the program. It would be best if you showed your ability to teach content and have effective interactions with students. You would feel very awkward and nervous to teach in front of the people judging you, but a teaching demonstration is an excellent opportunity to showcase your teaching skills. In most universities, successfully teaching students is critical for professors, so you want to prepare well to impress professors and students in the teaching demonstration.

Since the campus visit is so busy, stressful, and tiring, make sure to sleep well before the campus visit. You have a lot to prepare, but you will not have a successful campus visit if you sacrifice your sleep. Since teaching demonstrations and Job Talks happen at many universities, it is a great idea to prepare for them even before getting invited to a campus visit. In this way, you would feel less stressed and panicked even if asked to visit a campus in a week!

Other Things to Consider

While getting a sponsorship is critical if you are an international student, you need to recognize that fewer and fewer universities sponsor H1B and Green Cards due to the declining economy. If the job description says that the university will not provide the sponsorship while you need it, do not waste your time applying for the position. They cannot support you no matter how much you need it. Sometimes you figure out that the university does not provide sponsorship at the interview. Then, please take it as a great interview practice opportunity. Often, you don't know if they give the support until you go to the final round. You might feel tempted to ask if they provide the sponsorship, but it is usually best not to ask about "what they provide you" unless you get the job offer. Too many people negotiate before even getting a job, which gives a wrong impression. Once the Search Committee is attracted to you enough to provide you with the job offer, that is when you get the privilege to negotiate for sponsorship and other requests.

You can also refer to books on tenure-track job hunting, such as "The Professor is in: The essential guide to turning your Ph.D. into a job" by Dr. Karen Kelsky. Her book and others provide details about how to write a robust application and prepare for the interviews.

Conclusion

Many believe that job search ends when one gets a job. The authors who have been working for years say that the job search does not end at all. At least for the two of the authors, they have changed jobs three or four times. Career counselors state that most individuals change jobs four or five times during their career, if not a lifetime.

As the authors look back to their own job search experiences, they suggest that it is vital to take note of successful strategies one did or learned from others. They also mentioned that it is also good to identify what did not work well and not use it again. Some noted that one needs to pay detailed attention in putting together the job application packet. Every hiring organization, academia or not, has its preference on a good CV, letter of application and references, statement of teaching, and research philosophy. Finally, keeping track of where one applies is essential. The worst thing that can happen to an application is sending a letter to an institution with the name. Much worse is a letter that speaks of qualifications missing in the job advertisement.

The authors believe that searching for a job can be a full-time endeavor. The reflections and advice shared in the paper would be a good guide for planning to find the right job or a new position in the future.

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Visual Literacy and COVID-19:

Online Representations Connecting Learning and Impacting Teaching

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Introduction

Since March 2020, everyone's worldview and experiences have changed due to the COVID-19 pandemic. An already visual-rich online environment has been inundated by images, from charts to photographs, depicting changes in people's lives due to a prolonged bout with an invisible enemy. Being cooped at home with nowhere to go and teaching remotely, the researchers ventured into studying what their students considered and shared in their classes online as part of the visual journaling activity. The paper explores how the changing online visual landscape as a phenomenon connects to learning and teaching contexts.

Activity

Starting with Summer 2020, the researchers collected artifacts submitted by students in a visual and media literacy course. The artifacts allowed the students to complete a journaling assignment identified as a visual-based reflection. For the task, the professor asked students to post a visual aligned to a prompt. They also wrote an accompanying narrative as a response to a prompt. Students post their visual and written responses in a designated online discussion "space." Most of the visuals came from websites, online news, or social media postings.

Given that the students study visual and media literacy as a discipline, the prompts asked students to provide a brief narrative on what they see in alignment with course-related content. The writing entries focus on students' thinking of the relationship between the shared image and visual or media literacy concepts, such as visual or design elements, principles, compositions, and angles of a camera shot).

Element

Visual design elements refer to the basic units of visual communication (Hagen & Golombisky, 2013). Examples of visual or design elements include line, color, space, shape/form, size/scale, texture, and value.

Principle

Visual or design principles facilitate the creation of an aesthetic appeal. The principles guide the work and interact with each other to maximize the user experience. Though there are no definite principles, researchers and practitioners identified some as focal point/emphasis, rhythm/pattern, balance, movement, contrast, repetition, alignment, proximity, and unity (Hagen & Golombisky, 2013).

Composition

Researchers and practitioners identified visual or design composition style as "the arrangement of elements within a design" (Brown, Bussert, Hattwig, & Medaille, 2016, p.77). A typical composition technique is the rule of thirds. Other composition styles include leading lines, diagonal lines, framing, figure vs. ground, fill the frame, dominant eyes, and symmetry.

Camera Angle

The camera angle refers to how one composes a shot given the location of a camera about the subject. Researchers and practitioners classified the camera shot angle as eye-level (front or back of the object), high angle (top), low angle (bottom), or slanted (right or left). Using different camera angles to take a shot can provide different experiences for the viewer that may elicit an emotion.

Visual Sharing Prompts

To identify an image for the activity, students need an image that communicates or aligns with the prompts. Six descriptive statements provided the students with a focus for their visual sharing activity:

1. An image of an opening event at your school (if you are not in a school, then your children's school).
2. An image of the management of the pandemic in your community. Provide a narrative reflection demonstrating the pandemic impacts on you or your family.
3. A cartoon from online websites or social media that serves as commentary to the current political situation in the United States.
4. An image that serves as a commentary on the current health situation in the United States.
5. An image of children or young adults managing the daily challenges of living in a pandemic.
6. An image that portrays positivity given the current situation (health, political, social, economics).

Inquiry

For the initial study of the visual artifacts, the researchers chose to collect and analyze the submissions from the first two prompts. Since the students study visual and media literacy, the researchers wanted to know if image selection for sharing followed a pattern or theme. The researchers decided to focus on the following questions as part of the inquiry:

1. What visual or design elements or principles are the students connecting within their journal entries on each topic?
2. What strategies on visual or design composition styles and camera shot angles that the students connect within their journal entries on each topic?
3. How did the students represent the impact of COVID-19 on teaching?

Visual Coding and Analysis

The researchers performed a "close" review of each image using the four visual or media literacy concepts specifically for pictures or photographs. The researchers collected 48 images for prompt #1 and 42 for #2. Some students submitted a photo for only one prompt. The researchers decided not to include them in the study. Also, the researchers did not include images with embedded texts or cartoons. The final image count for the study numbered 26 for each prompt.

Once the researchers determined the images for analysis in the study, they coded them for the presence of a visual or design element and principle. Also, they identified the primary visual or design composition style and angle of the camera shot. After coding all the images, the researcher identified high frequencies in each category to answer the research questions.

Findings

Several patterns and themes emerged after analyzing the codes generated by the review of images in the four categories (i.e., elements, principles, compositions, angles). Table 1 identified those with the highest frequencies in each visual design category.

Table 1

	Prompt #1		**Prompt #2**		**Total**	
Element	**N = 25**	***f***	**N = 25**	***f***	**N = 50**	***f***
1. Space	23	0.92	17	0.60	40	0.80
2. Color	14	0.56	23	0.92	37	0.74
3. Line	17	0.60	16	0.64	33	0.66
Principle	**N = 25**	***f***	**N = 25**	***f***	**N = 50**	***f***
1. Repetition	16	0.64	13	0.52	29	0.58
2. Focal Point/ Emphasis	14	0.56	14	0.56	28	0.56
3. Contrast	21	0.84	6	0.20	27	0.54
4. Alignment	14	0.56	11	0.44	25	0.50
Composition	**N = 25**	***f***	**N = 25**	***f***	**N = 50**	***f***
1. Patterns & Repetition	11	0.44	11	0.44	22	0.44
2. Rule of Thirds	8	0.32	8	0.32	16	0.32

3. Leading Lines	9	0.36	4	0.16	13	0.26
4. Figure vs. Ground	8	0.32	4	0.16	12	0.24
Camera Angle	**N = 25**	***f***	**N = 25**	***f***	**N = 50**	***f***
1. Right	8	0.32	15	0.60	23	0.46
2. Front	10	0.40	3	0.12	13	0.26

Elements

The students submitted images that demonstrated elements of space, color, and line. These elements emerged as most common amongst student selections. The researchers coded the collected pictures based on these three elements and shape/form, size/scale, texture, and value. An example of an image from the study evidencing all three of these elements is displayed below (see Figure 2).

Figure 2. An example of an image with space, color, and line.

Principles

The researchers coded the collected images using the category of visual design principles. After analyzing the coded images, the researchers identified repetition, focal point/emphasis, contrast, and alignment. See an example of a student-selected image demonstrating the visual design principle of repetition below (See Figure 3).

Figure 3. An example of the principle of repetition

Composition Styles

The researchers identified nine visual design composition styles to facilitate coding the collected images. After analyzing the codes on composition styles, the researchers found patterns and repetition, the rule of thirds, leading lines, and figure vs. ground, are highly evident. Below is an example of figure vs. ground composition style (see Figure 4).

Figure 4. An example of figure vs. ground composition

Camera Angles

Finally, the researchers coded for angles of the camera shot among the collected images. The images selected and shared by students demonstrated camera shots taken using right or front angles. Below is an example of one of the images taken from a right angle (see Figure 5).

Figure 5. An example of a right angle shot of an image selected by a participant

Connection to Teaching and Learning

The pandemic impacted school activities at different levels. The pictures below (see Figure 6) demonstrate how COVID-19 changed how teachers and children worked together. The most common evidence of these changes is seen in these visual representations from using masks, teaching remotely, practicing social distance, checking temperatures, restructuring classroom space, and disinfecting hands. Masks became the new accessories in children's clothing for school. Teaching remotely became normal in conducting classes that challenged teaching practices for many teachers. If there is onsite teaching, then school staff rearrange desks, tables, and chairs to demonstrate social distancing and restructuring learning spaces. Finally, temperature checks and handwashing with disinfectants became the norms of everyday behaviors in some schools.

Figure 6. Visual representation of COVID-19 impact on teaching and learning.

Challenges

The researchers based the study on the output generated by a course activity. The activity asked students to reflect on the visual or design concepts learned and demonstrated the content visually.

The first challenge that the researchers encountered involved understanding the student engagement and performance with the activity. The research explored the type of images submitted, and the researchers analyzed the visual or design characteristics. However, given the study's exploratory nature, the researchers began to think that the images' exploration as a research study needs reconceptualization towards a scholarship on teaching and learning.

Another challenge the researchers experienced was the volume of data (both images and texts) available for analysis. The project started with over 40 pictures to code and decided to reduce the number to a more manageable number of 25 images. The researchers reduced the number of images in two ways. Initially, the researchers eliminated duplicate pictures submitted by students. For example, three students presented the same photo of a crowded hallway for their opening day prompt. The researchers analyzed the image once and removed the duplicates. Then, the researchers eliminated any picture that was not a photograph or with embedded text. In this manner, the researchers did not include political cartoons, infographics, and other non-photographic images.

The data collection also included narratives written about the image by the students. The researchers decided not to code these narratives but focused on the images as the primary data source. The researchers chose to analyze the descriptions at a future date. They prioritize studying the images to facilitate understanding the context of what made students select the photos, and how they connected the images to teaching and learning, and the impact of COVID on those activities.

Lessons learned

Three significant lessons emerged from the research experience. First, a coding framework for classifying and categorizing the data around visual literacy components is beneficial. Next, similarities and differences could emerge between and among the images. Finally, previous experience with visual literacy played a vital role in data analysis.

First, the researchers learned that a coding framework greatly aided the ability to classify and categorize data. They developed a coding framework around visual literacy components such as the elements, principles, composition styles, and angles of camera shots. The coding framework greatly assisted the junior researcher's ability to identify and code the images.

Second, the researchers identified similarities and differences among and between images. For example, using the category of camera angles, the researchers found that students submitted many pictures taken from a front or right angle. The results did not surprise the researchers, given their experiences in taking photographs since many individuals choose to shoot photos due to being right-handed.

Third, the researchers found that experience and exposure to visual literacy concepts make a difference when analyzing photographs. Each researcher coded 25 images, but the amount of time taken by each researcher differed drastically based on personal experiences. The researcher with expertise in visual literacy coded the collected data in a shorter time, while the second took more time due to less familiarity with the content knowledge. The finding spoke to the need for training coders.

Future actions

The next step for the researchers will be to continue analyzing the collected images as data. The students received six prompts to respond to over the semester. The researchers analyzed the data from the first two prompts for this paper. They need to analyze the responses to the remaining prompts to understand the emerging patterns and themes in alignment with the content learned by the students.

Another action needs to focus on analyzing the narrative portions of the students' visual journal entries. Since each student responded to all prompts with images and narratives, the researchers also needed to code and analyzed them.

After analyzing the images based on the visual or design categories, the researchers found that the students need more training on developing visual literacy knowledge and skills. Also, the researchers realized the importance of providing a tutorial on how to code images for consistency when using multiple coders.

Finally, the researchers would endeavor to connect the information and experience gleaned from this study to teaching media literacy.

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Leveraging ADHD: One Instructional Technology Professor's Journey

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Descriptors: Attention Deficit Hyperactive Disorder, Performance Technology

Abstract
This session chronicles the journey of one instructional technology professor's journey from diagnosis and surviving with ADHD to thriving by leveraging ADHD. The highlight will be techniques for leveraging distraction and focusing the mind.

How Did I "Get" ADHD-Inattentive Type

Like many ADHDers, I found out that I had Attention Deficit Hyperactivity Disorder (ADHD) as an adult in a round about way. While browsing in the self-help section of a bookstore, I came upon *ADD-friendly ways to organize your life* by Kolberg and Nadeau (2002). I always wanted to "add" more organization to my life, so I read further. I soon realized that the "ADD" in the title actually stood for Attention Deficit Disorder (ADD), and that the descriptions of people in the book with ADD sounded a lot like me. Just like them, I was easily distracted, forgetful, late, etc., so I ended up buying the book. The tips were very helpful, but I never really accepted the fact that, like those described, I might have ADD.

Fast forward a few years, and I was struggling to write my dissertation. In desperation, I enlisted the assistance of the director of the Writing Center at the University of Toledo, Dr. Carol Nelson-Burns. She suggested that I spend some time writing at the table in her office so that she could observe my writing process. After our session, she said to me, "As I watched you, you were listening to music on your headphones, moving along to whatever you heard, looking out the window at what was going on outside, AND typing away! Multitasking seems to be what helps you focus...and THAT seems classic ADHD—have you ever been tested for that?" At first, I was in shock; then, I came around and realized that it could be true. She suggested that I get tested to be sure of the diagnosis. After a number of sessions with a psychologist who specialized in ADHD testing, it was official—I had ADHD-Inattentive Type.

Looking Back

When going through the ADHD testing process, I was asked if I had any ADHD characteristics in childhood. While I am the opposite of hyperactive, I did have other ADHD-Inattentive traits as long as I can remember, such as staring into space, inability to concentrate, difficulties reading long passages or works, and needing music to concentrate on mental tasks. Beginning when I was about five, my brothers and sisters nicknamed me "the absent-minded professor" because I had trouble remembering everyday things but could recite volumes of information about whatever I found intriguing. Much to my parents' chagrin, I tried a plethora of hobbies, only to leave them abruptly when my interest waned.

After the Diagnosis

I would love to say that after the diagnosis, I changed drastically and became a fully-functional member of society. However, that was not the case. The Ritalin I took gave me amazing focus, but it only lasted for around five hours, and then I would crash. Timing was key. I had a short window of productivity for the day. I managed to complete my dissertation, but I realized that this would not be a long-term solution. That began a 14-year journey to explore ways to minimize distractions and build focus-friendly techniques. Each ADHDer is unique. What follows are some of the techniques that work for me.

Characteristics of ADHD

Although every ADHDer is unique, there are some characteristics that most of them share: porous short-term memory, an inconsistent sense of time, inconsistency of attention (distractibility and hyperfocus), a strong sense of adventure, and an aversion toward boredom.

Porous Short-term Memory

For some reason, the connection from short-term to long-term memory can be porous with only some information making it through the transition. This makes it easy for me to forget details of conversations and meetings. I use several techniques for increasing what I remember. Periodically, during conversations, I will stop and recap what was said. At the end of conversations, I summarize the key points, especially my next tasks. When possible during conversations and meetings, I take notes, which I process upon returning to my office computer.

Another time when my porous memory affects me is when transitioning from one location to another. For example, sometimes I have to park in different lots around my building. After years of searching for my car, I developed a little whiteboard where I mark my car location when entering the office. I also have a list of items to remember upon leaving (keys, phone, jacket, etc.). When I arrive home, I take a moment to put things for the office on a shelf on a bookcase near the door that I call my takeoff zone.

Inconsistent Sense of Time

It can be very difficult for ADHDers to sense the passage of time. I personally can not tell how much time has passed—what I think has been one hour, sometimes is just a few minutes and vice versa. It is very easy for me to get caught up in a 5-minute task and find I am late for an appointment. Therefore, I use the alarms and timers available on my cellphone to remind me of my appointments, meetings, classes, and other events throughout the day. I find that I have to change the sound I use every periodically or I will turn them off absent-mindedly and return to what I was previously doing. Habits can also be helpful. To keep my daily reminders clear, I have trained myself to look at my calendar and to-do list each time I switch tasks.

Distractibility

Many ADHDers have sensory processing challenges. Therefore, they can be sensitive to distractions to their senses. I personally find that sounds, smells, touches, and sights can distract me while I work. For many decades, unfruitfully, I searched for distraction-free locations to work. However, about ten years ago, I found that I could create my own purposeful distractions to keep my senses occupied so I can concentrate better and focus on my work. I play music or movies (depending upon the task), burn a woodsy scented candle on my desk, wear clothing that is soft to the touch; and have minimal visual distractions in my work zone. These purposeful distractions keep my senses occupied so the rest of the environment does not distract me from my tasks.

Hyperfocus

One of the greatest strengths of ADHD is the ability to hyperfocus. When we are motivated and free of distractions, ADHDers can enter a state of heightened focus where we can do tasks requiring intense concentration for an extended time. However, it is very difficult to maintain these periods consistently without following distractions like moving from searching for articles to transitioning to surfing the web.

I have found that the extent of my productive hyperfocus is approximately 15 minutes. I use a modified Pomodoro Method with 15-minute tasks. I plan four to five pomodoro periods each day. Within each pomodoro, I have five 15-minute tasks. Following each 15-minute task is a 5-minute break, in which I do an activity like stretching, speed cleaning, or refreshing my drink. After completing all five of the pomodoro tasks, I take an extended 25-minute break to do something recreational, like taking a brisk walk, playing a computer game, eating lunch, watching TV, writing a personal letter, etc. Woven in the list of tasks for the pomodoros are time for meetings and appointments. I try to match my pomodoros with my workload with one pomodoro daily for research, teaching, and service with remaining pomodoros wherever needed most.

Sense of Adventure

Since one of the characteristics of ADHDers is their adventurousness, I try to be proactive and front-load adventure in my week so that I acknowledge and support my sense of adventure. For example, I try to drive home by a different way; I plan new experiences weekly; and am always saving for something special. Likewise, when I acquire some unexpected money, I have found Dave Ramsey's philosophy of save some, spend some, blow some works best for my ADHD nature; otherwise, my sense of adventure will take over and I will spend much more than is wise.

Aversion toward Boredom

As an ADHDer, I also share an aversion toward boredom. When faced with a boring task, my instinct is to do something else. However, I can find that playing music or listening to a movie while I work can make monotonous tasks more palatable. I can also increase my adrenaline by setting a timer to induce me to speed up. When faced with a task that takes more time or effort, I resort to getting a person as a body double to help me stay on task. I always find it more fun to work with another person rather than alone.

Give Myself a Little Grace

I think the most important breakthrough I have made with my ADHD shortcomings is to give myself grace. I have learned to be gentle with myself and forgive the times I fall short by forgetfulness or the struggle to get things done. It is great to be able to step back and remember that I can choose to approach things with depression or a giggle, with pain or accepting that I am making progress, with guilt or grace.

My Team

Throughout my ADHD journey, I have had a team to support me. The biggest supporters have been my family. Many articles and books have been written on that topic, so I won't dwell on that here. In addition, I have a psychiatrist, who has matched me with medication that helps me focus. I also have an outstanding ADHD coach who matches me with techniques and strategies to get unstuck from inattention and anxiety, to set priorities, and to increase my focus. Since I live alone, I also have an extra helper (body double) who assists me with tasks around the house that have extreme distractibility and need concerted focus, like organizing the garage, doing spring cleaning, and my annual office organizational readjustment. My helper is an extra pair of hands, but she also keeps me on track by saying things like, “What is your goal,” “You’re taking too long…hurry up,” “What are you thinking,” “Do you *really* need that” or “You are digressing.”

Conclusions

I love my creative, adventurous, challenging ADHD brain. It allows me to be the unique and bright person I am. The key to being a professor with ADHD is working with my strengths to overcome the challenges with a large dose of grace.

101up: Implementation of a Gamified Curriculum to Increase Self-Regulated Learning Skills and Motivation for At-Risk Students in a First-Year Experience Course: An Action Research Study

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Abstract

The transition to college from high school is significant for at-risk students, especially as they tend to struggle with self-regulated learning skills when trying to adapt to the university environment. In an attempt to mitigate this challenge and assist students with this transition, many universities offer first-year experience courses. The purpose of this action-based research study was to evaluate the implementation of a gamified curriculum (EdApp) for at-risk students enrolled in a university first-year experience course. This seven-week action research study incorporated a gamified curriculum designed to increase self-regulatory learning skills (goal setting, strategic planning, task strategies, self-instruction help-seeking, and metacognitive monitoring) and motivation (choice, control, collaboration, challenge, constructing meaning, and consequences) for 10 academically at-risk students enrolled in a first-year experience course. Qualitative and quantitative data was collected from the Learning and Study Strategy Inventory (LASSI) instrument, journal reflection assignments, a Final Self-Reflection Learning Quest, gamification elements, and learning management system (LMS) metrics. Findings from this study indicated that although only one subscale of the LASSI, Self Testing, was found to be statistically significant, correlations were found between various gamification elements and the subscales of Information Processing, Concentration, and Using Academic Resources. Additionally, as a result of various cycles of coding and the emergence of themes, findings suggested that students perceived the gamified curriculum as helping to improve their academic mindset, study habits, and motivation, all while making their learning easier. Implications for instructors considering the implementation of a gamified curriculum and future areas of research are offered.

Keywords: EdApp, gamification curriculum, at risk students, first-year experience course, motivation, self-regulatory learning skills

The transition from high school to college is hard for the majority of students, but it is even more so for at-risk freshmen who tend to struggle with self-management skills and lower self-regulated learning skills when trying to adapt to the university environment (Sun et al., 2017; Tang & Wong, 2015; Vallerand & Blssonnette, 1992). The odds are stacked against them; over 40% of college students do not complete their degree in six years ("IES", 2018), with 33% dropping out entirely (Shapiro et al., 2017). The freshman year is especially critical, with 28% of students dropping out before their sophomore year (Shapiro et al., 2017). In order to help mitigate these odds, many universities have developed first-year experience (FYE) courses to ease students' transition to college life (Connolly et al., 2016). Ideally, the FYE course helps new students adjust to the university by developing a better understanding of the learning process to acquire essential academic success. Students learn to adapt and apply appropriate academic strategies to their classes and learning experiences, effectively managing their time and priorities (Young, 2019). The research of Dembo and Seli (2016) supports that self-regulated learning skills can be a predictor of academic success. When self-regulated learners are engaged – they adapt their thoughts, their feelings, and their actions to impact their learning and academic success. Additionally, both motivational and cognitive interventions are needed to effectively increase self-regulated learning (Pintrich, 2004; Zimmerman, 2013).

A gamified curriculum has the potential to be effective in a FYE course to address the issues of at-risk student motivation and self-regulated learning. Specifically, the use of game-based thinking, mechanics, aesthetics, and motivational design strategies has been successfully incorporated into curriculum design in order to promote learning (Fazamin et al., 2015; Kapp, 2012; Kim & Lee, 2015; Su & Cheng, 2015). One reason for this is that gamification has the potential to externally motivate students (Kumar & Khurana, 2012; Nah et al., 2014, Su & Cheng, 2015) which is key to its effectiveness (Burke, 2014; Sailer et al., 2017). The feedback associated with gamification can also empower students as self-regulated learners (Nicol & MacFarlane-Dick, 2006). Feedback strategies in gamification, such as rewards and incentives, can be effective at helping students set goals and reflect on successful learning methods (Dichev et al., 2018). Therefore, gamification may be a novel way to address both self-regulated learning and motivation for at-risk freshmen as part of a FYE course. With the promise of improved self-regulated learning and motivation, a gamified FYE course could very well be a suitable launching point for a student's successful academic career.

Purpose Statement

The purpose of this action research study was to evaluate the implementation of a gamified curriculum for at-risk students enrolled in a FYE course at a 4-year university. The first research question in this study explored how, and in what ways, the implementation of a gamified curriculum impacted the self-regulated learning skills of at-risk students. The second question explored how the implementation of a gamified curriculum impacted the motivation of at-risk students. And the third question examined the perceptions that at-risk students might have about the gamified curriculum on the quality of their learning experience.

Theoretical Framework

There were three theoretical frameworks that underpinned use of a gamified curriculum for this study. First, consistent with behavioral approaches which embody Skinner's theory of operant conditioning (Skinner, 1938), reinforcement schedules are used within a gamified curriculum by providing rewards, badges, and points at varying intervals order to maintain learners' interest (Kapp, 2012) by providing positive reinforcement (Woolfolk, 1998). Second, Ryan and Deci's (2000) Self-Determination Theory suggests that learners become more self-determined and motivated when three basic needs are met: Autonomy, Competence, and Relatedness. When assessed in this regard, gamification has been found to increase motivation by emphasizing positive learning habits, or fostering task-meaningfulness through chunked goals as well as immediate and positive feedback (Harrold, 2015; Sailer et al., 2017). Third, Turner and Paris's (1995) Six C's of Motivation theory was used as it emphasizes Choice, Control, Collaboration, Challenge, Constructing Meaning, and Consequences, all of which are inherent in effective gamification practices.

Methodology

Participants and Setting

The setting of this study was a FYE course at a regional campus in the South Eastern U.S. with an enrollment of about 2,000 students. The 16-week FYE section taught in Spring 2020 had 17 students. There were two inclusion criteria for the study—one was that the student had attended the university for at least one semester and that their GPA was less than 2.99, which is the institutional average. The other criterion was based on how, according to the provost, the university unofficially defines at-risk—students also could have failed a course to be eligible. After applying these criteria, 12 students were eligible to participate. Secondary to COVID-19 restrictions forcing the campus to shut down, two of the students did not login or finish the course. Thus, the purposeful sample population size of my study that met the inclusion criteria when data was being collected was 10 students. Sixty-percent of the participants were male and forty-percent were female.

Initially, the course met twice a week, in-person, for 75 minutes. The course was held in a classroom enabling each student access to a desktop computer where they could access the course content and all associated activities on the Blackboard Learn learning management system (LMS) during class meeting periods. After week 6, the COVID pandemic restrictions forced learning to be in the fully online environment.

Research Design

An action research approach supported trying out a novel gamified curriculum to help solve the problem of FYE students lacking self-regulated learning skills. Adjustments could be made through spiral of continuality, of implementing, evaluating, and revising the curriculum (Dick, 2002; Mertler, 2017). Use of a mixed-method design, with convergent strategies, offered the rigor of quantitative data analysis, coupled with the understanding gleaned from the qualitative data analysis. Triangulation was employed to ensure the findings were consistent regardless of the data collected or method utilized.

Innovation

The gamified curriculum was intentionally designed to help students acquire self-regulated learning skills through goal setting, strategic planning, task-strategies, meta-cognitive monitoring, help-seeking, and self-instruction. It was also designed to increase motivation, based on Turner and Paris' (1995) 6C's of motivation (see Table 1).

The gamification elements designed in Blackboard consisted of worlds, quests, badges, currency, and a progress board. During week 4 of the semester, it became apparent students were not engaged in gamification as part of the Blackboard LMS as

Table 1

Self-Regulated Learning and Motivation Elements Aligned to Gamification Strategies Using EdApp

Self-Regulated Learning Elements	Motivation Elements	Gamification Elements and Strategies
• Goal Setting	Choice	• Quests • Leveling-Up • XP • Currency (stars) • Achievements/Badges • Leaderboard
• Strategic Planning • Task Strategies • Self-Instruction	Control	• Gameplay • Quests • Leveling-Up • XP • Currency (stars) • Leaderboard
• Help-Seeking	Collaboration	• EdApp Customer Support Function • Group quests were not possible after everyone left campus due to COVID-19
• Meta-Cognitive Monitoring	Constructing meaning	• Quests • Leveling-Up • Achievements/Badges • XP • Currency (stars) • Leaderboard
• Goal Setting • Strategic Planning • Task-Strategies	Consequences	• Achievements/Badges • Leaderboard • XP • Leveling-Up • Currency (stars)
• Goal Setting • Strategic Planning • Task Strategies	Challenge	• Objectives • Quests • Leveling-Up • Achievements/Badges • Leaderboard • XP • Currency (stars)

evidenced by their expressed apathy and dissatisfaction, lack of checking their achievements, and paucity of enthusiasm during class discussions. Seeking a solution, some computer science students conducted a focus group with the FYE students to see what they desired in a gamification platform. The results indicated the majority of students preferred competitive games, convenient social media apps, and a strong desire for a visually attractive app. The majority said points would serve as a motivating factor and that they would like a leaderboard highlighting those students in the top running. As well, they would find extra-credit opportunities worthwhile to them. The recommendation offered was EdApp, a mobile LMS app with gamification capabilities of holding all the course content, and students could access the platform on their phones like any other app. Over the next couple of weeks when school was postponed for Spring Break and the COVID-19 transitioned to fully online course delivery, all of the class content (quests) were created in EdApp. This resulted in a seven-week innovation implementation. Fortunately, due to the ease of the platform, very little explanation was needed and students dove right in.

When students clicked on a quest, they experienced a journey with an opening objective followed by a mix of multiple-choice, free-response, Likert-Scale and true/false questions, words of encouragement, as well as various games. Slides were not static and there was always an element of interaction, whether it be pressing a button, swiping, dragging and dropping in a word, scrolling to select a number, circling the correct answer, drawing a line to associated items, expanding a bulleted list, or flipping a card for more detail, etc. Supplementary visuals and videos were also included so information could be expanded upon, or examined in more detail by students. Each main lesson quest concluded with a Jeopardy-style game in which students could win experience points (XP) and stars. Ending quest slides either offered encouragement, reminded students of the star bar opportunity, or an extra-credit mini-quest of the same name comprised of game opportunities. At the end of each extra-credit quest, students were encouraged to go to the star bar to spend their stars for a chance to win an Amazon gift certificate. In addition to the quests in EdApp, students were able to access the class leaderboard (populated by achievement points earned for each quest activity), the star bar (students earned star currency when answering reinforcement questions or engaging with the game slides in EdApp), their performance metrics (stars earned, lesson completion status, and badges earned), and the Brain Boost quiz function via the side menu in the app. See Figures 1 through Figures 4 for the design of EdApp used for this study.

Figure 1
Structure in Ed App

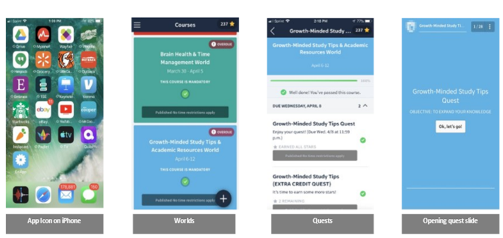


Figure 2
Answering Options

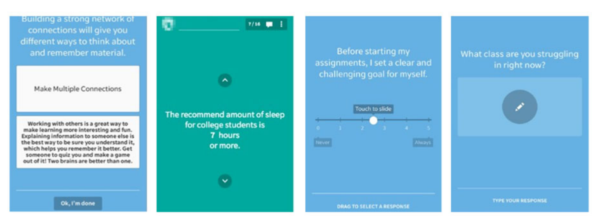


Figure 3
Badging Opportunities

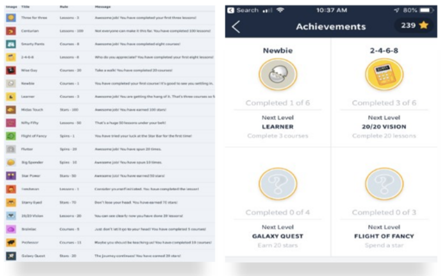
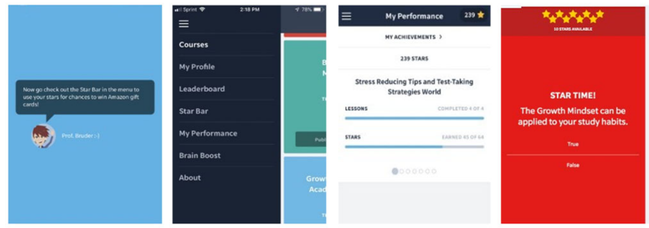


Figure 4
Game Currency: Star Bar



Data Collection

There were four data collection sources in this study: 1. Gamification Element Metrics; 2. Final Self-Reflection Learning Quest—which was comprised of free-response, multiple choice, and Likert-scale questions; 3. Reflection Journal Assignments, which consisted of two to three free response prompts; and 4. the Learning and Study Strategy Inventory (LASSI, Weinstein et al., 1987) which was administered to students at the beginning and end of the course. This survey measured the ten subscales of Anxiety, Attitude, Time Management, Test Strategies, Self Testing, Using Academic Resources, Concentration, Information Processing, Motivation, and Selecting Main Ideas. Each subscale was measured by the extent to which students agreed or disagreed, using a Likert-scale, with each of six reflection statements. To ensure rigor and trustworthiness, triangulation, member checking, thick, rich descriptions, peer debriefing, and an audit trail was conducted.

Results

Between the various LASSI subscale scores, the multiple-choice and Likert-scale questions used in the Final Self-Reflection Learning Quest, as well as the numbers of gamification elements and metrics, this study yielded sizeable quantitative data. The LASSI pre and posttest scores were analyzed using paired t-tests. The Bonferroni adjustment was used to help guard against the possibility of false positive findings since there were multiple measures to address a single research question. The findings revealed two subscales decreased, one remained the same, and seven increased—with only three of those being significant. After applying the Bonferroni adjustment, only the Self-Testing subscale showed statistical significance ($p<.001$) meaning participants' self-regulation regarding learning and study strategy skills improved after experiencing the gamified curriculum innovation. Descriptive and frequency statistics were used on the numbers of gamification elements. Without any context, it was difficult to ascertain whether or not these elements had intrinsic value. Therefore, a series of correlation analyses was performed, with Pearson’s r as the correlation coefficient, in order to identify statistically significant relationships between the LASSI subscale scores and the gamification element scale values. The findings indicated that the Information Processing posttest score strongly correlated with experience points (or “XP”, $r=.90, p=<.001$), as well as other measured variables, such as the number of stars earned (where in the context of EdApp, “stars” are a form of “currency”, $r=.89, p=<.001$). Information Processing also strongly correlated with the chance of winning a gift card motivating the student to do better in class ($r=.85, p<.01$). The gift card ranged from \$5 to \$20 during the course increasing the student’s desire to win one ($r=.82, p=.002$). The

Concentration posttest score strongly correlated with badges earned (*r=.81, p<.01*), and Using Academic Resources strongly correlated with the number of stars earned (*r=.80, p<.01*).

For the qualitative data, the process of inductive analysis began with initial rounds of coding that included Structural, InVivo, Process, and Descriptive coding (Saldaña, 2016). During the second cycle of coding, Pattern coding resulted in the emergence of 10 categories and subsequently, three themes. The first theme was students perceived their academic mindset and study habits to have improved which denotes an improvement in study skills as well as growth in terms of one's academic mindset. It is distinguishable from the other two themes in that it was tied to students taking the academic skills they have learned and applying them to their other classes. The second theme, the gamified curriculum served to motivate students was distinguishable from the other two themes, in that it involved more "will" to learn, as opposed to skill and ease of learning. The third theme, students perceived the gamified curriculum made their learning easier effectively addressed the impact that the content's delivery vessel had on students' experience.

Although the LASSI Motivation subscale was not found to be statistically significant (*p*=.08), it should be noted that the LASSI measured motivation across the board as it pertained to the students' total academic experience, which included other classes. It does not mean the gamified environment did not improve motivation in this class specifically, as evidenced by the many positive qualitative responses that the students provided (i.e., "The class has motivated me to become less lazy and get things done.", "This class motivated myself to manage my time when coming to studying for a test and having to finish something with getting enough time to sleep for class the next day", "I enjoy it. I like to compete and the games engaged me more in the classroom."). Virtual currency was also a big motivator for some students, especially those who participated in a chance to win a gift card in the star bar (M=4.5/6.0, SD = 0.90). As shared by one student, "The stars motivated me to finish my quests. The stars were my biggest motivation because I wanted to play in the star bar." Also, because the students found relevance in the content, they were more motivated to use what they learned outside of class. Three students expressed this in their final self-reflection learning quest responses, "When we went over the studying unit and how much you really should study, I applied that studying to my macroeconomics exam.", "This class helps you with your other classes and you can apply your knowledge.", and "I bettered my study habits in my history class."

Overall, the students perceived the experience on EdApp to be quite appealing—it was very well received, especially in terms of its clean, organized structure free of distractions, its perceived stress-free environment, its ease of use, and the opportunity to have all content right at one's fingertips on a mobile device. As stated by a couple students' final self-reflection learning quest responses, "This app sort of felt like a break and I enjoyed learning the information. My other classes are like stress and work. This was more of a weight off of my chest.", "I like the layout of the app, everything is well organized.", and "You can use it on the go with your phone and it was convenient if I was someplace else."

Discussion

It is essential to look at findings within current research regarding gamification in an educational context. To address the research questions, data were merged and analyzed through a mindset of self-regulated learning, motivation, and perceptions about gamified curricula.

The first research question this study explored was how, and in what ways, the implementation of a gamified curriculum impacted the self-regulated learning skills of at-risk students. The gamified elements of the course, as delivered through the EdApp platform, gave students an enjoyable venue in which to improve upon their own self-regulated learning as part of the course. This was not surprising, as when college students are given autonomy in gamified environments, they tend to have stronger self-regulated learning skills than students in traditional, controlled settings (Lambert, 2017). What made this gamified experience unique was that the students were actually learning how to improve their study habits through the curriculum content in addition to engaging with the gamified elements, thus providing them with a double dose of opportunity to improve in the area of self-regulated learning. As shared by one student, "The test-taking and study strategies were the most useful for me because test-taking and studying is usually what I have the most difficulty in." The opportunity for personal reflection allowed students to apply what they learned to their own lives and find meaning, showing how a gamification platform could be considered an ideal way to teach self-regulated learning skills such as goal setting and persistence through a growth mindset, especially as games exemplify these characteristics (Devedzic & Jovanovic, 2015; Educause, 2014; Gibson et al., 2015; Sailer et al., 2013; Tang & Kay, 2014). This was supported by a student's comment, "the course really helped me self-evaluate and better prepare myself for the future. I have not had a course that was so about myself and the critique and critical thinking of one's self-evaluation on schoolwork and everyday things." Students who are engaged and actively generating meaning while adapting their thoughts, feelings, and actions as necessary to affect their learning and motivation are considered to be self-regulated learners (Boekaerts & Corno, 2005). This can be accomplished with both video and written responses within the gamification platform as a form of metacognitive scaffolding to improve self-regulated learning (Tang & Wong, 2015).

The second research question explored how the implementation of a gamified curriculum could impact the motivation of at-risk students. Gamification has been found in the existing literature to yield increased motivational results (Harrold, 2015; Ling, 2018; Pilkington, 2018; Sailer et al., 2017). Quantitatively, this was not the case for the students in this study as the LASSI Motivation subscale did not indicate a statistically significant increase in score. However, qualitatively students did offer comments in their Final Self-Reflection Learning Quest about experiencing an increased sense of motivation through the use of the gamification curriculum. As evidenced by student responses on the final self-reflection learning quest, "After the class I've been really been motivated to do all of my assignments", or "pushed you to better yourself because everyone can better themselves." The integration of virtual currency through the form of being awarded stars in the EdApp curriculum was identified by students to be a source of motivation. As shared by one student, "The Amazon gift card thing was usually a challenge. I would end up spending all of my stars while trying to win." Additionally, the amount of engagement in earning badges, stars, and XP, which in turn resulted in students' completion of extra credit quests, are attributes directly associated with motivation (Yot-Domínguez & Marcelo, 2017).

Motivation through the use of a gamification curriculum can also be seen through feelings of competence and relatedness (Sailer et al., 2017). In order for competence to be experienced by the learner, gamified activities should pose optimal challenges to the student (Kam & Umar, 2018). Challenges in gamified curriculums can predict student learning while increasing engagement (Hamari et al., 2016). In this study, students voiced their pleasure in terms of the challenges they conquered in the course; which supported the notion that the motivational appeal of games may be their ability to provide players with challenges to master, thereby enabling feelings of greater competence (Mekler et al., 2017). Meeting students' needs for relatedness can be fostered by creating shared goals (Sailer et al., 2017) and achievements (Sillaots, 2015). In this study, a collaboration did not result from peers in class working together but rather from the students' collaboration having reached out to other students in the university tutoring center for help. As found in one student's reflection journal assignment response, "I was not suffering in silence anymore as I started going to the tutoring center." In support of this particular student's response, her score on the LASSI Using Academic Resources subscale showed an increase of 150% from the pretest to the posttest.

The third research question examined the perceptions that at-risk students might have about the gamified curriculum on the quality of their learning experience. Overall, this study's students' perceptions of their experience with the gamified curriculum using EdApp were very positive, and everyone shared that they liked the design of EdApp. In fact, they wanted more gamification, as found in a couple open-ended final self-reflection learning quest responses, "the whole course should be on the EdApp with the games", "use EdApp and make the whole class online.", "I wished we would have switched to EdApp sooner", and "it [EdApp] should keep going for years to come and be implemented in education as a whole." Although students' Concentration and Anxiety LASSI subscale scores did not show statistically significant improvement in their overall academic experience at college, there was a strong correlation between Concentration and badges earned. Moreover, students identified the gamified curriculum as making the content less distracting. As evident by two student responses, "I never felt distracted from the course," and "I felt less distracted in this course than any of my other courses." Similar positive student perceptions of the gamification elements were also found in the research of O'Connor and Cardona (2019). Gamification has been suggested as a platform to reduce anxiety levels in students (Paniagua et al., 2019) by offering low-stakes learning environments and allowing an opportunity for failure, which appeals to first-year college students (O'Brien & Pitera, 2019). As seen in one student response, "This app sort of felt like a break and I enjoyed learning the information. My other classes are like stress and work. This was more of a weight off of my chest." Other students as well perceived this class to be a stress reducing force in their lives.

As observed between this study's outcomes and that of Brom et al. (2019), students were indifferent to XP as a standalone gamification element, but they were more vocal in their attitudes regarding XP as displayed on the leaderboards. As one student expressed, "XPs in general were more like a bonus to me." Additionally, students can learn to view failure as an opportunity instead of becoming overwhelmed and helpless (Lee & Hammer, 2011). Students in this research aligned with the student perceptions of the research by Dicheva et al. (2019) as well as the research by Donovan et al. (2013) in that they tended to be more excited about the virtual star currency than badges, as shared by one student who felt "like a BOSS!!!" However, leaderboards and badges can also promote a sense of competence (Bai et al., 2020; Sailer et al., 2017), which was the case for one student who responded on the final self-reflection learning quest that she felt like she had "accomplished something" when earning a badge.

Student responses in this study reflect those of Shroff et al. (2020) showing that they really liked EdApp as it met the characteristics of being transparent, fun to use, and aesthetically pleasing; having a comprehensible organization of course content; and being easily accessible at all times of the day. As a couple students expressed in their reflection journal assignment responses when asked to compare the use of EdApp and Blackboard Learn, “It’s more interactive. It just felt cool. It was more than I was expecting.”, “EdApp is fun, colorful, and interesting,”, and “I love that games are part of the lesson and the stars remind me of coins in a game.” Many students also noted that EdApp was easy to use, “It is fast and smooth, making it really not annoying to work on.” and “I like the layout of the app, it is well organized.” However, it should be noted that students did encounter some hiccups with EdApp as well, “It made me restart the lesson a few times” and “it did glitch a little”. However, these glitches did not appear to temper their perception of the experience overall.

Implications

Gamification research should not be restricted to motivation, satisfaction, academic achievement, and engagement; it should also include the potential to promote teamwork and group cohesion (Bilgin & Gul, 2020). In a future implementation, it is recommended to add items to quests, perhaps adding extra-credit quests, to promote teamwork (Donovan et al., 2013) while realizing a more socially interactive experience that can help users develop social competence (Tang et al., 2020) through cooperative and collective gamification approaches (Koivisto & Hamari, 2019). An emphasis on a more social gamification experience would likely help build the participant’s social status, resulting in better retention rates and skill acquisition (De-Marcos et al., 2016). Use of the video discussion feature in EdApp, asking students to comment on various questions and concepts via the video chat, could help accomplish this.

An important element of incorporating gamification elements into academic courses is to provide students with a sense of control over how their learning takes place (Shroff et al., 2020). Moreover, when college students are given autonomy and choices through gamification, they tend to have stronger self-regulated learning skills than students in traditional, controlled settings (Lambert, 2017). Incorporating more choices of quests and activities within them, supports the notion that learners should believe they have freedom as a result of their own decisions to choose tasks or challenges presented to them (Turner & Paris, 1995). Clear goals can help structure the learning task and increase the learner’s feeling of competency and sense of autonomy (Brom et al., 2019). Learners who have a clear goal are more likely to complete a task than those who are simply told to do their best (Jung et al., 2010). During this study, badges were awarded for completing quests; however, it could have been more effective to have them match specific objectives or goals of the course (Bai et al., 2020). Incorporating badges into a leaderboard as a different means of social comparison than points (Bai et al., 2020) or markers (Hamari, 2017) may be something to consider, especially as leaderboards require participants to set their own goals, striving to place themselves at the top (Landers et al., 2017).

Other FYE instructors should keep in mind that student centered learning with the teacher as a moderator instead of lecturer, is essential in gamified environments (Lengyel, 2020). Traditional content can be refined with key salient points being emphasized on the gamified platform. Students can be savvy consumers that expect technical accessibility and adaptability of content at their fingertips, which can be addressed by the adoption of mobile apps to deliver gamified curriculum in a higher education setting. Effective gamification has the potential to help with retention, especially if delivered on a mobile app, offering the students constant accessibility (Pechenkina et al., 2017). It has been said that gamification is not about technology or a digital platform but rather the design and development of innovative instruction which incorporates game elements into activities (Zainuddin et al., 2020). However, the technology is not irrelevant. Use of the EdApp platform made the delivery of instruction easier and better in this study. This platform had preformatting that was applied to all text, which helped to make content look inviting and consistent. Instead of offering a busy PowerPoint, EdApp distilled that content down to salient points to be presented with ample white space and the capacity for scrolling and swiping as mandated by the necessary constraints of the EdApp platform. This ensured a clear and effective experience for the student users. In order to keep the FYE intimate, there needs to be plenty of opportunity for self-reflection and communication. Given that students had numerous opportunities to self-reflect, they were able to ascribe their own relevance to content and the experience. The EdApp gamified curriculum allowed students the freedom to fail and try again, which embodies the Growth Mindset (Dweck, 2007) at its core. As shared by one student, "The aspect that motivated me the most was the growth mindset quests." In contrast to the assumption that gamification is more time-consuming for the instructor—especially with technical issues (Daubenfeld & Zenker, 2015) and the increased amount of grading required in order to keep up with rewards and achievements (Evans, 2016)—a key benefit of gamification is that once the content is loaded into a platform like EdApp, the professor will have sufficient time to reach out to students personally and to spend time thoughtfully responding to their reflections. It should be noted, however, that the time commitment in setting up this system on the backend is significant (Bratt, 2020).

More gamification FYE studies are needed—especially those that are participant-focused and examine different types of learners. Studies need to be larger and longer, and they could examine personal versus private dashboards, especially in terms of goal-setting. Research should also be done to measure the effectiveness of different learning management systems and their potential to deliver a gamified curriculum. Implementing gamification platforms can change, for the better, how classes are taught and how the content is presented. It has been suggested that, similar to the swiftly changing field of gaming, the study and usage of gamification requires a constant review of research findings as it continues to evolve (Hulsey, 2015) both technologically and pedagogically (Banfield & Wilkerson, 2014; Barneva et al., 2017; Toyama, 2015).

Limitations

The most unexpected limitation of this study was the COVID-19 pandemic, which sent students home, and moved the class entirely online. The pandemic affected students' dispositions both in terms of motivation and turning in assignments in a timely manner. Other limitations include that of action research itself, which is not generalizable as well as the novelty effect (Clarke & Sugrue, 1988) that is common in gamification studies (Hamari et al., 2014; Hanus & Fox, 2015). And, of course, there are the challenges associated with self-reported data. The more widespread gamification LMS platforms become, and the more they compete for adoption, the more they are likely to continually refine and update their product, which will free the instructor to focus more on student relationships and keeping their content, not the platform technology, current.

Compliance with Ethical Standards

Conflict of Interest: The authors declare they have no conflict of interest.

Research Involving Human Participants: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to Participate: Written, informed consent was obtained from individual participants included in this study. No identifying information about these participants is included in this article.

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Effective Transfer of Meaningful Design of Active Instructional Tasks to Online Synchronous Format. Potential for Transitional and Post-Pandemic Instruction

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Abstract

An introductory pharmaceutics course was redesigned before the pandemic to integrate deep-learning active tasks. The primary objective of this research proposal was to analyze the design transfer for an online synchronous context and monitor its impact on students' performance, perceptions, and beliefs. We found that highly integrated active learning tasks effectively transferred to the online format. In addition, student performance, perceptions, and opinions were similar or slightly better when compared with the live form of the course.

Motivation and Objectives of the Study

The COVID-19 pandemic restrictions at the local university at the beginning of the Fall 2020 semester allowed the instructors to decide whether the course will be offered in mixed-attendance format with both in-class and online groups or fully synchronous online. At the same time, when the instructor provided mixed attendance, students could decide if they would use the live or online option for attendance. For the courses that offered live attendance options, the state-wide distancing strategies were implemented, and masks were required.

For this research study, the focus was an introductory pharmaceutics course (Pharmaceutics I) that was redesigned before the COVID-19 pandemic to integrate active tasks such as in-class instant feedback with a personal response system (clickers) as well as deep-learning strategies such as productive failure (Cernusca & Mallik, 2018) and concept mapping (Cernusca & Mallik, 2020). When faced, due to COVID-19 pandemic restriction, with the choice of a mixed-attendance or fully online option for the pharmaceutics course, the instructor worked with an instructional designer and decided to implement a fully synchronous online option to adequately transfer the benefits of the active learning strategies already built in the course design.

The primary objective of this study was to describe the impact of the design constraints and affordances specific to the local COVID-19 pandemic context on the nature of the course implementation and analyze the impact of the design transfer to online format on students' performance, perceptions, and beliefs.

Instructional Design Affordances and Constraints

Design in general, and instructional design as one of its subsets, is a complex, ill-structured, and context-driven problem-solving process (e.g., Jonassen, 2011). Therefore, as a first step in designing or redesigning an instructional process, is the analysis of the design constraints and affordances specific to the target context of the instruction (Larson & Lockee, 2014).

Design Constraints

The target Pharmaceutics I course was built, at the time of this study, on a heavy integration of the active learning tasks into the lectures that ranged from basic active learning tasks (e.g., clicker questions) to more extensive strategies such as productive failure and concept mapping. Before the course started, because of the COVID-19 pandemic distancing requirements (Figure 1), the instructor had the option to use a mixed-attendance option and split the class into two groups: one group came to the class and the other attending remotely through Zoom. Besides the issues related to ensuring an equitable split of the students for the two attendance groups, several instructional constraints associated with selecting the mixed-attendance option were found.

Figure 1
Typical COVID-19 Pandemic Classroom

First, the classroom designated for the course was not fitted with audio and video technology to seamlessly integrate distance students in the live classroom. Consequently, a mixed-audience option would not allow integrating the live and remote students during the discussions associated with the hands-on activities in the course. Moreover, even for the students in the classroom, the requirements of safe distancing combined with the use of masks would have been hardly conducive to teamwork. Second, with a class size of 62 students, the instructor decided that it would be very hard, if not impossible, to fully and effectively integrate the live and the remote groups during the class time, especially without any previous training and a very short time to prepare for this type of classroom setting.

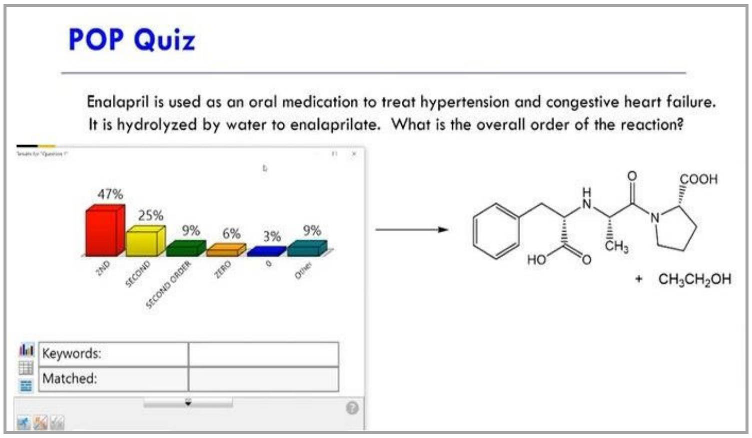
Design Affordances

On the other hand, when the existing course design and implementation were analyzed, several design affordances pointed toward the benefits of a fully online synchronous format of the course.

First, the lecture materials used in the course were already in a digital format, PowerPoint slides. Therefore, these instructional materials were readily transferable to an online synchronous form using online conferencing platforms such as Blackboard Collaborate Ultra or Zoom, both available to the instructor at the time of this study. Second, and even more critical for the overall effectiveness of the instructional process, active learning tasks were either already using a virtual tool or strategy (e.g., virtual clicker questions for on-time feedback) or directly transferable to online synchronous format (e.g., breakout rooms for group activities).

For example, active learning tasks already integrated into the instructional process, such as think-pair-share and productive failure, used virtual clickers in the live format and required no accommodations to transfer them online (see Figure 2).

Figure 2
Virtual Clicker Question Used During Lectures



Finally, the exams were set up in the live format of the course as open-book, and the only restriction imposed to the students during the exam was to not communicate with peers. This exam-related requirement could be easily enforced by requiring the students to use a second device that will allow live monitoring of their working space in the online conferencing environment used for the course.

Transfer of the Course to Online Synchronous Format

The analysis of the design barriers and affordances indicated that the synchronous online format of the course would fully use the identified design affordances and minimize the potential negative impact of design constraints. Also, a pre-course short survey sent by the instructor to the course cohort provided support for the above decision with most of the students either having a strong preference for online format of the course or no preference for a specific course format and only less than a fourth of the students indicating a strong preference for the live form of the course.

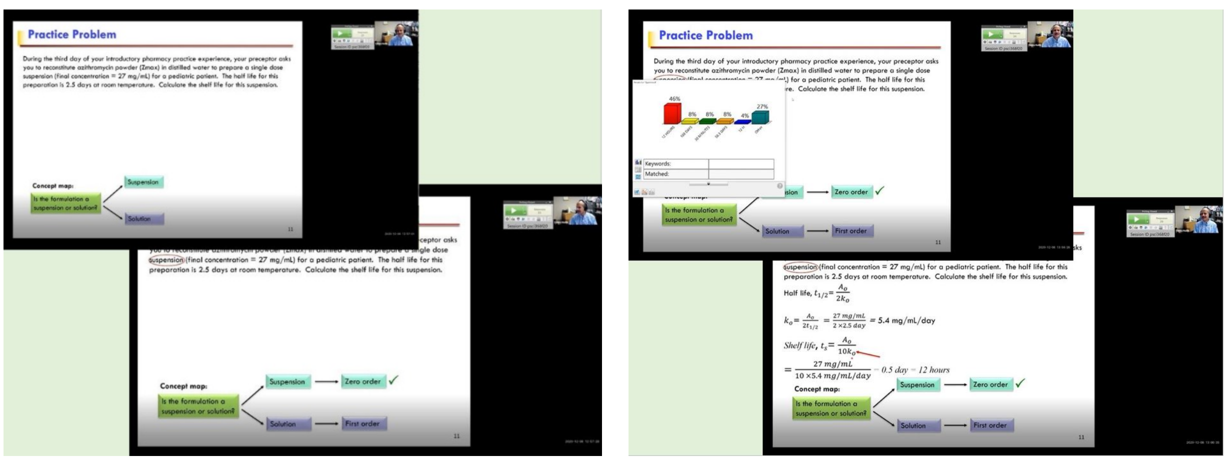
At the same time, the above analysis indicated that the instructor's preparedness for the online course administration was critical for the transition to the fully online format of the course. To ensure the effectiveness of the instructional process, the instructor set up a well-equipped office with a second monitor and HD webcam that allowed a smooth control of the course materials and a continuous monitoring of the chatroom. The online course was administered with Zoom® (https://zoom.us/) conferencing platform. All the online features required as part of the synchronous online course administration, from the chatroom to breakout rooms, and the use of the virtual clicker were pre-tested by the instructor with the help of an instructional designer and the teaching assistants assigned for this course. This process continued during the semester through short debriefing meetings between the instructor and the instructional designer and resulted in fine-tune adjustments to the online instructional process. Once the course started, the instructor kept his camera on and encouraged all students to keep their cameras on to get as close as possible to the live format of the course. On average, about 90% of the students complied to this request from the instructor and showed their cameras during the course (Figure 3).

Figure 3
Sample Lecture Zoom Wall-View

During the online synchronous lectures, the instructor successfully integrated active learning strategies such as clicker questions and concept mapping to support the problem-solving process and productive failure to provide additional instructional support for difficult problems. All these strategies were built and tested as part of live activities prior to the COVID-19 pandemic.

For example, Figure 4 shows a sequence of steps associated with a practice problem for which the instructor used a combination of concept mapping conceptual guiding strategy and clicker questions as support for the problem-solving process associated with worked examples used in the lecture.

Figure 4
Integration of Concept Maps and Virtual Clickers During Online Synchronous Lectures



Finally, for the team activities that ranged from the think-pair-share tasks associated with knowledge testing clicker questions to problem-solving, the instructor randomly split the class into small groups using the breakout room feature in Zoom. Then, when the problem-solving was the focus of the group activity, the instructor asked a representative from each group to type their answer in the chatroom and used the students' chatroom input to move to the next step in the instructional process.

In addition, at the beginning of the semester, the instructor decided to monitor the overall pandemic situation for one month and decide at that time, along with his students, if a switch to hybrid attendance would be preferred. However, when students were asked about the potential change in the course format, they selected the fully online synchronous option for the entire semester.

Design Transfer Effectiveness: Research Methodology

The instructor worked with an instructional designer both before and during the COVID 19 pandemic to monitor the significant active learning instructional tasks implemented in this course to identify possible improvements in the course structure.

Research Design

We used a comparative exploratory quantitative research design for this study complemented with qualitative triangulation data from students' course evaluations. The analyzed dependent variables were students' course self-efficacy, perceived course difficulty, perceived impact of productive failure, the perceived impact of concept mapping on students' learning and student performance outcomes for two assessments significant for the major active learning tasks implemented in this course. The independent variable was the cohort and had two levels: pre-pandemic face-to-face instruction and CODIV-19 fully online synchronous instruction.

Data Collection

Every semester the instructor administered a prior knowledge survey to test the homogeneity of the cohorts. In addition, an exit survey that included believes and perception constructs adapted from the literature was administered online using Qualtrics during the last two weeks of the course. The exit survey included a beliefs construct, self-efficacy, adapted from Bham et al. (2011) and three perception constructs, one related to perceived course difficulty adapted from Kappelman (1995) and two related to the perceived impact of productive failure and respectively concept maps, adapted from Grasman et al. (2013). All constructs were evaluated on a 1-low to 9-high scale, and most of them showed a very strong internal reliability above the 0.70 benchmarks suggested in the literature, as follows: self-efficacy, Cronbach's Alpha=0.91; perceived difficulty, Cronbach's Alpha=0.62; the perceived impact of concept maps and respectively productive failure both with Cronbach's Alpha=0.97.

All students enrolled in the course were invited to participate in this study. Participation was voluntary, and there was no payment or grading reward for participating in this study. For the face-to-face group (Fall 2019) of the 75 students enrolled in the course, 74 (99%) completed the prior knowledge quiz and 56 (75%) completed the exit survey. For the online group (Fall 2020), of the 62 students enrolled in the course, 60 (97%) completed the prior knowledge quiz, and 36 (58%) fully completed the exit survey.

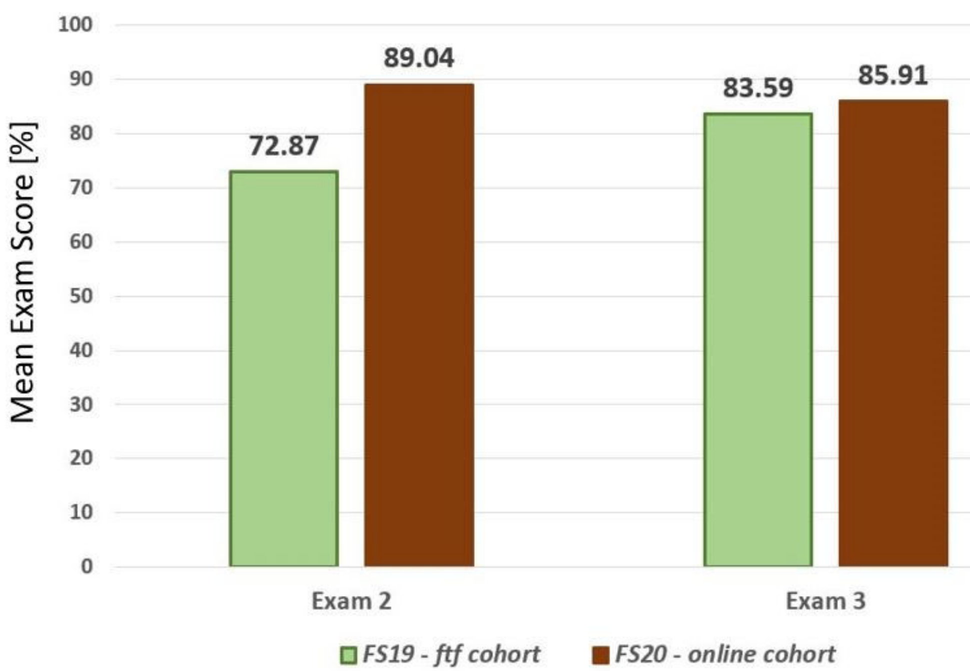
Data Analysis and Results

Data was analyzed using SPSS v27®. An independent sample t-test indicated that the exam mean score for the online cohort (38.33%) was slightly higher than for the pre-pandemic cohort (38.12%). However, there was no statistically significant difference between the mean scores of the two cohorts ($p = 0.93$). This finding showed that the two cohorts were homogeneous at the entry point in the course.

To analyze if the transfer of the target course to the online format was successful in the first stage, we examined students' perceptions of the major instructional strategies implemented in the course and the course as a whole. First, an independent sample t-test indicated that for the perceived impact of productive failure. At the same time, online students' mean score (6.61, on a scale of 1-low to 9-high) was lower than for the live cohort (6.95). However, the difference was not statistically significant ($p = 0.36$). Similarly, the mean score for the perceived impact of concept maps for the online cohort (6.59) was lower than for the live cohort (7.21), but the difference was not statistically significant ($p = 0.11$). Second, an independent-sample t-test indicated a statistically significant lower perception of online course difficulty, 4.94 compared to the pre-pandemic face-to-face format of the course, 5.96, $t(90) = 3.55$, $p < 0.01$.

In a second stage, we analyzed two factors related to student performance, epistemic beliefs, typically seen as a proxy for learners' future performance, and respectively student performance on the two assessments, second and third exams, that measured the impact of productive failure and concept mapping strategies. First, an independent-sample t-test showed that the mean scores for the online cohort (7.06, on a scale from 1-low to 9-high) were practically identical to the fact-to-face, pre-pandemic cohort (7.04), $p = 0.95$. Second, for the second and third exam that included assessment items that were the target of the two primary active learning strategies implemented to improve students' learning outcomes, concept mapping, and respectively productive failure, the average mean scores were higher for the online cohort when compared to the face-to-face, pre-pandemic cohort (Figure 5).

Figure 5
Mean Exam Scores for the Online and Face-to-Face Cohorts



While the online cohort had higher mean scores than the face-to-face, pre-pandemic cohort, an independent-samples t-test indicated a statistically significant difference for Exam 2, $t(129) = 9.84$, $p < 0.001$ but no statistically significant difference for Exam 3 ($p = 0.30$).

Finally, students' comments from the course evaluation report confirmed the effectiveness of the transfer of the course to the online format during the Fall 2020 semester. They ranged from focused short answers that recognized this effectiveness, "…thank you for easily adjusting class to zoom", to the ability of the instructor to make the course easy to engage in, "I enjoyed his class! He [the instructor] was easy to listen to and did very good at keeping us focused, which is very hard to do when a class is only online" and to the more detailed description of the benefits of this fully online format compared to the regular in-class format:

> Overall, I really enjoyed going to this class every day, even though I do not normally enjoy Zoom lectures because of how dry they tend to be. He [the instructor] was quite the opposite. He also was able to get at least 90% of the class to turn on their web cameras during the lecture, which was impressive.

Discussions and Further Research

The research results from the analysis of students' self-reported and assessment outcomes data indicated that highly integrated and targeted active learning tasks can be effectively transferred to an online synchronous format. The student perceptions, epistemic beliefs, and assessment performance were similar, slightly better, or statistically significantly better than the ones we found in the live, pre-pandemic format of the course. In addition, student input in the final course evaluations supported our findings from the quantitative analysis.

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Application and Feasibility of various Teaching Tools used in Online Classes during Covid-19 in Tertiary Education

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Abstract

The study aims at comparing the effectiveness, popularity and the ease of applicability of different learning tools in virtual classrooms among university teachers and students, with reference to the users' technological literacy and trainings, as well as equipment support offered by the universities during the pandemic. Comparisons between face-to-face teaching in classrooms and virtual classrooms online will be drawn, with respect to limitations, incentives, motivation and effectiveness towards learning. This also leads to the question of future course development by exploring the possibility of course design and assessment restructuring with a switch to online education with the new mode of technology as the trend.

1. Introduction

This research conducted aims at investigating the tertiary learners' and educators' perception and attitudes towards gamification in both online classrooms and face-to-face classrooms, during and before the outbreak of the pandemic in Hong Kong. This study also focuses on the effectiveness, practicality and limitations of game-based learning in motivating and engaging students towards effective and sustainable learning in remote and traditional classrooms in higher education in Hong Kong.

2. Methodology

Two sets of questionnaires were administrated and distributed to university and college students and teachers in Hong Kong studying and teaching in various English Language courses at different levels. Among the student respondents in questionnaires and surveys, a vast majority of them (90.7%) are undergraduate degree students from different disciplines and specializations taking English Language subjects across curriculum among different universities in Hong Kong during the pandemic era. More than half of them (63.2%) are currently studying bachelor degree programmes in The University of Science and Technology, followed by undergraduates from The Hong Kong Polytechnic University (23.7%), City University of Hong Kong (5.3%) and King's College of London (1.3%).

Apart from education background and the level of competence in English Language acquisition, gender also plays a role as determinator of the competence and attitude towards game users in classrooms. Considering this variable, respondents are asked to indicate their gender in the questionnaires. Interestingly, a majority are males (72.4%) while a minority are females (26.3%). In addition, 90.7% belong to the student group whereas 9.3% are English Language teachers in universities and colleges in Hong Kong. Further data analysis later reflect how demographic and other gender variants can govern the competence of digital technology, practicability of gamification and thus the effectiveness and success of gamification in classrooms, which influences the level of interactive learning environment and student-teacher relationship in both online and face-to-face classrooms.

3. Results and Findings

It is concluded game-based learning is an interactive learning methodology and instructional design strategy that integrates educational content and gaming elements, by delivering interactive, game-like formats of instruction to learners [2]. Moreover, such learning integrates aspects of experiential learning and intrinsic motivation with game applications that have explicit learning goals, thereby allowing learners to engage in complex, problem-solving tasks and activities that mirror real-world, authentic situations [2]. With simulation and physical artifacts, physical classmates could be simulated during the pandemic period.

3.1. Learners' perception and attitude towards gamification among universities and colleges in Hong Kong

Among the student respondents, a vast majority (87%) of university and college students indicate positive perception towards the effectiveness of learning in classrooms through gamification. On the other hand, only 1.4% disagree learning through games is effective. More than one-tenth (11.6%) totally agree that learning through games is effective while more than half of them (55.1%) strongly agree such teaching strategy is effective. More than one-third (31.9%) believe that it is somehow effective. In the view of the perception of effectiveness of gamification towards classroom learning from students' perspective, a majority (73.9%) think that incorporating games is a constructive means to learn. 15.9% regard this approach as the most effective, followed by 58% perceive gamification is very effective in tertiary education and 18.8% are neutral. 5.8% disagree that gamification is an effective pedagogy in helping university and college students to learn better while 1.4% regard it as the least effective way.

More than half of them (53.8%) believe the major reason is that learning through games in classrooms is fun, followed by 26.2% regard visuals and colours are more appealing than plain words which come as the second most important concern. Interestingly, more than one-tenth of student respondents (10.8%) explain that they want to win their fellow classmates which demonstrates peer influence as an important factor in governing the level of class participation. Less than one-tenth (7.7%) feel that gamification encourages them to accomplish tasks through teamwork, which in return motivate them to learn with peers. 1.5% believe that playing games online has been the trend and therefore it is necessary to incorporate games in classroom learning.

3.2. Students' recount of university teachers' experience in using game-based platforms and other innovative digital tools in online classrooms and face-to-face classrooms for English Language subjects

Among all the game-based platforms, more than half of the student respondents (55.4%) recall the experience of having their English Language teachers using "Kahoot" in their virtual classrooms in their universities or colleges in Hong Kong in both online classrooms during the pandemic and face-to-face classrooms before the pandemic. Shared document serves as the second most common digital tool in the language classrooms, which constitutes almost one-fifth (18.5%) of students have the experience in being asked to use shared document. 7.7% of them have experienced roleplays in English Language classes, followed by 4.6% have used storyboards before. A small minority (3.1%) have used Class123. The other 3% indicate that they have been instructed to use Soqqle and Flipgrid, with 1.5% students out of 3% revealing their English Language teachers have used Soqqle and Flipgrid respectively. 5.5% reveal that they have never experienced any digital learning tools in classrooms except Zoom as the major communicative classroom platform during the pandemic in Hong Kong.

[3] points out that teachers experiment different digital teaching strategies which focus on visual such as images, paintings and shapes; auditory through rhythms, chants and tones; and kinesthetic like body movement and gestures, in order to help students to stay engaged with the taught materials in the remote learning. Among all, one of these teaching strategies is learning through gamification. With reference to the comparison of frequency of usage of various games in online classrooms and physical classrooms, 34.8% of student respondents believe that teachers have been incorporating games in online classrooms as much as face-to-face classrooms. While 33.3% claim that there are more games to be designed in physical classrooms, 26.1% recall more games have been incorporated in online classrooms during the pandemic instead. Only 5.8% cannot recount their learning experience in relation to learning through games in classrooms.

3.3. "Kahoot" is favoured as the most popular game-based platform in digital learning among university students and teachers in Hong Kong

Among all the game-based platforms, it is found that Kahoot is regarded as the most popular game by English Language teachers in both online and face-to-face classrooms. It has a user-friendly interface that requires low level of technical expertise and the use of "Kahoot" increases undergraduate students' motivation because of its easy-to-use implementation [4]. According to research from [4] the before and after tests, "Kahoot" was concluded to be one of the most effective digital tools which encouraged creativity and innovation. In the studies, it was found that active participation of students stimulates their imagination and their creative capacity to make their own tests and learn from those made by their teachers and classmates. It successfully increases students' engagement and motivation to learn and their ambitions for success as it creates a stimulating and competitive environment in which students actively participate. In fact, both students and teachers can create a positive learning experience in a clear and understandable way using only pictures, video and questions to foster an intensely innovative social learning experience. Furthermore, "Kahoot" is easily accessible by any device with internet connection, smart phones, tablets or laptops. It thus promotes a type of synchronous interaction that encourages real-time collaboration and fosters a sense of community, promoting participatory evaluation that favors the development of cross-disciplinary skills [4]. Furthermore, "Kahoot" and other similar innovative tools been shown to improve students' ability to grasp the meaning of new information, ask questions, make decisions, and draw conclusions that help achieve learning goals and expected outcomes. The results obtained in also confirm students positively value the use of this digital platform, which can encourage the adoption of these motivating ICT proposals in similar contexts later [4]. With regards to the data on the digital competence of learners, it should be noted that the participants welcome these online proposals and feel able to master this platform in terms of understanding game options, basic instructions and question formulations. More importantly, no specific training or complex technical knowledge is required [4].

3.4. University students' comparison of the effectiveness of gamification in online classrooms during the pandemic versus face-to-face classrooms before the pandemic

In this view, there is a significant remark that the popularity of gamification in classrooms lies in face-to-face classrooms more than online classrooms, while there is a similar proportion of student respondents reckon that teachers use games in online classrooms as much as face-to-face classrooms. This illustrates that gamification is not an exclusive approach to be commonly used in virtual classrooms by English Language teachers in universities and colleges in Hong Kong only during pandemic era. On the contrary, the contexts and localities of teaching are not a factor in governing whether they adopt gamification in classrooms or not, with or without the impacts from the pandemic and social distancing measures in the society. Considering a small proportion of students fail to recall their learning experience as shown from the questionnaires, the limitations of the effectiveness of using gamification in teaching and learning will be further analyzed in later section.

4. Implications

4.1. The necessity and need for gamification in online university classrooms during the pandemic and the possibility of transformation from traditional teaching practice to game-based learning (GBL)

The promotion of game-based learning (GBL) has undoubtedly changed academic environments and traditional teaching styles by significantly modifying the roles of teachers and students [4]. In particular, GBL implies more active participation in these learning processes with regards to students, who responds more effectively to their current interests while improving digital literacy and promoting quality and sustainable education [4]. To achieve these objectives, the emergence of new teaching and learning models has encouraged educators, as social actors, to adapt to the needs of learners in order to create conditions suitable for developing more motivating and innovative practices [4]. Today, remote controls are no longer necessary because smartphones, tablets or laptops favor the implementation of these systems due to wireless connections, applications and websites. Therefore, content knowledge and fun can be merged into daily lessons without the need for other intermediate devices due to the advancement and application of Information and Communication Technology (ICT). On the Internet, a variety of high-quality online platforms can be found such as “Kahoot”, “Socrative”, “Quiz”, “Acadly” or “PollEverywhere”, inter alia [4].

However, it poses a challenge to discover the dichotomy and contraction between the internalization of necessity of gamification in various modes of classrooms by students and teachers, and the success of gamification in virtual classrooms versus face-to-face classrooms in enhancing the effectiveness of learning and motivations of university students, especially during the pandemic in Hong Kong. Some interviewed students hold the view that online games are equally popular in face-to-face classrooms to online classrooms. Likewise, games in face-to-face classrooms are as much as being adopted by teachers before the pandemic in Hong Kong when compared to online university classrooms during the pandemic in Hong Kong. While it may be deduced that the trend of incorporating different games in university classrooms to make the classes lively and fun is commonplace due to the global pandemic, some students reveal that the process of gamification is actually smoother and more effective in face-to-face classrooms even before the pandemic when online mode of classes have not been adopted. This conforms to the earlier finding that more than one-third of student respondents (34.8%) in the questionnaire highlight that their teachers have been incorporating games in online classrooms as much as face-to-face classrooms. Similarly, slightly more than one-third (33.3%) recall that more games have been incorporated in their formal face-to-face classes in English Language acquisition. While it may be expected that gamification is getting more popular in online classrooms as digital learning has become the prevailing norm in education across different disciplines and sectors accelerated by the global pandemic, games of different categories and pedagogy have been popular in fact for long in face-to-face classrooms even before the outbreak of Covid-19.

Rather than a surge of popularity of gamification in virtual classrooms, only approximately one-quarter (26.1%) of the student respondents recount their memory of having more games in online classrooms in their learning experience in universities or colleges during the pandemic period in Hong Kong aforementioned. A few interviewed students also conclude that games in online classes cannot serve the purpose of attracting students' attention during class fully, which means that gamification is a less dominant and significant driving force in motivating students to learn in virtual classrooms since face-to-face presence promises students' attention span. In addition, it is suggested there is a possibility that some university and college students may just simply ignore the game playing part in class during online lessons. However, teachers can ensure every student is engaging in the assigned games in face-to-face classrooms due to the physical presence. In this light, gamification is not the solely effective way to facilitate students' interaction with their fellow classmates and teachers as much as we expect. Games cannot guarantee all students are entirely participating in the whole lesson during either online or offline classes.

4.2. Students' preference of various gaming tools and perception of the reasons for English Language teachers not adopting gamification approach

Regarding the categories and nature of games to be incorporated in virtual learning, almost half of the student respondents (47.8%) claim that they prefer both competitive and collaborative games. More than one-fourth (26.1%) prefer competitive games, which compose of the competitive elements among classmates. Level-up games in which students need to proceed to different levels are only popular among less than one-fifth (18.8%) of the student respondents. Collaborative games come to the least popular, in which only 7.2% of university and college students in Hong Kong prefer teamwork during class activities.

It is found that university and college students in general have the perception that time is the dominant factor for the absence of gamification in university classrooms. Less than half of them (41.8%) believe that teachers lack time to prepare for games to be incorporated in classrooms, especially during the pandemic era. However, almost one-fifth (19.4%) perceive their English Language teachers are not synchronous with the concurrent trend and thus gamification in classrooms is not adopted. 16.4% account their teachers may not understand the importance of games, while 10.4% interpret their teachers may not know much about games and 9% believe their teachers may not comprehend the importance and need of games. 1.5% indicate the absence of games in classrooms is due to the difficulty in designing different games for some specific subjects like language, literature and statistics.

4.3. University students' perception and attitude towards gamification in general in English Language teaching classrooms in Hong Kong

It is interesting to find out that students in general tend to equalize whether lessons are fun and interesting as the determinators for their intrinsic and extrinsic motivation in learning. Most of them assess whether their learning experience is effective or not mainly on the basis whether their teachers can keep their attention long during the entire classes. In addition, physical sensations to physical body and positive psychology both play the vital roles in motivating university students to learn better in classrooms. Apart from the fun nature of games as the chief motivator, the second most important reason to support games to be incorporated in classroom learning is due to the intrinsic nature that visuals and colours in the design of games are more sensationally powerful than plain words, followed by learners' desire to win their peers as the third key cause in their conclusion that gamification can motivate them in both virtual and face-to-face classrooms. In other words, it is obvious that traditional classrooms with teachers' one-way lecturing and teacher-centered classrooms are no longer enough to satisfy students' need for innovative learning as the new trend nowadays, especially with the acceleration of digital learning impacted by the outbreak of Covid-19 in the globe. [5] identifies gamification as “using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems”.

An active learning context refers to the various learning approaches and instructional methods such as experiential learning, collaborative learning, cooperative learning, case-based, inquiry-based, problem-based, team-based and game-based learning. These different models cover the subset of active learning. Hence, active learning is an umbrella concept that encompasses the different learning approaches and instructional methods of learning [2]. As aforementioned, almost half (47.8%) of the university and college students respond they prefer both competitive and collaborative games, followed by competitive games as the second most popular type of games (26.1%), then level-up category of games (18.8%), and finally collaborative games (7.2%) come to as the least popular kind. From the collected data, it is illustrated that university students have greater expectation on the variety of games that they can be exposed to in classroom learning owing to the commonplace digital learning and technological competency. Competitive games in which students compete with their fellow classmates and level-up games require players to proceed to advanced levels progressively are more popular than collaborative games comparatively. By examining the demographic background of the targeted respondents and interviewees, these groups of university and college students belong to a more advanced and mature learners than the younger learners before the admission to tertiary education. This can be explained by the psychological behaviour of learners, who are academically and mentally stronger students from dominant universities and colleges in Hong Kong, and simultaneously having the experience in surviving through public examinations, tend to be more used to competitive learning environment and thus are relatively more self-driven to win. On the other hand, collaborative games such as games relate to teamwork are regarded as less popular among these student groups. This can imply these student respondents in general may imagine their fellow classmates as academic rivals rather than teammates to collaborate and cooperate with. Level-up games are also popular due to the sense of achievement and accomplishment that students can attain by proceeding to another level, which can also be impacted by the prevailing level-up concept designed in video games that students are always exposed to nowadays.

Many studies have proved that friendships play a critical pivot on students’ social, emotional, and cognitive development. [6] found that about 50% of students’ achievement-related comparisons were made with their best friends and they often prefer to compare themselves with friends. Moreover, some studies indicated that friendship relations are a key role in maintaining positive interactions and alleviating negative interactions among students in a learning activity. Theoretically, friendship relations are beneficial for students situated in competitive learning environments, but friendship relations are still absent in relevant studies, especially on the surrogate competition [6]. Apart from friendship, some studies have also shown that gender differences can impact the preference over a competitive learning. According to [6], boys are more highly motivated to participate in game-based learning environments than girls and tend to have higher incentive to attain higher scores in competitive games than girls. This means gender stereotypes exist and thus play a role in students’ learning attitudes, which corresponds to the demographic background of student respondents which are represented by 72.4% males and 26.3% females aforementioned. When students are involved in an effort-demanding activity like competitions, they need to improve their learning status to win and thus are guided to realize that winning is closely correlated to the level of effort they exert. This cause-and-effect relationship is helpful for the establishment of a positive attitude towards motivational learning [6], which is enabled by competitive gams in classroom learning.

4.4. University teachers' perception and attitude towards gamification in virtual English Language teaching classrooms in Hong Kong during the pandemic

In order to analyze from a more holistic view in the practice and success of gamification in university classrooms in Hong Kong during the pandemic, data from English Language teachers is also collected for university teachers' perspective towards the usage of games in classrooms. It is found that a majority of teacher respondents (62.5%) agree that gamification is an effective means to motivate students in universities and colleges to learn better, with 25% totally agree and 37.5% strongly agree that incorporating games in classrooms is an effective approach to motivate students to learn better. In contrast, more than one-tenth (12.5%) strongly disagree that gamification is successful in motivating students while one-quarter (25%) are neutral towards gamification in both online and face-to-face classrooms.

It is clearly indicated that a majority of teacher respondents (62.5%) hold the belief of the necessity of positive reinforcement towards student motivation with the use of gamification in both online and face-to-face classrooms among universities and colleges in Hong Kong. However, the comparative findings between student respondents and teacher respondents also illustrate distinctive and different perceptions and attitudes towards learning through games among the two groups. As shown from the data analysis aforementioned, a majority of students (73.9%) think that incorporating games is a constructive means to help their effective learning in English Language classrooms, with the major concern about whether classroom learning is fun and interesting, which constitutes more than half of student respondents' (53.8%) need as learners for second language acquisition. In addition, almost all students (94.2%) claim that games act as remarkable incentive to draw their attention in classes of different modes and thus drive them to learn dependently inside and independently outside classrooms. In contrast, viewing the teachers' attitude towards the incorporation of games in both virtual and physical classrooms, more than half of university English Language teachers (62.5%) internalize the importance of gamification and other digital teaching tools as the current and upcoming innovative trend and thus there is a need to adopt a more interactive approach for students by devising new pedagogy in relation to digital technology in order to supplement or even replace one-way lecturing in traditional classrooms. According to [4], systems that only focus on lecturing and other traditional teaching strategies produce passive learners. "Spoon feeding" techniques in traditional classrooms tend to suppress students' creativity and neglecting their strengths as students are highly dependent on their teachers' lecturing instead of independent thinking [4]. One-way lecturing also demotivates students to learn effectively if lessons are found to be dull and boring. In general, students prefer games to be incorporated in all classrooms more than teachers, given the intrinsic nature of collaborative and competitive games as motivators in getting students to work with peers, with 31.7% difference regarding the popularity of game usage between university students and teachers.

The statistics also demonstrate that all teacher respondents have the experience in running their English Language classes with gamification, as shown from the questionnaires that none of any individual teacher respondent claims he or she has never used games as teaching tools in university classrooms. Nevertheless, when it comes to the practicality and frequency of the usage of games in English Language contexts, only half of them (50%) incorporate gamification in classrooms generally for a few times every semester for English Language teaching. If there are 13 to 14 weeks in every semester, it is implied that only approximately 15% to 35% of their total class time have been devoted to the practice of gamification in university classrooms. One-quarter (25%) recount that they include the elements of games in their English Language courses for more than half of the semester, which means this group of teacher respondents have spent half of the class time on incorporating games in university classrooms for students. Meanwhile, only more one-tenth (12.5%) design their English Language classes once every week and the other 12.5% conduct games in classrooms once every two classes respectively.

While a vast majority of university teachers (87.5%) reckon incorporating games in classrooms of any form is constructive in helping students to learn more effectively and positively, it is indicated that there is also a majority of 75% teacher respondents believe games motivate students to participate more fully in class and learn better. On the contrary, 12.5% of university teachers think gamification is not effective for students to learn better while 25% regard gamification cannot motivate students. It is concluded that there are striking differences between learners and educators in universities and colleges in Hong Kong, with reference to students and teachers' perceptions and attitudes towards the necessity and the effectiveness of gamification towards effective learning and motivator of learning.

4.5. University teachers' comparison of the effectiveness of gamification in online classrooms during the pandemic versus face-to-face classrooms before the pandemic

In terms of effectiveness in using games online and face-to-face, most interviewed teachers believe that student engagement is the major concern. It is easier for teachers to engage with students in face-to-face classrooms due to their physical presence in concrete settings. On the other hand, it is harder to build rapport with students when the lessons go online, making teachers' assessment of students' learning progress more difficult. While students can switch off cameras on Zoom in virtual classrooms, teachers can walk around in the face-to-face classrooms to establish a sense of presence. Thus, implementation of gamification becomes more inclusive for each student in face-to-face classrooms, in which both active and passive learners are more motivated by gamification in physical classrooms, making learning more direct and effective. Nonetheless, there is a possibility that gamification can exclude the passive learners in online classrooms since it is more challenging for the teachers to supervise every student online. Meanwhile, a few interviewed teachers advocate that the ease of incorporation of games in online classrooms and face-to-face classrooms are both at a similar level. The most dominate reason relates to the positive psychology among university students that learners are in general attracted by the nature of games and fun lectures. Furthermore, the content of the lecture is always very much the same and materials are delivered via the similar platform.

4.6. Limitations of gamification in remote and face-to-face classrooms Most of the student interviewees hold the view that there would be differences in respect to the effectiveness in using games in online in face-to-face classrooms. Most of them reckon that gamification is more effectively implemented in face-to-face classrooms before the pandemic rather than virtual classrooms during the pandemic in tertiary education in Hong Kong. Interestingly, it is generally believed that learning through collaborative games is more effective in face-to-face classrooms than virtual classrooms as shown from the fact that most student interviewees internalize the notion that face-to-face classrooms promote collaboration and effective communication in comparison to remote learning. Apart from collaborative games, it is also stated that competitive games online may be less fun and interesting than games in face-to-face classrooms, explained by the difficulty of online classrooms in establishing a competitive environment to encourage students to engage in competitions. Comparatively, face-to-face communication enables learners to interact and accomplish given tasks collaboratively in an easier and more comfortable way, providing the concrete physical settings which allow spontaneous and direct communication instead of potential communication barriers in intangible virtual channels. Hence, face-to-face classrooms facilitate both collaborative and competitive games more effectively in helping and motivating students to learn better than online classrooms.

In addition, online classrooms pose a challenge for teachers to create a positive and proactive learning atmosphere and thus is more difficult to set up the mood for game playing in virtual classrooms. Furthermore, the difficulty in implementing gamification to all students in online classrooms without excluding any passive learners is a crucial hinderance for student engagement. This includes the constraint in monitoring whether students are following house rules during online classes since some students can possibly turn off the cameras and mute themselves. One interviewed student cites an allegory that lecturers can spot out any student in physical classrooms who is not paying attention and thus the internalization that students should listen and respect the lecturers can in return facilitate students to concentrate better and reinforce students' full participation in face-to-face classrooms. One interviewed student has internalized the idea that online learning is dull and boring anyway and he is always distracted at home especially when he is sitting in a comfortable private area. It is generally believed among university students that they and their fellow classmates are more proactive in face-to-face lessons. This corresponds to some interviewees who proclaim that learning through games would be more "interactive, exciting, fun and attractive" with face-to-face and direct communication since the sense of student engagement increases behaviorally and emotionally in physical classrooms. It is also said that face-to-face classrooms can trigger more interactions between teachers and students and among students, which result in better student-teacher and student-student rapport.

On the other hand, the technological nature of virtual classrooms hinders the effectiveness of incorporation of games in digital learning experience. Among the interviewed students, it is found that they sometimes experience delay of response from teachers and classmates due to internet connection problem in remote classrooms, and thus reckon face-to-face learning to be more effective and direct.

4.7. The gap between university teachers' acknowledgement of the vitality of gamification in classrooms and the frequency of its usage in practicality

Given most university teachers recognize gamification as a constructive, effective and innovative means in facilitating students' learning, it is indicated that only 12.5% of teacher respondents incorporate games in their English Language courses once every week and once every two classes respectively. Likewise, none of any teacher respondents disagrees that gamification in classrooms is effective in motivating students to learn. The limitations of the practicality of gaming in both online and face-to-face classrooms can be justified by numerous obstacles in adopting gamification in university classrooms and other digital teaching tools. A large majority (75%) of teacher respondents hold the view that one major hinderance in incorporating games in classrooms is due to the tight teaching schedules. Half of them (50%) believe that there is lack of trainings and resources received and somehow games and the content of courses are not interrelated. The third most common limitation (37.5%) is that there is lack of access to different software and tools to support the learning through games in classrooms. It is unavoidable that the use of realia and concrete props in classrooms are unlikely in virtual classrooms during the pandemic. Therefore, implementation of gamification in online classrooms requires more institutional support, trainings to be received and know-how of the technology than that in the status quo, which further limit the feasibility and scale of incorporating games in classrooms during the pandemic.

4.8. Effectiveness and practicality of incorporating games in online classrooms versus face-to-face classrooms

Regarding the kinds of innovative teaching tools used in classes so far, most interviewed university teachers name a few including “Zoom polling”, “Zoom whiteboard”, “Kahoot”, “Padlet”, “Word Clouds”, “Everything Poll”, “graph Drawing”, and “Lucky Draw”. It is also highlighted that “Kahoot”, “Padlet”, “Spotify”, “Word Clouds” and “Lucky Draw” are their preferred tools in both online and face-to-face classrooms for English Language teaching in universities and colleges in Hong Kong. From the results of interviews of teacher respondents, it is revealed that university teachers who deploy the concept of gaming in classrooms are in the purpose of enhancing spontaneous interaction and participation among students. It is also relatively easy for both teachers and students to use these game-based tools. On top of the interactive nature of gaming in classrooms, concepts can be visualized to students more easily and effectively with colours, symbols, graphs, shapes, videos and music through games.

In addition, the interviewed teachers hold the belief that games are catchy to students' attention and teachers can make use of gamification to monitor whether students are attentive in class at that time. However, one interviewed teacher holds an opposite view by raising her concern that there is a possibility that some students may feel harassed by the compulsory gaming in classrooms and students may also believe learning should be serious instead. Most interviewed English Language teachers explain the usage of games in classrooms can be hindered by the fact that the application of games and other digital tools rely too much on the content of the subject knowledge at that time. At times, ideas and inspirations from games can be interrupted by the lack of originality. Besides, the unstable internet connection for teachers and all students makes smooth adaptation of games in online classrooms during the pandemic even more difficult.

While gaming tablets and social media have been a major part of students’ life, teachers face a significant problem towards students’ motivation and achievement inside classrooms. Learners get easily distracted and show a loss of interest, and communication between students and the teachers becomes remote and fragile, especially with the distancing learning during the hit of pandemic [4]. In particular, some teachers even find the digital platforms discouraging, as they have to do extra work to adjust the pace of the class to achieve a better understanding of the content. This requires enormous effort both inside and outside the classroom in order to integrate the digital content into lesson plans. This also requires the intensification of educational adaptations made in classrooms to promote content learning by all students in a comprehensive and meaningful way. Another disadvantage pointed out in some studies is linked to the negative attitude of some students to these digital challenges, since not all students prefer to play an active role in classrooms [4]. In fact, some of them feel more comfortable taking notes and studying content after class without using their mobile phones for academic purposes because they fear making mistakes in public when using this digital resource or not feeling supported by their peers when asked about content previously worked on in public [4]. Further research and information on the application of these innovative proposals in higher education contexts is therefore needed to better understand and adapt these ludic strategies to the main interests and demands of students in higher education.

5. Conclusion and Limitations

This research compares and evaluates the success of gamification and effectiveness of various digital teaching and learning tools used in motivating students in university classrooms in Hong Kong during the pandemic. It also explores the possibility and limitations of applying the notion of gamification in virtual classrooms. With the research analysis, gamification in classroom learning has been an unavoidable trend in education. With data collected from both learners and educators towards English Language learning in tertiary education in Hong Kong, the future research can be extended to compare the data analysis from both pre-and post-tests, with the integration of different games for experiments into the teaching process to assess the level of students' active participation and motivation towards a more interactive and stimulating environment. It is also recommended that more resources, trainings and technical support can be offered by the authorities and educational institutions to pursue the sustainable game-based learning and provide a more engaging and interactive environment for learners in the new technological era.

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Design and Development of an Educational Design and Learning Technologies Wisdom Community

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Abstract

Faculty and graduate students in an Educational Design and Learning Technologies program collaboratively developed their own online wisdom-community in Canvas as a project in a *Foundations of Learning Desig*n course. Community goals established by program faculty and students were to facilitate learning community, enhance identity as professional educational technologists, expand professional knowledge for the duration of their studies toward their degrees, and leverage and prepare members for use of various online learning technologies. We analysed and explored the EDLT learning context, learners, and goals, and student-constructed prototype environments following educational design and development research methods. Findings were needs, tasks, and features students wanted addressed in their WisCom, as well as suggestions for implementation.

Imagining something may be the first step in making it happen, but it takes the real time and real efforts of real people to learn things, make things, turn thoughts into deeds or visions into interventions. – Mr. Rogers

Problem

Masters' and doctoral students often do not mingle or have opportunities to learn from and mentor each other. Instead, they attend classes face-face or online, study, and complete assignments and assessments independently. Group work provides them with opportunities to work with and learn from each other, but such work limits their exposure to a small group of people in the same courses in which each is enrolled. Students do not have the benefit of learning from others across the spectrum of experience in their degree programs, particularly if they are fully online and are unable to mingle in the brick-and-mortar college setting.

For several years, in the hope of creating bonds among masters' and doctoral students and because of the structural, social, and organizational benefits cohorts promise (McCarthy, et al., 2005), Educational Design and Learning Technologies (EDLT) students have been accepted into their programs at our Southwestern, Hispanic Serving Institution (HIS) as members of cohorts. In our cohort model, students' programs are prescribed in that all members begin the program together and progress through course content in a shared sequence and pace.

However, the cohort model has created some problems. Learning in cohorts means that students are all studying the same content at the same time. Those who do not have time or finances to attend a full-time degree program may choose not to apply. Each cohort consists of just those students who enroll in the program in the same term. Following the prescribed course-sequence limits students' abilities to receive differentiated, personalized instruction. Students rarely form solid bonds or a shared knowledge-base, and faculty members are detached from most students other than those that they advise or intermittently instruct. McPhail, Robinson, and Scott (2008) reported that factors such as dominant group members, lack of commitment to the cohort, failure to meet group expectations, traditional instructional modalities, and inadequate facilities negatively impact the cohort experience. Most importantly, the cohort model limits enrollment to traditional students who can afford the time and resources to participate in the scope and sequence of a highly structured degree-program.

In short, the current structure of college degree programs in general can limit students' abilities to network with other students in order to learn from the strengths of diverse others who have different perspectives, cultural backgrounds, and levels of experience and professional knowledge. As Gunawardena, Frechette, and Layne warn (2019), "Without proper deliberation, online learning experiences…[can] unduly reflect the cultural biases and limitations of their architects," (p. 1).

Theoretical Framework, Previous Research, and a Solution

Sociocultural learning theories provide a rationale for building any online learning community that facilitates discovering content knowledge, solving problems, thinking critically, forming identity, and including voices of diverse learners across their degree seeking experiences. The sociocultural perspective on learning emphasizes that learners develop and learn by transforming their understandings through socially shared activities conducted with diverse others. Learners with diverse levels of competence learn from one another as well as from their instructors (Vytotsky, 1978). Each learner has unique knowledge, needs, experiences, culture, and expectations that, when shared, can broaden others' perspectives and knowledge bases while they themselves reciprically benefit from others. A learning community of students within and across degree programs in a specific discipline can provide a venue for students' sociocultural learning by exposing them to a broad population of other learners who have diverse interests, experiences, and circumstances.

Although socio-cultural learning theories have been proposed for many years, developing learning environments that facilitate sociocultural learning has been difficult until the advent of online learning technologies. Such technologies can bring diverse thinkers, experts, and learners together in distributed learning communities to contribute to each other's learning.

Online Learning Communities

Students can both learn and gain personal satisfaction in online learning communities when they fully participate in them. Much has been written about the power of interaction, mentoring, and presence between students and faculty in online learning communities. In addition, online peers have tremendous influence on one another. Student-to-student interaction can lead to increased levels of student satisfaction and student learning outcomes (Eom & Ashill, 2016). The Association of American Colleges and Universities identified establishing, building, and maintaining learning communities as a high-impact practice that leads to student success (Brownell, & Swaner, 2010).

The literature on learning communities most typically focuses on creating online community in the context of coursework. But, community rarely happens in the context of a single course. Rather, community can be formed at the program level by intentionally coordinating and linking the content of courses, materials, assignments, grading rubrics, and course resources within programs; orienting students to expectations across a program; using instructional-teams; and using engaging pedagogies (Brownell, & Swaner, 2010; Linder & Hayes, 2018). As Jody Donovan (2015) claims in her blog, "taking an online course should be more than sitting in front of a computer – real engagement involves becoming a part of the community of learners." Learning communities can provide diverse college students with a sense of belonging to a group that shares their goals and interests. Often individuals in shared communities interact through social media beyond their courses and become colleagues as they build their careers.

Palloff and Pratt (2011) created a framework for distance learning that generates growth of learning community in online programs. Their framework advises that—

- online [communities] should include focused outcomes with buy-in from everyone in a program and time spent sharing goals,
- content knowledge should be achieved actively through and with interaction and feedback,
- [Communities] should include facilitated collaboration, and,
- faculty guidance toward teamwork with mutually negotiated guidelines helps students be part of a learning community.

The hope of online learning communities is that they increase comfort, communication, and collaboration among students and with instructors. Online collaboration tools and social media can be incorporated into online communities to promote learners' senses of community and increase the knowledge flow between students, thereby facilitating social negotiation of meaning as learners construct their own understandings (Bliss & Lawrence, 2009; Dawson, 2018; Kumi-Yeboah, 2018).

Wisdom Communities

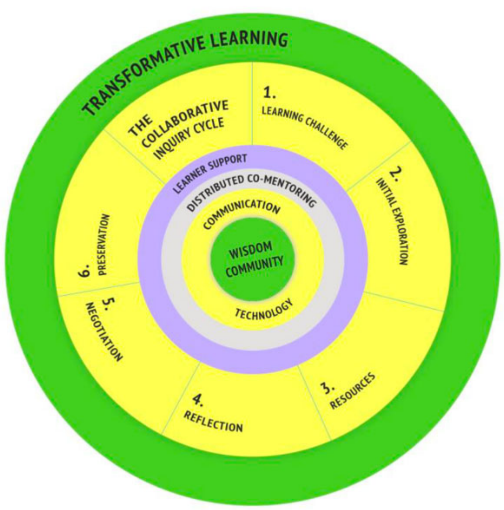
In a wisdom community (Gunawardena, Frechette, & Layne, 2019), here forward called a WisCom, students use technologies to communicate with one another online. Social interaction, dialog, discourse, collaborative problem-solving, and construction of new knowledge with instructors and peer guidance are the fundamental activities of WisComs. Gunawardena et al. call this transactional approach “distributed co-mentoring.”

An alternative to requiring students to study within a cohort is to offer an online WisCom that spans the duration of students’ programs-of-study. With the goal of facilitating bonding and shared knowledge, students bring their cultural and historical perspectives, experience, and knowledge to each other and form bonds around a shared identity. Social interaction, dialog, discourse, collaborative problem-solving, and construction of new knowledge with instructor and peer guidance are the fundamental activities. Co-mentoring, and learner support play critical roles in wisdom-communities. Communication, distributed co-mentoring, and learner support take place within “collaborative inquiry cycles.” Members work together in collaborative inquiry cycles (CICs), one cycle at a time, to “explore a problem or issue, brainstorm solutions and considerations, and work together to synthesize findings” (Gunawardena et al., 2019, p. 278). Once learners agree that the cycle is completed it is preserved and the group moves on to the next CIC.

Along with co-mentoring, learner support plays a critical role in WisComs. Student retention, motivation, identity formation, academic achievement, satisfaction, engagement, and success all hinge on learners knowing that they are supported (Mehran & Mahdi, 2010). Therefore, a WisCom includes access to interactive activities and services intended to support and facilitate the learning process of each student (see Figure 1).

Figure 1

Wisdom-Community Framework Created by Casey Frechette for Gunawardena, Frechette, & Layne (2019). Used with permission from the authors.



A Solution

In the hope of strengthening the EDLT graduate programs in a Southwestern United States, Hispanic serving university, students in a *Foundations of Learning Design* course designed and developed a WisCom as their term project. The WisCom will be used and contributed to by EDLT faculty and Master’s and Doctoral students across the scope and sequence of their studies. Community goals established by faculty and students are to -

- facilitate professional learning community,
- enhance sense of identity as members of the global professional learning community,
- expand professional knowledge among community members, and
- leverage and prepare members for use of various online learning technologies.

During students' design and development processes and based upon their final products, we asked the following question— Given the opportunity to design and develop a WisCom in the Canvas Learning Management System what needs, tasks, and features did students want addressed in their WisCom, as well as what suggestions did they have for implementation.

Methods

Instructional design methods were applied in this educational design and development research with the goal of developing "theoretical insights and practical solutions in real-world contexts, together with stakeholders" (McKenny and Reeves, 2019, p. 6). Iterative phases of—

(1) needs analysis and exploration,
(2) design and construction, and
(3) evaluation and reflection comprise such studies.

In this study, we report on phases one and two. In phase one as suggested by McKenny and Reeves, we attempted to "generate a clear understanding of the problem and its origins as well as specification of long-range goals" (p. 85), for the wisdom-community. In phase two, through teamwork, communication, and creativity we produced a potential solution to the stated problem by creating a WisCom in Canvas. In phase three, which is yet to come, we will evaluate the impact of the WisCom on faculty and students. We included EDLT students as designer-developers following the principles of user design (Carr-Chellman, 2006), also known as participatory design. User design involves input from potential users of the design so that the resulting instruction meets their needs. As potential users of an EDLT WisCom, EDLT students participated in the design and development of their own WisCom.

Context

In the context of the graduate level *Foundations of Learning Design* course, EDLT students helped design and develop the EDLT WisCom in accordance with the principles of instructional design. They analyzed, designed, developed, implemented, and evaluated example EDLT WisComs. As potential end-users, they were actively involved in the design process to help ensure the resulting WisCom would be compelling, usable, and responsive to their cultural, emotional, spiritual and practical needs. Recent research suggests that designers create more innovative concepts and ideas when working within a co-designed environment with others than they do when creating ideas on their own (Treischler, Trischler, J.; Pervan, S. J.; Kelly, S. J.; & Scott, D. R., 2018). Therefore, they built Canvas-based WisComs in four teams of three to four students.

Topics of modules in the course follow: Becoming a Learning Designer, IDer, and Educational Technologist; History of the Field; ID Models; Foundational Theories; Needs and Learner Analysis; Task Analysis and Identification of Types of Learning; Assessing Learning; Development of Strategies that Address What We Know about How People Learn; Implementation and Management of Learning Design Projects; Evaluation; and Conclusion. Readings included *Culturally Inclusive Instructional Design* by Gunawardena, Frechette, and Layne, (2019) and the instructor of generated content in each of the modules. The overarching assignment was for students to follow the principles of instructional design to develop an EDLT WisCom. Beginning with the fifth module, each had assignments that led to the systematic development of their team's WisCom.

Participants

Participants in phases one and two were one faculty member (the lead researcher), one doctoral student, and fifteen students enrolled in an eight-week online graduate level course on learning design. The faculty member identifies as a white female from the U.S Westcoast with several years of teaching experience in educational technology and instructional design. The graduate student identifies as a white female from the Southwest with several years of teaching experience and educational administration experience. Students' ethnicities were 8

Hispanic, 4 White, 1 African American, 1 Native American, and 1 West Indian; genders were 12 females and 3 males; and location when growing up were 8 from the Southwest United States (U.S.), 4 from the Westcoast of the U.S., 1 from the midwest, 1 from the South, and 1 from the West Indies. In terms of teaching experience, 62% of the participants had 0-5 years, 31% had 6-10 years, and 7% had 11-15 years.

Data Sources

Data sources included 1) a *Pre-Wisdom-Community Design and Development Assessment* developed and administered by the researchers to determine students' perceptions regarding their needs*;* 2) a needs assessment developed and administered by students and distributed to EDLT students who were not in the class; 3) a goal/task analysis developed and conducted by students; 4) assessment criteria identified by students; 5) strategies identified and described by students; 6) implementation strategies identified by students; 7) one-on-one and small group evaluations conducted by students, 8) a *Post-Wisdom-Community Design and Development Assessment*, and 9) the four student-developed WisComs.

Procedures

The fifteen participating students enrolled in the online *Foundation of Learning Design* course. In a Zoom mediated course orientation, students were introduced to their term project of developing an EDLT WisCom for future use by Masters and Doctoral students. They were also given written instructions for the assignment in the first Canvas module. They were divided into four groups and each group was given a Canvas shell in which to build an EDLT WisCom. The *Pre-Wisdom-Community Design and Development Assessment* was administered online using Google Forms in the context of the first course module. It was designed to establish whether or not there was a need for a WisCom, whether or not EDLT students were likely to participate in a voluntary WisCom, and what topics students would be interested in exploring together in a WisCom.

In the fifth course module student-teams developed and conducted a needs assessment of their own by sending surveys to all EDLT graduate students. In response to subsequent modules, the teams went on to conduct a goal analysis, establish assessment criteria, develop WisCom prototypes, describe implementation strategies, conduct one-on-one and small group evaluations, and revise their WisComs accordingly. The resulting products were four WisCom prototypes. The researchers identified the most effective and compelling components and features of each in order to assemble one WisCom that addresses EDLT students' needs. In the final course module students filled out the *Post-Wisdom-Community Design and Development Assessment* using Google Forms.

Data Collection and Analyses

Inputs explored were needs, tasks, and features identified by students as they developed their WisComs, as well as what suggestions they had for implementation. Data collection took place in the context of course activities in the *Foundations of Learning Design* course. Therefore, design and development tasks were realistic in scope. Multiple data sets were used to triangulate the data. Students collaboratively generated and submitted design and development documents for each design and development phase. All data sources were qualitatively focus-coded according to the following codes: needs, goals, objectives, assessments, strategies, implementation, evaluation, technology, communication, distributed co-mentoring, learner support, collaborative inquiry cycles, WisCom features and emergent themes. Those findings will be shared in a subsequent manuscript.

Results

The EDLT students strove to gain a clear understanding of the problem they were addressing with their design. The tasks were difficult for them, particularly assessment, given that participation in the WisCom environment will be optional and content will be developed by students as they participate. They concluded that testing or quizzing EDLT students on content in the WisCom context would be oppressive and turn students off to participation. They did design exit surveys to collect students' responses to the environment for formative evaluation purposes. They realized that they were to develop a flexible framework for participation. However, their final products did not reflect full understanding that co-mentoring and collaboration are to take place across time, content, and activities and not in just one space. Also, students did not address content of collaborative inquiry cycles or how they would be administered and implemented. We conclude that their avoidance of addressing this important feature in WisComs was due to their lack of understanding of how they might be presented and sustained.

The *Pre-Wisdom-Community Design and Development Assessment* as well as the student administered needs assessment that went to all EDLT students established that students felt the need for an online environment where they could share content with other students in EDLT. Many offered that they were likely to participate. Needs, tasks, and features of the four student-developed prototypes are illustrated in Figure 2 below:

Figure 2

The Home Pages of Four Student-Developed Prototypes.

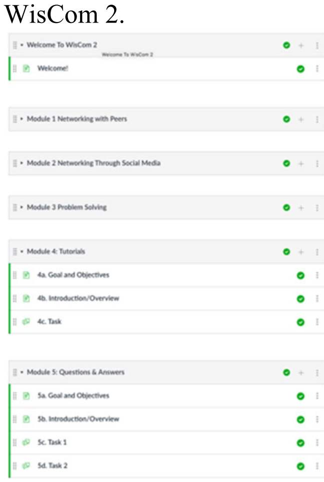
WisCom 1.

Wisdom Community- Group 1

Each module has multiple and varied components.

1. Welcome and orientation
2. History and key terms
3. Co-mentoring
4. Opportunities in the EDLT field
5. Popular technologies in ID
6. PD organizations
7. Using theory to evaluate projects
8. Collaboration
9. WisCom exit survey
10. WisCom suggestions

WisCom 2.

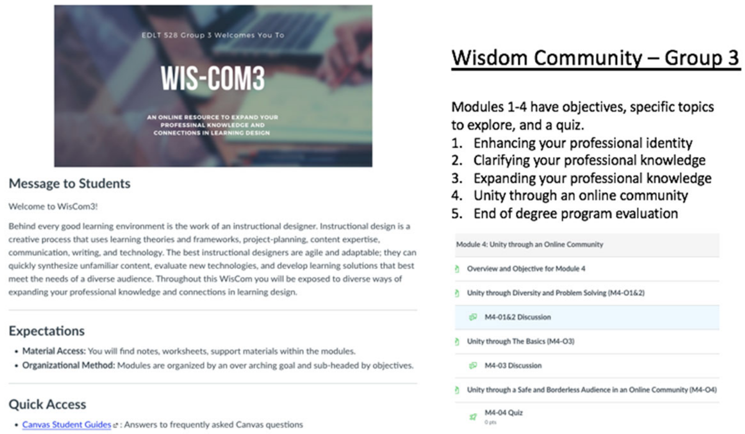


Wisdom Community- Group 2

Each module has objectives, intro and overview, and tasks.

1. Networking with peers
2. Networking through social media
3. Problem solving
4. Tutorials
5. Q & A
6. Wellness
7. Informational text
8. Post survey (upon degree completion)

WisCom 3.



WisCom 4.

The researchers will identify the most effective and compelling features of each in order to assemble one WisCom that addresses EDLT students' needs, provides for co-mentoring, and facilitates completion of collaborative inquiry cycles. The WisCom will be launched in January, 2022.

Regarding implementation, students offered that systems need to be in place for providing access and knowledge of the WisCom to all EDLT students. They suggested that, because participation will be optional and students are typically working full time while going to school, motivation to participate must be addressed through the design. We will apply the ARCS-V (Keller, 2010; Keller & Deiman, 2012) motivation model across the environment and in that context demonstrate the model to students suggesting that they apply it as they lead others through CICs. Students recommended using a lot of visual representation to gain EDLT students' attentions to activities. They do not want a text-heavy environment. With each CIC, we will emphasize relevance, confidence, and satisfaction. We expect that these emphases will increase students' volition to be active in the WisCom.

Students want to run the WisCom themselves indicating that the site should be managed by faculty or a graduate student intern under faculty supervision, but that students should generate content. They suggested monthly activities. Although the framework proposed by Gunawardena et al. suggests that participation in CICs continue until a CIC is complete, for ease of management, each CIC in our WisCom will be led by a small team of 1-3 doctoral students and last one month at which point a new team will take over.

Topics of CICs will be chosen by EDLT students. Students will lead and conduct CICs in modules and students will know where on the site they are collaborating each month through announcements made by the student team that is in charge for that month. Each CIC will begin with an orientation and statements of objectives. In addition to contributing to the Canvas WisCom site, students want to share links to valuable content. They hope to work together and network with others in the field using social media and tools such a TEAMS and Discourse, so links to those communication channels will be posted. CIC content will be preserved on the Canvas WisCom so that students can review previously submitted content.

Conclusion

In summary, EDLT students identified needs they wanted addressed, tasks they wanted to work on, and features they wanted included in their WisCom in order to collaboratively gain professional identity, knowledge, and community during their graduate degree programs in EDLT. The completed first and second phases of this longitudinal study set the stage to generate guidelines for developing and implementing WisComs offered over the duration of learners' studies in degree programs. Prior studies have explored the impact of design components in courses offered as WisComs. This study explores the impact of a longitudinal wisdom community to inform both theory and practice for preparing professional educational technologists. The study contributes to the literature by describing how WisComs can be collaboratively designed with potential users to enhance professional identity, community, and professional knowledge for students across the span of their Educational Technology degree programs. In addition, specific components and features that appealed to graduate students were identified. Findings in this study contribute to instructional practice by providing a practical solution to the problem of graduate students' sense of isolation and lack of identity as experts in their fields, particularly those who are studying in online programs.

Ruja Benjamin (2020) tells us that "Emancipatory designs are not only possible, they already exist." The EDLT WisCom is meant to be an emancipatory design that will promote cultural inclusivity in EDLT graduate programs. This study validates Gunawardena et al's framework and guide for building online wisdom communities by demonstrating the ease with which the guide can be used by designers and developers (Richey & Klein, 2014). In this case, students were able to use the guide in combination with systematic instructional design processes to develop a learning environment meant to meet their needs as well as the needs of others.

A first limitation of the study is that EDLT students designed and developed the WisCom in the context of an EDLT course led by a professor who openly shared her vision for the learning environment. Although she clearly stated that she was open to all design ideas, she likely influenced many of the students' design decisions. For instance, one of the *Foundations of Learning Design* modules was on the history of instruction design. That students chose to include history in their WisComs may reflect the professor's value of history. Secondly, the compiled specific components and features that appealed to graduate students in this study cannot be generalized to other contexts. Rather they are perhaps a jumping off point for exploring the needs of other learning technologies students. In this case, students in the specific context of the region and university culture, socially constructed their WisComs and each WisCom was remarkably different from the others.

This study of user design and development of the EDLT WisCom is the beginning. In a future representative field evaluation study (Richey & Klein, 2014), we will implement and evaluate the WisCom with educational technology students from the time they enter the degree program until they graduate, we will ask the following questions: What are the impacts and effects of the WisCom on goal achievement? How has the WisCom impacted professional identity, community, professional knowledge, and transformational learning? What unanticipated needs arise? What technical, temporal, physical, transactional, or pedagogical components can be revised, added, or deleted to better support communication, co-mentoring, collaboration, inquiry, reflection, negotiation, and learning among EDLT graduate students? And, how does the WisCom impact EDLT faculty? Answers to these questions will inform both socio-cultural learning theory and practice in higher education, as well as contribute to the research on online learning communities and, in particular, wisdom-communities.

Other studies such as this one need to be conducted exploring design and development of WisComs and the efficacy of wisdom communities to facilitate culturally inclusive instructional design for students in different disciplines, at different ages, and across and within different global regions.

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Lessons Learned in Virtual Supplemental Instruction: Enhanced Engagement to Support FSG Leader Transformation

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Abstract

This paper explores virtual teaching and learning innovations in Facilitated Study Group (FSGs) delivery at the University of Toronto Mississauga (UTM). To increase access and representation in an already successful in-person Supplemental Instruction (SI) program, we seized the opportunity during the COVID-19 pandemic to create new alternatives by introducing Virtual Facilitated Study Groups (VFSGs). We have since introduced hyflex options in peer-led programs that include a combination of both face-to-face (F2F) and online SI Instruction. With new format options in our program, we recognized the need to re-examine and reflect on the metrics used for measuring outcomes and impact. Supported by the Institute for the Study of University Pedagogy at UTM where SI is administered, a "virtual cineplex" FSG platform was developed to offer a unique and efficient access point for students to network, congregate, and self-select new variations and opportunities in FSG programming. Prior to the pandemic, a specialized 12-week undergraduate experiential academic course, *EDS325: Supplemental Instruction in Higher Education*, had already been introduced to enrich and deepen the training of FSG leaders (FSGLs). The course is experiential in nature and requires a 100 hour internship in FSG instruction. This one-of-a-kind for-credit course engages FSLs in SI theory and scholarship while supporting post-graduate outcomes with a focus on transferable leadership skills and professional learning. In the winter of 2020, EDS325 made its debut as an online course and is now offered in both virtual and in-person formats. This paper tells the story of several lessons learned in hyflex program expansion as we reimagine the multimodal and multiplatform future of SI.

INTRODUCTION

Supplemental instruction (SI) was introduced across university campuses in the early 1970s as an alternative approach to academic instruction. A voluntary offering, students participate in peer-led sessions that meet outside of class time in small subject and course-specific groups to work and study collaboratively. Post-secondary institutions have historically tied evaluation of SI to student enrolment and specific performance metrics, most often looking for improvements in GPA and university retention. However, as Vijay et al. explains, "It is critical both to identify at-risk students and implement evidence-based instructional strategies and interventions [...] with recent literature showing that cognitive, affective and demographic characteristics all contribute as risk factors" (2021; p.552). Alongside recent hyflex opportunities in SI, we propose the use of alternative metrics that also focus on the "affective" domain to better understand FSG experiences and, in particular, FSG leader experience. Focusing new metrics around how FSG leaders experience their role fills an important gap in research around the potential for SI impact. We decided to look at *affective* characteristics cultivated through the frame of Debebe's "psychological capital" (PsyCap) criteria described in the acronym "HERO" - **H**ope, **E**fficacy, **R**esilience and **O**ptimism (2017). With a robust analysis and correlative study on leaders, we can learn more about hyflex SI programming and its potential.

In response to the COVID-19 pandemic, the University of Toronto Mississauga (UTM) successfully launched Virtual Facilitated Study Groups (VFSGs) that served 2,409 students through the instructional efforts of 271 Facilitated Study Group Leaders (FSGLs) supporting 64 undergraduate virtual non-credit courses over the Fall 2020 and Winter 2021 academic terms. By moving UTM's existing Facilitated Study Group (FSG) program from in-person to hyflex we expanded our ability to offer alternatives as students sign up for a combination of in-person and virtual learning opportunities. During development, we wanted to ensure the level of access and efficacy in this already well-established and successful program would be continued. Seizing the opportunity during the pandemic to move forward with the offering of hyflex alternatives in SI, we sought to focus more specifically on the experience of virtual FSGLs as they adjusted to online SI Instruction on our campus. Acceleration in SI program-level innovation took place through a trial-and-error process with our FSGLs helping to remove instructional restraints while "shaking loose" important new research questions to inform SI theory and practice. The following paper will share our progress and some key milestones fostering transformative learning experiences in FSGL training.

Reassessing Metrics: Psychological Capital (PsyCap) as a Metric for Impact

First developed at the University of Missouri-Kansas City in 1973, SI in its inception was structured as an in-person, peer-to-peer, and co-curricular academic support program. Gaining considerable momentum through the 80s and 90s, students on college and university campuses recognized the value of engaging in study groups in the judgement-free comfort of peer-to-peer support. Enthusiasm for these programs was complemented by growing evidence of success in reducing course failures (Zaritsky 2006). Unlike tutorials where the Teaching Assistant's (TA's) instruction and related grading protocols frame the experience, SI is non-evaluative and peer-focused. Impact data shows overwhelming success in improving GPA performance in difficult or high-attrition courses (Zaritsky 2006). Terrion and Dauost point out that FSG can be especially helpful for first-year students as their persistence in school can be directly linked to engagement with faculty and peers: the more interactions that first-year students have, the more likely they are to remain enrolled in university (p. 312). In designing effective SI programs, educational developers, faculty, and staff continue to seek evidence-based guidance to implement high-impact programming. While peer-led FSGs on college and university campuses have historically been a proven strategy for retention ensuring university students stay in school, we knew from anectodal evidence on our campus SI impact goes beyond the "GPA boost" metric as students and FSGL leaders describe unique and lasting impact of the socio-academic network they build, the work-integrated learning they experience and transferable leadership competencies they adopt. As a result, UTM is now turning its attention to affective qualities and graduate outcomes starting with a focus ons FSG leaders, to assess to what degree students leading our program experience feel changed and transformed through the experience of leading instruction.

Inadvertently, the transition of the FSG program to a virtual environment and hyflex delivery model provides an opportunity to rethink the goals of the SI program more generally around how it might evaluated. We were initially guided in our thinking by Universal Design for Learning (UDL) a pedagogical framework we had employed in the transition to hyflex to help us think about and promote inclusive and equitable environments for all learners (Lee 2021; Ahhyun 2021). We were excited by the possibility of offering learning alternatives that would increase the number of SI options available to students using various "on-demand" practices We saw this as a positive first step to increase opportunity and access. The conceptual framework of UDL which advocates for the removal of barriers so that all students can experience meaningful engagement in their learning environment by incorporating multiple means for students to (1) engage with content, (2) represent content, and (3) express skills and knowledge. UDL frameworks help sus to see that not all engagement platforms will be optimal for all learners. We do know that SI programs, separate from the classroom experience in a credit course, already offer alternatives and are rooted in multiple representations. (CAST 2018). Tobin and Behling further highlight the intentionality that students bring to the learning experience when choosing to participate in SI, and how the openness and co-construction of knowledge can increase the personal connection students have to the material (p. 92).

Initially only offered in-person, the urgent and immediate shift to remote delivery pushed FSGs through several iterations across different platforms. We began by testing FSG delivery on the learning management system BbCollaborate embedded into the university's preferred platform Canvas. Our program managers and developers were especially concerned about data protection and privacy management, and these were the safest options at that time. Limited by some of the tools and functionality, we transitioned after term one line and test SI delivery on the platform Zoom as their safety and functionality became a more convincing option. In piloting these different technologies with our FSG Leaders, we were able learn processes for training and supporting FSGLs within this new learning space. This involved focusing on leveraging how the distinct features of oftware enabled virtual teaching pedagogies and ed tech could be used. While we saw UDL as a useful framework to expand our ideas about alternatives, we realized we had limited ways to understand how leaders were responding to uncertainty, volatility and complexity of the times.

We became curious to know more about how our leaders were feeling stepping into these new roles of responsibly, guiding their FSG participants through uncertainty while modelling flexibility and self-efficacy. We noted that FSG leaders involved in this experienced enhanced engagement as we watched them respond, invest and restructure their programs to meet student learning needs. In noting the outcomes of these experiments in hyflex learning, we understood immediately that prioritizing PsyCap as an outcome of FSG training should be prioritied. As Debebe outlines, positive PsyCap is a systematic process for developing learned resourcefulness. In this process, the instructor intentionally cultivates hope, self-efficacy, resilience, and optimism in the student (Debebe 2017) to eliminate deficit thinking and, in turn, intervene with ascription. Ascriptions are the beliefs that students hold about themselves and their potential, as cultivated through their socio-environmental experiences. As we saw FSGLs succeed and adapt to new technologies, applying the model of PsyCap would shape our goals and aims for leader training and alertus to specific "look-fors in professional development." Consistent with Lozada (2017), our experiment prioritized a better understanding of how "SI facilitators experience transformative learning and the nature of civic engagement within their student leadership roles" (p. 80). Data shows many of our FSGLs leave university and continue to significantly contribute within their community and professional roles post-graduation. We hope to learn more about the impact of the FSG program on those talent trajectories and, in turn, expand our initial Universal Design for Learning (Lee 2021; Ahhyun 2021) framework accordingly.

A Framework for Leadership Engagement

The evolution of the FSG program at UTM is indebted to benefactor Robert Gillespie, who in donating funds to help found SI on our campus had this to say of his university experience: "I felt too much emphasis was placed on learning by rote and not enough on reaching conclusions based on deduction, experience and collaborating with others." With this in mind, our specialized 12-week undergraduate course *EDS325: Supplemental Instruction in Higher Education* was created to extend collaboration opportunities for FSG leaders in a course that has been successful in attracting highly motivated FSGLs across the university's disciplinary programs. The course has become an important training ground for high performance as learning outcomes were shaped to match and promoting PsyCap outcomes. FSGLs participate in self-advancement as they learn about themselves, their purpose, and the unique contributions they can make to the broader community while practising and applying skills of professional facilitation, public speaking and learning about theory and research around group dynamic, engage in equity challenges and critical thinking as they put into practise the experience in the use of educational technology. Operated in collaboration with the Program Manager and taught by two professors in the Education Studies program, student leaders taking the course practice crisis management and participate in theory, research, and in the application of case studies through problem-based learning. In this hyflex course, there is a focus not only on the obvious inventory of virtual pedagogies (e.g., using breakout rooms, engaging with the chat) but on the experience and outcomes of the FSGL through the lens of reflective learning.

Mezirow's pioneering work in the field of transformational learning found that the integration of critical reflection and peer review could lead to a transformation in the way an adult learner constructed their understanding of knowledge (1991). Within this theory, frames of reference that are constructed through previous experiences are challenged each time individuals encounter new experiences. When these new interactions question our established frames of reference to the point of questioning the presuppositions on which the references are based, then the intervention could lead to a revision of the initial frame of reference, thus *trans*forming them. Mezirow's theory has been used to substantiate the use of critical reflection in a variety of learning environments, from the development of the Scholarship of Teaching and Learning (Kreber 2006) to how transformation can be used to enhance other learning theories, such as threshold concepts (Hodge 2019).

In pivoting to a virtual format, we were initially excited by the many alternatives that we could offer our FSGLs. We continued to pursue, however, what this shift to remote and now hyflex learning might mean for student engagement. Enhanced engagement is a view of academic success that goes beyond what needs to be learned and focuses on how we learn, taking into account identity, learning processes, and community needs. It is centered on a co-constructivist approach that involves promoting opportunities for students to become active learners through a process of civic involvement that focuses on the transformation that takes place from those experiences. Enhanced engagement fosters a sense of collective and individual identity-building where students see their role as participants in the collaborative reconstruction of knowledge.

Indeed, the type of student engagement achieved through FSGs is of particular interest to us in this current study as we hade witnessed many of the same benefits reported in recent studies on student engagement (collated in Dawson et. al. 2014), including enhanced social relationships through student-to-student contact (Mahdi 2006) as well as a reduction of anxiety towards difficult courses due to the supportive environment and increased opportunities to talk through challenging course material with others (Bronstein 2008). Additionally, we identified a connection between agency and success, wherein the voluntary aspect of FSGs afforded students a sense of control over their learning experience, resulting in a small but significant contribution to success in post-secondary education (Richardson et al. 2012).

Explorations in Virtual, In-Person, Hyflex Delivery

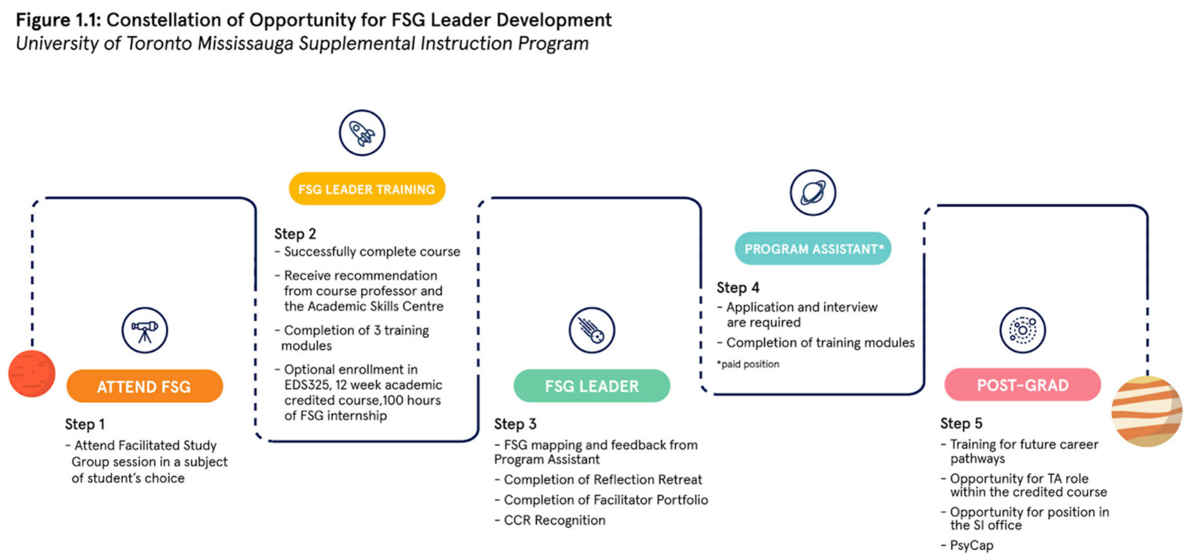
As we experimented with online platforms and technologies to create new learning environments for our students and FSGLs, we discovered that our own evolution of platform and approach supported and nurtured resilience in our leaders. To understand where we might go next in FSG, we thought it important to first look at the past. Innovation in SI has been going through a slow-paced but constant evolution since its inception, moving from in-person learning among small groups, shifting to flipped classroom experiences in some schools, and now arriving at a hybrid configuration of interactions on college and university campuses. As Alden (2017) points out, recent innovations in SI have come naturally alongside the proliferation of social media and advent of online learning complements that enhance what traditional SI provides. She explains, "Innovations include (but are not limited to): video lectures, practice exams, and promotion of group collaboration among students. Through the use of platforms including Facebook, Twitter, Piapp, and Slack, the SI session can be held almost exclusively online and provide just as much if not more benefit to the students involved" (p. 2007). As new options open up further alternatives for SI, we can see how a targeted preparation of FSGLs would be essential to the effective, sustainable delivery of FSGs within a virtual environment, and that establishing such a foundation now would ensure the success of the program in the years to come.

The University of Toronto Mississauga "virtual cineplex" FSG platform, named by its designer as a metaphor for the multiplicity of options that one can choose from in this online, on-demand space, provides a portal by which students could easily enter and join FSG classes offered around the clock in a multitude of disciplines. Providing alternate formats to engage with FSGs, including an accessible virtual format, created opportunities for a much wider population of students, bypassing the commuting delays that often impact in-person scheduling. At the same time these new integrations presented challenged to our leaders to adopt to new ways of doing things. For example, initial data indicated that allowing cameras to be turned off during FSGs was helpful for students who wished to remain anonymous on Zoom and "listen in" on conversations. However, what FSGL's deemed an inclusive practice, it turns out, significantly reduced levels of meaningful engagement as visual communication cues were eliminated and networking and community building opportunities were minimized. Leaders had to find other ways to achieve the same results as they had experienced during in-person FSGs,. These setbacks led to ongoing testing of different and new virtual pedagogies and, by default, created work-integrated real-world simulations of problems that our leaders had to solve. With findings from each new prototype of FSG development, leaders understood that new technology in SI was never going to fix all pedagogical problems. They readjusted their expectations and set out to understand and reflect on practice as they learned more. We saw in this how digitization and new tools could be adopted with the intention to enhance our aims and amplify opportunities for our leaders to work in a safe trial and error environment where they could collaborate and reflect and, in turn, build PysCap as transferrable skills future problem solving. Despite the benefits of VFSGs, and this resulted, in some cases, to more inconsistent attendance than among in-person iterations of FSGs. Simultaneously, however, the additional skills developed in VFSGs, including mastery of technology, helped us to reconfigure ideas about how collaboration occurs online and to define essential competencies we wanted to share with our virtual FSGLs. On the other hand, many students reported increased engagement in their VFSGs due to the multiple modalities of engagement, including texting via the chat feature. The availability of these features allowed students to participate more freely and suggest answers more readily, and with greater confidence, regardless of their certainty towards their answers. Multiple studies suggest that greater, rather than lesser, confidence in an incorrect answer will increase the likelihood of remembering the right answer when it is corrected (Metcalfe 2017). The VFSGs provided enough instances of greater access to our SI offerings, so as to support our pursuit of new visions of student engagement in future SI iterations.

Enhanced Engagement Opportunities

We quickly began to see FSGLs as our co-constructors in hyflex remodelling. With that, a new "constellation of opportunity" (see Figure 1.1) has emerged in our program. In the process, we saw a clear path for nurturing programs that focus on what Portelli describes as the "curriculum of life" (p. 59). For the past decade or more, McMahon and Portelli have asked questions about what student engagement looks like and feels like, examining and interrupting popular discourses on this topic. Consistent with their view of engagement, we see opportunities to address not only the technical needs of our new virtual environment, but the need to foster transformative learning experiences. We broke from training approaches "simply as a matter of techniques, strategies or behaviours" and instead built into the program more "intrinsically the purpose of democratic transformation where everyone has an opportunity to bring their needs to the table and participate in understanding the curriculum of their lives" (McMahon & Portelli p. 70). This view of the FSG program allows us to expand from a minimalist or homogentisic perspective where student engagement is simplified down to a "correlation between engagement and academic achievement" (Finn & Voelkl 1993; Newmann, Wehlage & Lamborn 1992; Steinberg 1996, from Portelli 2004). Instead, we see the FSG environment as one in which each stakeholder, from the EDS325 course instructor to FSGLs and Program Assistants, is involved in unwrapping, unwinding, and reconstructing knowledge together. FSGs evolve according to what each ndividual brings to inform individualized mentoring, and related competency development in our leaders. Figure 1 shows the new constellation of opportunity we provide for leader development Step 1 involves access to pariticipation in FSG sessions. Step two involves providing opportunities for those students who have taken the FSG to then sign up for the hyflex EDS 325 course and experience training sessions on leadership and PsyCap topics. Leaders can then move into the teaching assistant role in a paid position within the EDS 325 Supplement Instruction course and/or become an RA and program assistant in the program. As a result of program assistantship, they can be involved in research in SI and receive one-on-one mentoring to support post-graduate pathways. We know that students enrolled in the same course have the opportunity to study together in peer clusters, the process facilitates the development of academic skills (Hurley & Gilbert 2008). The weekly FSG leader course guides the group through problems and issues that participants identify need focus. WE continue to want to know more about the potential lasting impact these learning communities for our FSGLs have on talent trajectories as FSGLs learn alongside their peers in an active learning setting that utilizes team-based learning (TBL; Silva et al. 2021)

Figure 1.1: Constellation of Opportunity in Supplemental Instruction
University of Toronto Mississauga



Cultivating Psychological Capital (PsyCap) in a VFSG Environment

As Lozada (2017) proposes, "Providing students an opportunity to serve in a leadership role can lead to the actualization of transformative learning experiences, which may materialize in a heightened development of skills that are transferable to future academic, professional, and civic aspirations" (iv). Building a community for FSG leaders has really been a response to students needs through community. We are cognizant that cooperative learning goes beyond physical proximity or the mere sharing of information in a group setting, and that it needs to be structured in order to be effective (Johnson & Johnson 2002). In the virtual learning environment, the importance of structuring cooperative activities is heightened due to the increased sense of isolation students feel when they are not sharing a physical space. Students and instructors have reported feeling "disconnected" in virtual classroom environments, and offering opportunities for true collaboration can help to mitigate these feelings. To address this, we instructed FSGLs on the five basic elements of cooperative learning: (1) positive interdependence, (2) individual accountability, (3) face-to-face promotive interaction, (4) social skills, and (5) group processing

(Johnson & Johnson 1989, 1999a; Johnson, Johnson & Holubec 1998a). The elements we found to be particularly helpful in the VFSG environment for leaders were positive interdependence and face-to-face promotive interaction. Positive interdependence relies on the perception that students' success is inextricably linked to the success of others: individuals succeed when the group succeeds and vice-versa (Johnson & Johnson 2002). In our VFSG environments, for example, we promoted activities in which each group member was assigned a portion of an overall assignment, as in the jigsaw cooperative learning strategy. By coming together to share and discuss their findings, students discover the completeness of the activity. Learning is "complete" only when the group comes together and all of the individual contributions make up the whole.

Face-to-face promotive interaction involves encouraging the collective as they complete their tasks, as well as facilitating the completion of the tasks. Both are employed in order to reach the group's goals (Johnson & Johnson 2002). The virtual iteration of this cooperative element is fundamental to establishing and maintaining not only group morale but group cohesiveness as they work on cooperative tasks together. We found that frequent and targeted promotive interactions helped the students stay-connected. Other techniques such as committee-building, lesson study, breakout rooms, micro-teaching, and guest speakers have all become key parts of our FSGLs' learning experience.

CONCLUSION

At the University of Toronto Mississauga, we are presently in an important trial-and-error phase of program-level innovation in SI. This was the result of the hard pivot to VFSG and the new for-credit academic course that we adopted as part of SI instruction. We know that the FSG program on our campus attracts students who are already on a leadership path and the offerings we provide are designed to amplify the very qualities that attract students to the program.

George Couros, in his book *Innovate Inside the Box*, explains that reflection is a key component of any kind of process. Incorporating learning from past mistakes is an essential step in innovation (Couros 2019). In this paper, we have responded to Couros' suggestion by reflecting on what the future of enhanced engagement for SI leaders might look like while identifying challenges and constraints that we encountered while responding to new opportunities in hyflex delivery.

We wanted to know how FSG leader training is enhanced or limited by the use of virtual technologies and whether barrier reductions could be achieved by a virtual SI program that utilized multimodal approaches. We found that this innovation indeed augmented opportunity. Using a UDL framework to guide development, we applied criteria to assess alternatives in our programs, which helped us to recognize the need to better plan for learner variability in our student population. As David Gordon suggests, we can do this by providing students with options:

> Options are essential to learning, because no single way of presenting information, no single way of responding to information, and no single way of engaging students will work across the diversity of students that populate our classrooms. Alternatives reduce barriers to learning for students with disabilities while enhancing learning opportunities for everyone (Council for Exceptional Learning, 2011 in Tobin and Behling, 25).

This virtual iteration of our SI programs *inadvertently* provided opportunities for multiple means of engagement, representation, action, and expression—namely, the main criteria of the CAST UDL guidelines (CAST 2018). Through this methodology, we continue to seek to uncover the degree to which these options have been beneficial and to provide a framework for how to *intentionally* incorporate enhancements into our SI FSG Leader training programs, thereby fostering more inclusive alternatives for all students.

The introduction of a new hyflex credit-bearing course for FSGLs in leadership and self-development added a significant opportunity for enhanced engagement. One focus that was important to us was to ensure that our FSGLs and Program Assistants were provided with adequate training in both VFSGs and in-person FSGs by utilizing the for-credit course to not only teach leadership theory and scholarship but to centre time in that class on strategic life planning that widen opportunities for civic engagement and the exploration of post-graduate pathways. Responding to the needs of our student FSGLs, many of whom apply to professional post-graduate programs in areas such as medicine, nursing, teaching, and law, saw the relevance in FSG instruction and virtual with the aim to focus learning outcomes and mentoring on affective domains by creating an environment both online and inperson that cultivates of PysCap

Thinking beyond the borders of both the classroom and the institution, a next step in understanding FSG leader experiences is to propose a longitudinal study to follow FSGLs post-graduation to understand the transfer of qualities and characteristics after university. Rather than focusing on the metric of GPA improvement in the student groups they serve, we propose using the four pillars of the PsyCap metric (HERO: **H**ope, **E**fficacy, **R**esilience **O**ptimism) to evaluate trasferable qualities of leadership that our leader take with them in the characteristics associated with fulfillment, wellbeing, and thriving. The longitudinal study of these newly proposed post-graduate outcomes will allow us to better assess our unique FSG train the trainer program and more fully evaluate ithe potential of a 12 week course and hyflex alternatives as a means to foster transformational for FSG leaders.

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Exploring the Needs, Practices, and Attitudes Toward Technology Integration of Community College ESOL Instructors

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Index words: professional development, technology integration

Abstract

Research has established both the importance of integrating technology in English language learning and the importance of properly training teachers in order to integrate technology effectively. While this is true for English as a second language teachers in all contexts, there is a strong need for instructors working with adult learners to utilize technology and be properly trained in technology integration. The integration of professional learning communities or communities of practice and coaching/mentoring been shown to be effective professional development interventions. For professional development to be successful, it should cater to the specific needs of the instructors; it is therefore important to understand the needs of the instructors and to explore the different types of professional development that fit their needs. This research explored the needs, current technology integration practices, and attitudes toward the use of technology with English to Speakers of Other Language (ESOL) educators within a community college context in order to make recommendations for professional development in technology integration. Using an interpretive-descriptive qualitative design, this study utilized classroom observations, one-on-one instructor interviews, a focus group interview, and a researcher journal. Acting as a needs analysis, these sources were analyzed inductively in order to make professional development recommendations. Based on the needs of the study's participants, it was determined that they would benefit from a technology mentor/coach and a professional learning community or community of practice to provide support as well as offer collaboration opportunities, resulting in increased technology integration including both instructor and students uses of technology.

Keywords: professional development, technology integration, ESOL instructors, interpretive-descriptive qualitative design, community college

Research has established both the importance of integrating technology in English language learning and of properly training teachers to effectively integrate technology into their teaching practices (Kessler, 2018). While this is true for English as a second language (ESOL) teachers in all contexts, there is a strong need for instructors working with adult learners to utilize technology and be properly trained in technology integration (Bergey et al., 2018). Professional development (PD) is a way to increase successful technology integration and to overcome barriers that prevent it. For PD to be advantageous, it should cater to the specific needs of the instructors within the context of their instruction (Kopcha, 2012; Oliver & Townsend, 2013). This research explored the needs, current technology integration practices, and attitudes toward the use of technology of four ESOL educators within a northwestern United States community college context in order to make recommendations for PD in technology integration.

Literature Review

Integrating technology into language teaching has shown to aid learners in reaching higher proficiency levels, as well as increase their autonomy (Adair-Hauck et al., 2000; Healey et al., 2011). Healey et al. (2011) identified three general themes that target a need for technology standards for the field of Teaching English to Speakers of Other Languages (TESOL). Those themes include: (A) research shows that there are benefits from the use of technology in language learning and teaching; (B) technology should be integrated to support acquiring the second language and to develop electronic literacy; and (C) research shows that technology in learning is not being used to its fullest potential because of inadequate teacher and learner training. The international TESOL organization developed these themes within its framework for best practices of technology integration in the language classroom because of the positive impact it has on English language teaching/learning (Healey et al., 2011). The benefits technology has for teaching adult English language learners in the U.S. include increasing motivation, engaging students in learning, providing authentic language use, and accommodating diverse learners (McClanahan, 2014). Eyring (2014) suggests that technology is a valuable tool for adult English language learners and can be transformational in increasing literacy, engaging students, increasing proficiency, and exposing learners to 21st century skills needed in the modern world. While it is recognized that there are challenges and barriers to using technology within adult ESOL programs (McClanahan, 2014), the benefits are too great not to overcome the barriers. The use of technology in language teaching and learning has been established as beneficial enough to have a dedicated subfield, computer-assisted language learning (CALL). Even though CALL is necessary to successfully utilize it for language teaching and learning, the majority of training is acquired through conference workshops, personal reading, and other modes of self-education (Healey et al., 2011; Kessler, 2006, 2007).

Teacher training and professional development (PD) regarding technology integration in English language teaching/learning needs to take place in order for technology to be utilized effectively (Arnold & Ducate 2015; Healey et al., 2011). Chapelle (2008) recognized that even though some language professionals have had limited technology training, such as in a general education course, more training is necessary to understand specifics about technology in language teaching. While this is true for ESL teachers in all contexts, there is a strong need for instructors working with adult learners to utilize technology and be properly trained in technology integration (Chisman, 2008; Warschauer & Liaw, 2010).

Three large bodies of research established both the importance of integrating technology with adult English language learners and the importance of properly training teachers to integrate technology: (A) The Center for Applied Linguistics (2010); (B) Passing the Torch: Strategies for

Innovation in Community College ESL (Chisman & Crandall, 2007); and (C) TESOL Technology Standards (Healey et al., 2011). The Center for Applied Linguistics (2010) determined that practitioners working with adult English language learners need continual PD following a specific framework, which they developed because of the rapid growth of the immigrant population in the United States in the last 20 years. In this framework, one of the essential elements is the appropriate use of technology to support learners before, during, and after their courses. Chisman and Crandall (2007) conducted one of the largest studies regarding adult ESL community college programs in the United States, which studied five exemplary ESL community college programs for two years. The study revealed that a contributing factor to the success of these colleges were a variety of PD activities offered through the colleges to their faculty and staff, including ongoing technology training and support (Chisman & Crandall, 2007). The study found that in-house PD and support is "essential to maintaining a high-quality faculty" (p. 91). In the TESOL technology standards, it is stated that there is a lack of proper training among ESL teachers and learners regarding effective uses of technology in English language learning (Healey et al., 2011). This suggests that PD is necessary in order to support teachers in technology integration in the language classroom.

PD provides the opportunity for teachers to acquire new perspectives, knowledge, and skills through both formal and informal experiences; these experiences come in a variety of formats including structured in-service trainings, peer teaching, mentoring, books clubs, and informal discussions (Coldwell, 2017; Gaines et al., 2019). PD is considered effective when teacher practices are improved and student achievement increases as a result (Evens et al., 2018; Twining et al., 2013). In order to determine what type of PD will best support teachers within a given context, it is important to understand the needs of the instructors within that context. Oliver and Townsend (2013) and Kopcha (2012) assert that a needs assessment is important in developing PD opportunities that cater to the needs of a specific teacher population and their context. A needs assessment is an effective way of determining the internal/personal factors, such as beliefs, that teachers hold that may impact the type of training that is best for them (Kopcha, 2010; Vatanartiran & Karadeniz, 2015). Therefore, prior to implementing PD in technology integration, it is essential to fully understand the context in which it will take place (Kopcha, 2010, 2012; Oliver & Townsend, 2013). Additionally, in developing and implementing PD opportunities for educators, it is important to align with theories of adult learning, which emphasizes the self-directed nature of these learners (Beavers, 2009; Center for Applied Linguistics, 2010).

Using PD as a vehicle for increasing technology integration practices is supported by numerous models for effective technology integration. To understand best pedagogical application for technology integration in classroom practices, the Technological Pedagogical Content Knowledge framework (Mishra & Koehler, 2006), the Technology Acceptance Model (Davis, 1989), and the Diffusion of Innovations theory (Rogers, 2003) were appraised. These models agree that PD in technology integration can lead to more effective technology integration in the classroom and suggest that ongoing PD is necessary for teachers to increase and improve their technology integration practices. In order to determine how PD should be designed to meet their needs and aid in overcoming common barriers found in the adoption of new technologies, understanding the pedagogical beliefs and self-efficacy values of the teachers involved, as well as the environment in which they teach, including the characteristics of their learners and their institutional context, is crucial.

The context of this research was in an adult ESOL program at a Pacific Northwest

Community College (PNWCC, a pseudonym) in Oregon. ESOL programs within community colleges fall within adult basic skills and are committed to aiding their learners in meeting the adult learning standards that align with the National College and Career Readiness Standards (Oregon Higher Education Coordinating Commission, n.d.). The standards for English language arts and literacy include several domains including, reading, writing, speaking, and listening. Within the standards across these domains is the analysis and integration of information from media to reflect the importance of the students' ability to adapt and utilize new technologies (Pimentel, 2013). The adult learning standards recognize the importance of technology in teaching and learning to prepare learners for the skills they need for work or educational endeavors after the community college.

Methodology

The lead researcher of this 10-week study was immersed in the ESOL community college culture as a peer instructor. Because of the exploratory nature of the study, action research with an interpretive-descriptive qualitative design was used to systematically explore and analyze a phenomenon that allowed for recommendations for future action (Thorne, 2016). As described by Thorne (2016), interpretive-descriptive qualitative research was brought into existence through observation of the features and characteristics that make for valuable qualitative studies for real world application. Through classroom observations, one-on-one interviews, a focus group interview, and a researcher journal, the participants in this study illustrated their experiences with technology in their teaching, as well as the barriers they face in using it more. In exploring the needs, technology integration practices, and attitudes toward technology of the ESOL instructors at PNWCC, ideas and recommendations for PD regarding how to aid instructors in increasing their technology integration practices emerged; therefore, this study acted as a needs analysis for a type of instruction.

Setting and Participants

The setting for this study took place within the ESOL department at PNWCC, which comprised five faculty, serving approximately 125 students. Students in this program receive English language instruction in the four major language skill areas of reading, writing, speaking, and listening. There is not an established curriculum in place for this program. There are, however, learning standards and benchmarks, all related to language skills needed in real life situations, which establish the normative standard within the local context. Instructors in the program are allowed to choose what standards and benchmarks they want to include in their courses. Benchmarks are the focus because they are intended to act as objectives, containing information about the instructional focus, and identifying skills students will need to practice (Oregon Office of Community College and Workforce Development, 2017). Embedded within a large portion of these benchmarks are expectations for students to utilize technology to support the development of their language and computer literacy skills.

Courses in the ESOL program at PNWCC are provided for students of four different proficiency levels: (A) Beginning Literacy/Low Beginning, (B) High Beginning, (C) Low Intermediate, (D) High Intermediate/Advanced. Each course meets twice a week for three hours, for a total of six instructional hours a week. The program consists of non-credit classes and students are able to stay in the program for as long as they like. Classes are taught in modern classrooms equipped with a podium that has a computer, internet access, sound system, projector, and document camera. Some classrooms have circular tables for students and some have longer tables, where students sit side by side. No classroom has individual desks. For one hour a week, each course is expected to meet in a computer lab on campus, where all students have access to their own computers. Four PNWCC ESOL department instructors agreed to participate in this study. The participants range in age from 40-60, three have Masters degrees in TESOL and one instructor has a Master's in Education degree.

Data Collection

Data was collected in the form of classroom observations using a modified version of the Looking for Technology Integration (LoFTI) instrument (William & Ida Friday Institute for Educational Innovation, 2010), one-on-one instructor interviews, a focus group interview, and a researcher journal. The purpose of the LOFTI instrument is to aid in the observation of technology integration into teaching and learning. The data gathered through the use of this instrument is helpful in planning and/or providing professional development in instructional technology (William & Ida Friday Institute for Educational Innovation, 2010). Classroom observations added to the conceptualization of the technology integration practices of the instructors. Each instructor, who participated in the study, was observed once for 45-50 minutes of a three-hour class. It was requested that the instructors use technology in some capacity during the portion of the lesson observed. As included in the LoFTI tool, PNWCC teacher activities with technology were observed, such as the use of technology to activate prior knowledge, differentiate instruction, lecture, and summarize. The use of technology for assessment was also observed.

One-on-one instructor interview questions offered an understanding of the participants' technology integration practices and attitudes toward technology, as well as their needs and the barriers they face. These interviews were face-to-face, semi-structured, and lasted approximately 20-30 minutes. Base questions for the interview were in place with follow-up questions asked as needed (Mertler, 2017). Gathering this information was important to determine how to design and implement an effective PD that may result in increased technology integration practices.

The focus group interview provided a more in-depth conception of the instructors' technology integration practices, but especially the barriers they face. The focus group interview also offered suggestions and ideas from the instructors about how to overcome these challenges and increase their technology integration practices. The focus group interview included open-ended interview questions and occurred after the classroom observations and instructor interviews were conducted.

A researcher journal was kept during the entire data collection process to document and recap interviews, email exchanges, and observations that took place at various other points during the data collection process. The lead researcher's reflective perspective offered in the journal provided a place to write about what happened immediately following the event, as opposed to relying on memory.

Data Analysis

Acting as a needs analysis, these qualitative data sources were analyzed inductively in order to make recommendations, in collaboration with the ESOL faculty, regarding professional development in technology integration. The total number of digitized data sources uploaded to Delve software for coding was 13. From these 13 sources of data, 1,371 codes were applied. From these codes, Saldaña's (2016) first and second cycles of coding took place resulting in 10 final categories and three themes materialized. These three themes supported the assertion: Participants discern that the attributes of technology use outweigh student and instructor barriers for English language teaching and learning within this context (see Figure 1).

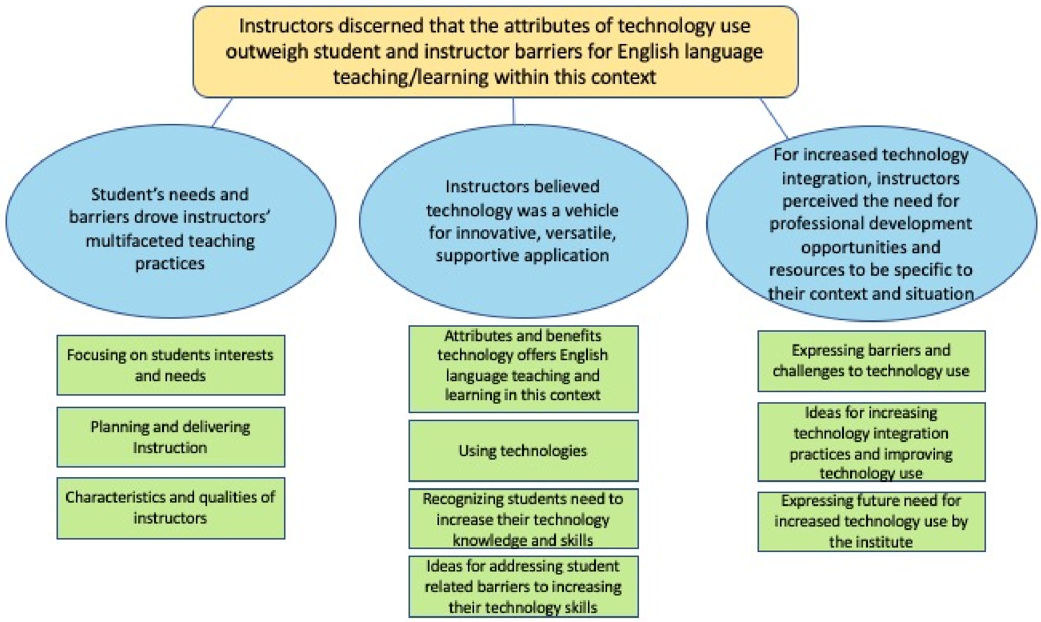

Figure 1 Assertion with supporting themes and categories.

In this study, the findings suggested that PD in technology integration within the community college ESOL be specific to the unique needs of the instructors. These findings were congruent with existing literature regarding PD in technology integration, PD in CALL, and PD within the ESOL community college context. Ottenbreit-Leftwich et al. (2010) and Kopcha (2012) both emphasize situating PD in technology integration to address the needs of the teachers that are specific to their environments. Kopcha (2012) suggests that situating professional development can aid in overcoming barriers such as vision and beliefs. The contextualized nature of CALL training is also emphasized throughout research, where it encourages that professional development focus on technologies that are applicable to the context of focus (Almuhammadi, 2017; DelliCarpini, 2012; El Shaban & Egbert, 2018). Situating and contextualizing PD based on the unique characteristics of the context is also recommended for PD for community college ESOL instructors (Rodriquez & McKay, 2010). Young and Petyon (2008) recognize the complexities of designing PD opportunities for educators working with adult ESOL learners in community colleges, and recommend using a data-driven, systematic process to determine the needs of these practitioners in order to plan for PD.

This study acted as a data-driven and systematic approach in determining the needs of the PNWCC participants. Without fully exploring their needs and coming to understand their barriers based on their experiences, it would not have been possible to recommend avenues of PD that met those needs. The input from the participants regarding their experiences and their ideas guided the recommendations, aligning with theories of adult learning (Chen, 2014), which encourage participants to be involved in decisions about PD. Trotter (2006) claims that teachers should be given freedom to develop PD opportunities based on their needs and personal interest. The recommendations made as a result of the findings of this study offered the participants the opportunity to determine the direction of the PD.

Recommendations for Professional Development in Technology Integration for ESOL Instructors

It is hoped that the TESOL technology standards will motivate professional organizations, teacher education departments, and individual English language programs to evaluate and educate their teachers to meet targets articulated in the performance indicators of the technology standards (Healey et al., 2011). As has been established through the existing research and as evidenced in these findings, technology is a valuable tool for teaching and learning within this context. Participants recognized the benefits technology has for instructional purposes and utilized it frequently. Their uses of technology were largely driven by the needs and interests of their learners, as were the types of technological activities and resources used in their classes. These activities were centered on preparation for language use in the real world and were supported through the use of authentic materials, which were identified having been found through the internet. Participants realized that they could be using technology more, especially with their learners, and presented ideas for increasing practices in that regard. They had also identified PD opportunities specific to their needs within the situation of their context. The following PD for increased technology integration was identified:

1. A technology lead who:
    a. Determines suitable websites for learners and creates a simple link or icon to these websites with an accompanying handout that lists these sites for learners to take home.
    b. Creates and organizes an online space for instructors to share resources and experiences.
2. Collaboration in the online space, where resources, lesson plans, and experience are shared.
3. Collaborative meetings twice a year to share ideas and collectively share resources and organize the online space to ensure continuity in instruction and resources for students.

Technology Mentor/Coach

Oliver and Townsend (2013) state that having a technology mentor or coach is a form of technology integration training, where those who are well-trained or experienced with technology support their less experienced colleagues. Peer coaching and mentoring provide collaboration and reflection, which are considered key components in effective PD (Sprott, 2019). They lead to positive outcomes regarding the increased use of technology integration in classroom practices (Charbonneau-Gowdy et al., 2016; Oliver & Townsend, 2013; Richter et al., 2011; Sprott, 2019). Mentoring or coaching provides an opportunity for expanding perspectives, analyzing preconceived notions, and sharing expertise to support adult development (Drago-Severson, 2008). The participants in this study identified the need for a technology lead from within the department who can vet suitable websites for learners, create and/or spearhead the creation of a simple URL or icon to these websites with an accompanying handout for students to take home, identify strategies for helping students increase their use of technology in the classroom, and develop and maintain an online repository for instructors to share resources and experiences, as well as facilitate collaborative meetings to further develop the online space. This technology lead could be considered a mentor or coach.

Professional Learning Community/Community of Practice

Having a shared space could be considered a type of professional learning community (PLC) or community of practice (CoP), where there is a small group engaged in collaboration, discussions, the sharing of related resources, and a common practice (Jones et al., 2011). PLCs and CoPs are shown to increase technological knowledge and skills regarding technology in education (Cifuentes et al., 2011; Jones et al., 2011; Thoma et al., 2017). This can be attributed to the support, collaboration, and reflection offered through participating in a PLC or CoP. Research supports those opportunities for collaboration are among one of the characteristics that lead to successful PD (Bostancioglu, 2018; Sheffield et al., 2018; Sprott, 2019; Wennergren, 2015). PLCs and CoPs are forms of ongoing professional development that can better support educators than traditional forms of PD, such as one-shot workshops (Smaldino et al., 2012; Stewart, 2014; Thoma et al., 2017). Based on the idea generated by participants, a PLC/CoP is recommended for them. This would allow for continued communication via face-to-face meetings similar to how the focus group interview was structured. It was suggested that these collaboration meetings take place twice a year where sharing ideas, experiences, and resources could be a mechanism for overcoming challenges and increasing technology integration.

Action Research

As established by Dawson (2012), action research is a powerful vehicle for professional development, particularly within the realm of technology integration, as it can offer teachers an intentional study of the ways that technology impacts student learning, as well as “a lens through which teachers may experience conceptual change regarding their beliefs about technology integration practices” (p. 117). Rodriguez and McKay (2010) suggest action research is a particularly effective option for practitioners working with adult English language learners within programs in the U.S. because of the unique needs of the experienced teachers within this context. They also indicate that mentoring/coaching and peer observations could provide the opportunity for teachers to step out of their normal teaching roles and develop new paradigms for their work (Rodriguez & McKay, 2010). Because of the ability action research has to positively impact a change in teaching practices (Avalos, 2011; Dawson, 2012; Manfra & Bullock, 2014), another cycle of action research is recommended for PNWCC as a form of professional development. In addition to identifying a technology mentor/coach, creating a collaborative online space, forming a PLC/CoP, and meeting biannually, the integration of peer observation into the next cycle of action research is recommended. Peer observation offers a form of active learning and can play a role in successful professional development (Avalos, 2011; Richter et al., 2011).

Implications on Future Research

The three themes and one assertion from the interpretive-descriptive qualitative analysis of this study offer implications for future research regarding PD for technology integration within the community college ESOL context. The interpretive-descriptive qualitative study, acting as a needs assessment, sought to fully understand the resources, skills, and concepts that the instructors within the proposed context currently had. Through exploring their interests, needs, insights, and ideas, the lead researcher and fellow faculty collaborated to determine PD endeavors that could be developed to best support them in increasing technology integration in their courses. This study could provide other researchers with a model for designing and conducting a study that acts as a needs assessment regarding technology integration within this context, or potentially within other similar contexts. It should also be noted that this study offers a recent contribution to the body of research regarding effective PD opportunities for instructors within community college ESOL programs, where there seems to be a paucity in research. This study shows promise for utilizing a needs-based approach to designing technology integration PD for practitioners of adult community college ESOL through the use of an interpretive-descriptive qualitative design within a cyclical action research study. These findings could inform and guide others in developing a needs assessment within a context of focus in order to determine directions for PD.

Limitations

As is characteristic of qualitative research, limitations regarding the absence of quantitative data, ambiguities that inherently exist in human language, as well as the small population size need to be considered. Additionally, action research could be considered a limitation because it is focused solely on a problem identified within a specific context (Mertler, 2017), making it difficult to suggest the findings of this study as applicable to other contexts. A needs assessment conducted by an insider in collaboration with other insiders is a viable option to determining and creating PD opportunities. Further, the use of an interpretive-descriptive qualitative design within an AR model allowed for a thorough exploration of the participants' situations based on their experiences that led to solutions to problems unique to them. While these limitations should be considered, they should not prevent others from using this study to guide and inform their own practices.

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Adults in Distance Education: A Multimodal Approach to Understanding Learner Engagement

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Introduction

In this paper, we propose a novel research methodology which used recorded study sessions with screencast, webcam video, and audio recording of adult students in their home environments as they participated in their online classes to understand the experience of adult learners in distance education. We will describe how we used screencast analysis to deconstruct study sessions to understand embodied actions distance students take during learning activities and the impact of their environment on their learning. This paper includes links to copies of the coding tool developed and sample video clips for analysis. A discussion of limitations and other applications of this research method are included.

The State of Screen Recording Analysis

Video analysis has a long history in the behavioral and education sciences (Erickson, 2011), but the analysis of screen recordings has yet to become widely used. Screen recording analysis has been used to study user interaction with technological devices (e.g., Kim et al., 2020), user experience in educational software (e.g., Lahav et al., 2020), and language learning or translation (e.g., Mueller-Spitzer et al., 2018; Orrego-Carmona et al., 2018). In a recent meta-analysis of multimodal research studies, only four of the 207 articles used screen recordings as a data source (Noroozi et al., 2020). Many of the studies that use screen recording techniques to capture data use quantitative approaches to data analysis and very few are done outside of controlled settings. Our method used an embodied discourse approach to data analysis in ecologically valid settings of students' homes. Most research on adult learners relies on self-report which can be problematic as student perceptions and recollections may not accurately reflect what happens during the learning process. By combining subjective data from student reports and objective data through screen recordings, we were able to corroborate findings.

Why Screen Recording Analysis is Important

Using a multimodal approach to data collection afforded us the opportunity to watch participant facial expressions and gaze while simultaneously observing actions on their computer screen. While participants were recording their study sessions in the comfort of their home we could also hear the sources for distraction. We witnessed if a noise actually distracted their work or if they were able to work through the din. Observing mouse movements, eye movements, and hearing students speak to themselves out loud are artifacts we would not have been able to observe concurrently using other data collection methods.

Methods

Participants

Participants in our collective case study (Merriam & Merriam, 1998) were six academically high-achieving working mothers with prior experience in distance education. The students were studying at both the undergraduate and graduate levels. All participants were juggling multiple roles, employed outside of the home and had school-aged children. Initially, when we sought out participants, we were recruiting any adults currently in distance education. However, due to the small number of respondents, we were left with six participants who coincidentally were all high-achieving working mothers.

Data Collection

Our data collection methods included interviews with faculty of the targeted courses, interviews with student participants, recorded study sessions, debriefs with participants on these sessions, and student reactions to selected clips of study sessions. Interviews were conducted with each faculty member. These interviews were recorded, transcribed, and coded for common themes relating to instructor perceptions, interactions between students and the instructor, instructional design, and growing into the role of an online instructor.

Interviews were also conducted with each participant at the start of the study. Students were read a statement about the goals of the study, were asked for recording permission, and whether they agreed to participate. Upon agreement, initial interviews were recorded. Questions relating to students' assets and challenges, time and place, and learning strategies were asked. All of the participant interviews were recorded, transcribed, and coded. Upon completion of the initial interviews, students were provided with instructions for video screencast recordings.

Participants were asked to record at least 30 minutes of study sessions over the next three weeks at a rate of about one per week. Each participant had their own individual Zoom link that would automatically upload the recording to our private, secure Kaltura account. These accounts are through our University, are password protected, and are FERPA compliant. Students were prompted to share their screen and ensure their audio was on. Students were asked to also record these sessions even if they were not actively using their computer for the study session. For example, one student was reading from a text and taking notes but we were still able to capture her study session because we were recording with her camera.

After each study session was recorded, a 15-minute debrief was conducted with each participant. We questioned students about what the recording was capturing, what went well for them during the week academically, and what posed a challenge for them. We also asked what tasks they completed for coursework during the week that were not recorded in the screencast.

Throughout analysis of the screen recordings, we found that questions arose about what was happening in the recordings: *What were students doing and why? How did that distraction impact their ability to complete a task? How did they work through that distraction?* To gain more insight into the recordings, we compiled a few short video clips from study sessions for each participant. We then met with the participant to show them the short clips, get their reaction, and ask questions regarding the clips.

Data Analysis

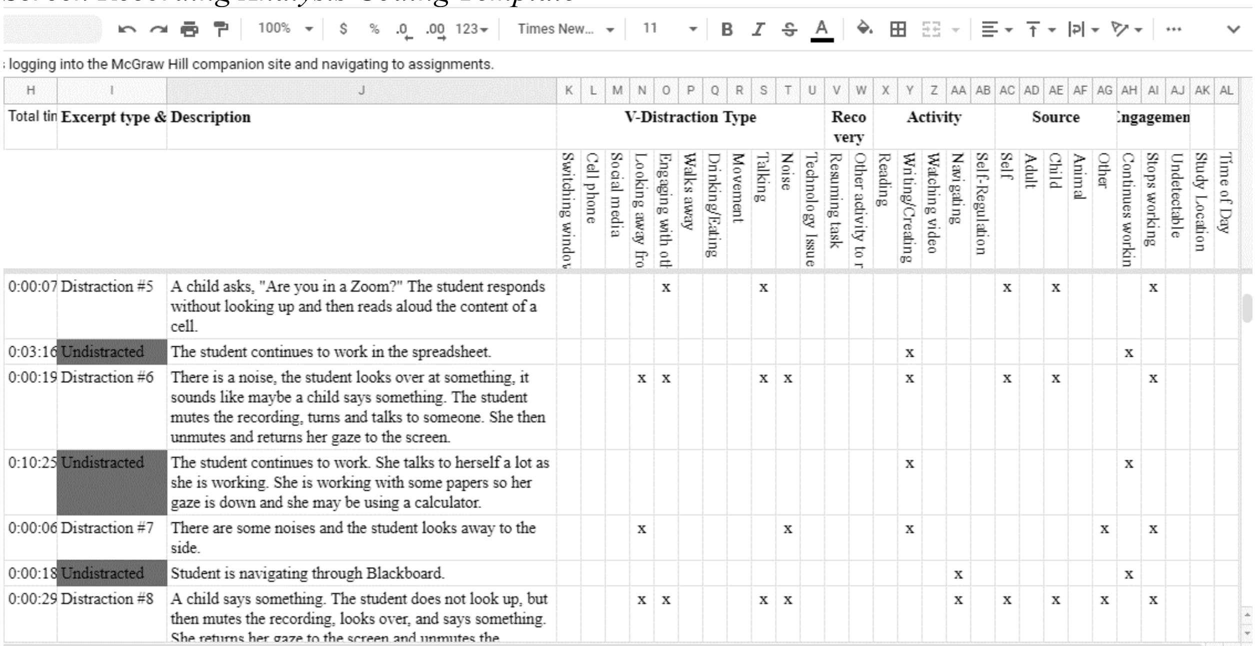
Macro-Level Review. We utilized a whole-to-part inductive approach (Erickson, 2006) to screen recording analysis, watching all of the recorded sessions to identify a construct for further analysis. Each researcher watched at least two recorded study sessions in whole from each participant, noting observations and questions for further analysis. For example, some questions that arose while we were watching the videos included: *Does the amount of content on the screen impact how efficient the learner is with locating the information they need? Is on-screen behavior different when the student is familiar with the resource? How long does it take students to read text on the screen? What factors impact this reading speed? LOTS of distractions here. Are they different from the distractions of other students?*After watching the videos and discussing our observations, we were all struck by the overwhelming amount of distraction that these students experienced during their study sessions in their homes. Distraction became the construct on which we focused on our analysis.

Video Annotation. Our next step in data analysis was to begin annotating each study session video. We played, paused, and rewound video segments frequently to capture the actions we saw on the screen and in the environment, as well as the audio, noting start and stop times. A discourse analysis approach helped us to describe the actions we observed visually and auditorily, while embedded within the natural context that provides meaning to the actions (Hardy et al., 2004). A new excerpt was created in the annotation every time the action changed on the screen or there was a new interruption, which determined our units of study. Each excerpt was labeled as “un-distracted” or “distracted” to identify whether a distractor was present, whether or not the student appeared distracted by it. We used evidence in our observations to justify any inferences we made. For example, while we may not have seen a cell phone in the video window, hearing an alert tone followed by the student looking down for several moments led us to conclude that the student was looking at a message on their phone. Our initial annotations were created in tables in Microsoft Word. Each researcher watched some of the same study sessions and annotated them so that we could come to agreement on what we were seeing and calibrate our strategy for documentation. During the annotation process, we began to note that there were different types of distractions and different sources.

Video Coding. After we had completed annotating several videos, we began to develop a coding scheme to analyze each study session moment-by-moment. Initially, we categorized the type of distraction the learner experienced, the type of activity interrupted, and source of the distraction. This was done by moving the tables from Microsoft Word to Microsoft Excel and adding columns for each distraction type (switching windows/scrolling, cell phone, social media, looking away from screen, engaging with other person, walks away, drinking/eating, movement, talking, noise, technology issue), the type of activity the student was engaged in (reading, writing/creating, watching video, navigating, self-regulation), and the source of the distraction (self, adult, child, animal, other). An x was placed in the corresponding column to mark each of these three categories for each excerpt (see Figure 1). In order to facilitate collaboration on these files, we moved the files to Google Sheets. One of the videos was coded by each researcher using this template to determine inter-rater reliability and calibrate our interpretations of the codes (Miles et al., 2020). As new codes were added, such as *technology issue* or *self-regulation*, we went back to re-code the completed videos to include these new codes. During this phase, we began to realize that some distractors did not seem to affect the students and they remained engaged in their work. Our constant comparative approach and the iterative nature of our coding led us to notice what we initially overlooked (Glaser, 1965). We then added a new category of engagement (continues working, stops working, undetectable) and went back to recode each excerpt. View the data analyzed in this study here: https://tinyurl.com/3m2ycek8.

Figure 1

Screen Recording Analysis Coding Template



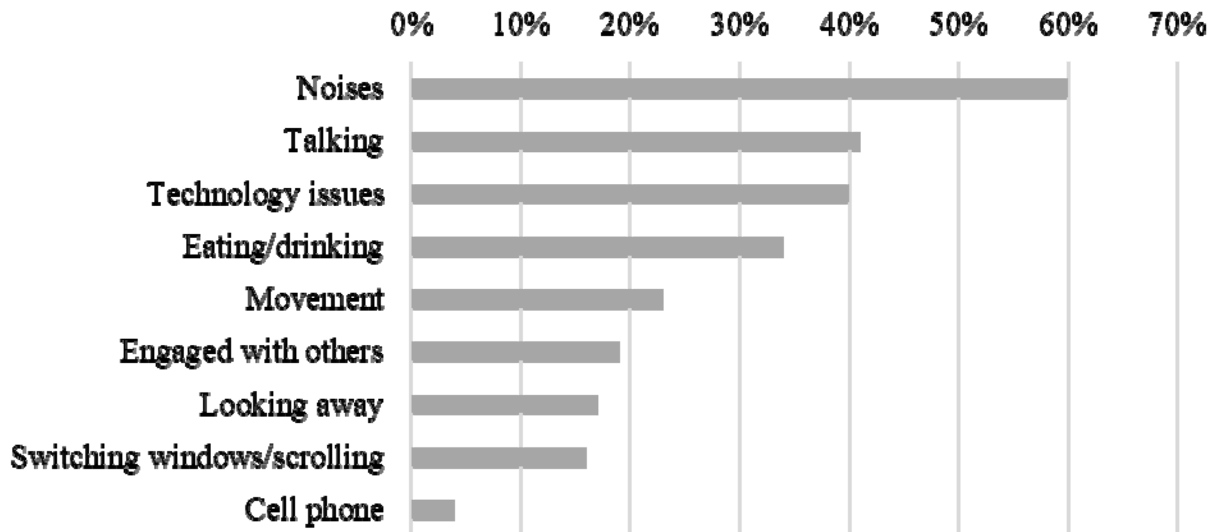
H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
Total tin	Excerpt type &	Description	V-Distraction Type											Reco very		Activity					Source					:ngagemen				
			Switching windov	Cell phone	Social media	Looking away fro	Engaging with otl	Walks away	Drinking/Eating	Movement	Talking	Noise	Technology issue	Resuming task	Other activity to r	Reading	Writing/Creating	Watching video	Navigating	Self-Regulation	Self	Adult	Child	Animal	Other	Continues workin	Stops working	Undetectable	Study Location	Time of Day
0:00:07	Distraction #5	A child asks, "Are you in a Zoom?" The student responds without looking up and then reads aloud the content of a cell.					x				x										x		x				x			
0:03:16	Undistracted	The student continues to work in the spreadsheet.															x									x				
0:00:19	Distraction #6	There is a noise, the student looks over at something, it sounds like maybe a child says something. The student mutes the recording, turns and talks to someone. She then unmutes and returns her gaze to the screen.				x	x				x	x					x				x		x				x			
0:10:25	Undistracted	The student continues to work. She talks to herself a lot as she is working. She is working with some papers so her gaze is down and she may be using a calculator.															x									x				
0:00:06	Distraction #7	There are some noises and the student looks away to the side.				x						x					x								x		x			
0:00:18	Undistracted	Student is navigating through Blackboard.																	x							x				
0:00:29	Distraction #8	A child says something. The student does not look up, but then mutes the recording, looks over, and says something. She returns her gaze to the screen and unmutes the				x	x				x	x							x		x		x		x		x			

Quantitative Analysis. Adding codes and timestamps allowed us to conduct quantitative analysis on individual study sessions and then collectively to determine the frequency and source of distractions and to determine which activities were most engaging. We developed a list of questions to ask using the data we collected. Those questions and the results are listed here.

1. *What was the ratio of time that students endured distraction during study sessions versus being distraction free?* On average, distractions were observed during 34% of the recorded study sessions.
2. *How did students spend their time on the different types of learning activities?* Students spent the majority of the recorded study time writing/creating (53%) or reading (36%), with the remaining time spent watching videos (22%), navigating (22%), or self-regulating their learning (6%). Sometimes students work engaged in more than one activity at the same time, so these values do not total to 100%.
3. *How often did students stop working and for how long?* Students stopped working for 21% of the recorded study time, remained engaged in work for 72% of the time, with the remaining 6% undetectable. Students stopped working an average of every three minutes and thirty-eight seconds.
4. *Which distraction types were associated with students stopping (or continuing) working?* Levels of engagement during distraction varied by distraction type (see Figure 2). Students continued to work during 60% of the time where there were extraneous noises, 41% of the time when there was talking, 40% of the time during technology issues, 34% of the time while eating/drinking, 23% of the time when there was movement observed, 19% of the time

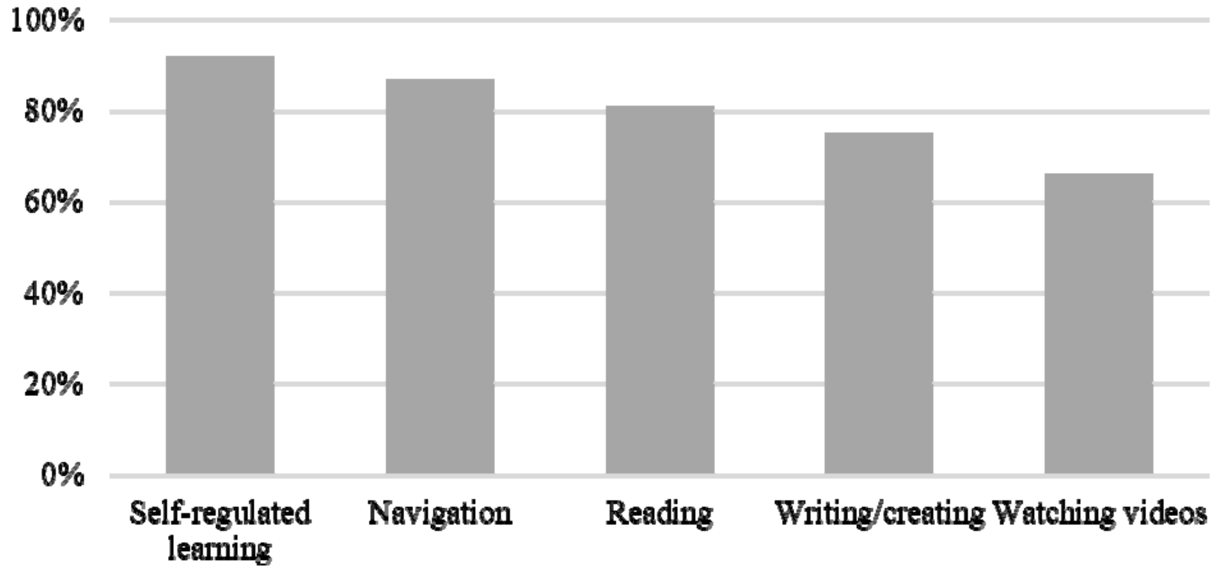
while they were simultaneously engaged with others, 17% of the time while they were looking away from the screen, 16% of the time while they were switching windows, and 4% of the time while they were using a cell phone. They disengaged from their work completely when they were using social media or walked away from their computer.

Figure 2
Percent of Time Engaged During Distraction by Type



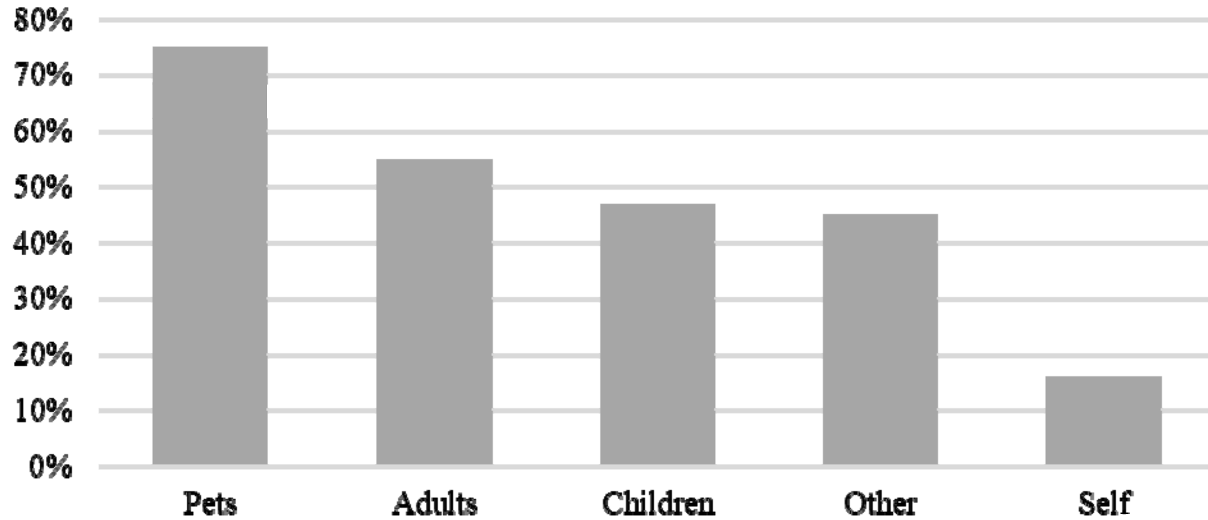
5. *Which learning activities were associated with students continuing (or stopping) working?* Students appeared to remain engaged during distraction at different rates depending on the type of activity they were engaged in (see Figure 3). During self-regulated learning activities, students persisted through distraction and remained engaged 92% of the time, 87% of the time during navigation, 81% of the time while reading, 75% of the time while writing/creating, and 66% of the time while watching videos.

Figure 3
Percent of Time Engaged through Distraction by Learning Activity



6. *Who/what was the greatest source of distraction?* Students were their own greatest source of distraction, either by engaging in a different task other than the learning activities or choosing to respond to a distractor such as a child or message alert. Students were the source of distraction for 24% of the total recorded study time, with distractions from children accounting for 17% of the recorded study time, 9% by other sources, 8% by other adults in the environment, and 1% from pets.
7. *Was the source of the distraction related to whether they continued working?* The source of the distraction appeared to be related to whether the student continued to remain engaged (see Figure 4). Students were able to remain engaged during 75% of distractions from pets, 55% of distractions from other adults, 47% of distractions from children, 45% of distractions from other sources, and only 16% of distractions where they were the source of the distraction.

Figure 4
Percent of Time Engaged During Distraction by Source



Triangulation. Results were corroborated with interview data and voiceover reflection by participants of selected clips (Beach et al., 2021; Sezen-Barrie et al., 2014). Interview and weekly debrief transcripts were analyzed to identify qualitative data that supported the observations we made in the recorded video sessions. For example, one student appeared to remain engaged during loud noises her spouse was making while he was playing video games right behind her during one recorded study session. In her weekly debrief, she explained that she also plays video games and was easily able to tune out those noises. Other students explained that their level of engagement during distraction also depended on their interest in the content being studied and how applicable and engaging the assignment was.

After each student had completed recording at least three study sessions, we reviewed these recordings to select clips that we wanted the students to help us understand. We then met with each student again to play back those video clips. The reactions from the participants during this phase of the project included shock and disappointment. For example, in one student video reflection session, a student became upset while watching one of the clips we selected. Her son was very excited and interrupted her studies to tell her something. The student looked up briefly, saying, "Hey, you guys are triplets! Super cool. I love it," then went right back to her work. While watching this clip, the student teared up and said, "That was my, 'I'm really, really trying to engage with you and to give you what you need, but I can't right now.' That was awful." The participant was conflicted with doing her job as a student and doing her job as a mother and it was apparent in her emotional reaction to the clip.

Discussion

Results of our data analysis included high levels of distraction in the home during study sessions from children, spouses, and pets, with distraction experienced during an average of one-third of the total recorded study time. Interest in the content and instructional design were two factors that were related to maintaining engagement during distraction. Students remained more engaged through distraction during self-regulation, reading, and writing/creating activities and responded more positively to courses that were systematically designed using effective practices in distance education.

The quantitative analysis described here averages all of the study sessions from the six participants, which is a small sample size. There was much variability between the participants on the amount of distraction that they faced from a low of 10% to a high of 60% of a total recorded study session. Therefore, these results cannot be generalized to the whole population. However, the data described here does provide some insight into the experience of adult learners as they participate in distance education.

Potential Concerns Regarding This Method

Potential concerns rest in technological complications such as a participant's camera not being turned on, their sound not working, or the participant not recording the study session. Because of the ecological validity that this method affords, sensitive events or information from the home environment of the participant may be captured in recordings that could cause distress for the participant. The screen recording only captures what we can see on camera. When a student reaches for something, has a conversation with someone off camera, or leaves the view, we do not know what is happening. Assumptions can be made, but at the risk of being inaccurate.

Screen recording analysis is a very labor intensive methodology. Analysis of videos and multiple coding strategies took a lengthy amount of time. Tools that would assist in automating this process or speeding the process up would be beneficial.

Suggestions for Using this Method and for Further Research

The quality of the recorded video and audio will determine the ability to accurately capture events in the screen recordings, so effort should be made to work with participants to optimize equipment. Some troubleshooting may need to be completed with participants before they record their sessions. Management of media and coding files should be considered during study planning. Screen and webcam recording could be combined with other data from tools using Harvard's Multimodal Toolkit (https://mmla.gse.harvard.edu), such as eye tracking or emotion detection; with physiological inputs like heart rate or electrodermal activity; and LMS data from log files to provide a more complete analysis of the learning experience. While our study helped to illuminate the experience of adult learners in distance education, we recommend using this method to study other populations, such as K-12 students in remote learning, traditional-aged college students, or other special populations.

Conclusion

The use of screen recording analysis in authentic environments as a methodology to understand the experience of adult learners in distant education is an innovative approach that proved beneficial in our research, however, we recommend future research in other settings to determine further benefits, feasibility, and limitations. The use of screencast, webcam video and audio recordings provided a modality for the researchers to collect data and analyze the learning techniques and distractions in the learners environment and how it influenced student learning.

This method in natural settings can be combined with traditional techniques, like participant report, to more fully understand the underlying experiences of the learner through screen observations.

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Asset-based Pedagogy: A Case Study Evaluating Evidence of Self-identity and Culture in a Higher Education Online Learning Environment.

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Abstract

Learners in higher education settings across the country bring to the classroom a wide array of educational experiences, cultural practices, and individual identities. The cultural differences learners carry into their online learning environments have the potential to influence how they interact with their classmates and instructors as well as how they interpret course content, learning objectives, and assignments (Chita-Tegmark, 2012). An asset-based approach to instruction frames the diverse nature of learner experiences as strengths and provides opportunities for learners to express their individual identities through choice (López, 2017).

Introduction

Identity development can be viewed as the result of the interaction among psychological/individual factors, cultural factors, and contextual factors of a learning environment (Collins, 2018). Implementing an asset-based pedagogical approach can encourage learners to see themselves reflected in their work. Further, opportunities for learners to build upon prior knowledge can serve to validate their experiences and help develop and strengthen their identities as learners (Darder, 2012). Asset-based approaches to instruction view students' prior knowledge and lived experiences as valuable tools that can be utilized to solve problems that are both meaningful and relevant to their lives. This instructional approach positions students' lived experiences, their interests, geographic locations, familial and cultural values, and social concerns as central components of the learning process (Wright et al., 2016; Yosso, 2005).

Exposure to asset-based instructional strategies that are problem-based can encourage and support the identity development of all learners, particularly for those interested in pursuing careers where they are often underrepresented such as those in STEM fields. Problem-based learning challenges can provide educators an opportunity to not only leverage students' social and cultural capital, but also develop agency and strengthen identity through the process of working on a project that is both relevant and meaningful to them (Freire, 1970).

Purpose and Research Questions

This study examined the ways in which learners express their identity and culture when provided opportunities for voice and choice in an online learning environment. The study addressed the following research questions:

- When given choice in learning outcomes, in what ways if any do learners express aspects of self-identity?
- How are opportunities for identity expression perceived by learners in an online learning environment as they relate to agency, voice, and choice?

Methodology

Participants

Participants (*N*=105) were a convenience sampling of learners from three sections of an introductory education technology course offered in a college of education at a large public, southeastern university. The first two sections were held in Fall 2020, and the third section was held in Spring 2021. All participants were enrolled in undergraduate education degree programs, including early childhood education, elementary education, and exceptional education. The course titled *Introduction to Technology for Educators* included modules related to classroom management tools, multimedia, communication networks, interactivity, educational software and legal, ethical and social issues related to educational technology tools. The purpose of the course was to prepare learners to be competent computer-based technologists. Throughout the course, students learned how to successfully integrate instructional technology tools into their teaching approach and cultivated their own sense of the importance of effective instructional technology modeling as part of their teaching and learning strategies.

Procedure

This study examined data collected from an introductory education technology course for undergraduate learners. In the first module of the course, learners were asked to complete a digital T-shirt assignment to introduce themselves to their classmates. The purpose of the introductory digital T-shirt assignment provided learners an opportunity to utilize technology to create and present T-shirts that incorporated images they felt represented salient aspects of their identity. The importance of each image was described by the learners and a rationale for the images, words, and hashtags included on the digital T-shirt was posted in a public discussion forum. Learners in the class were asked to comment on the work of other classmates. The submissions from this assignment were used as the baseline to determine how learners self-identified aspects of their identity such as their personality traits, ethnicities, religions, hobbies, and family structures (see Figure 1). In addition to the creation of a t-shirt, learners were asked to post a response that included what their image represented about them and if they had a hashtag to describe themselves, what would it be (see Figure 2). Learners were also asked to respond to at least two other classmates.

Figure 1

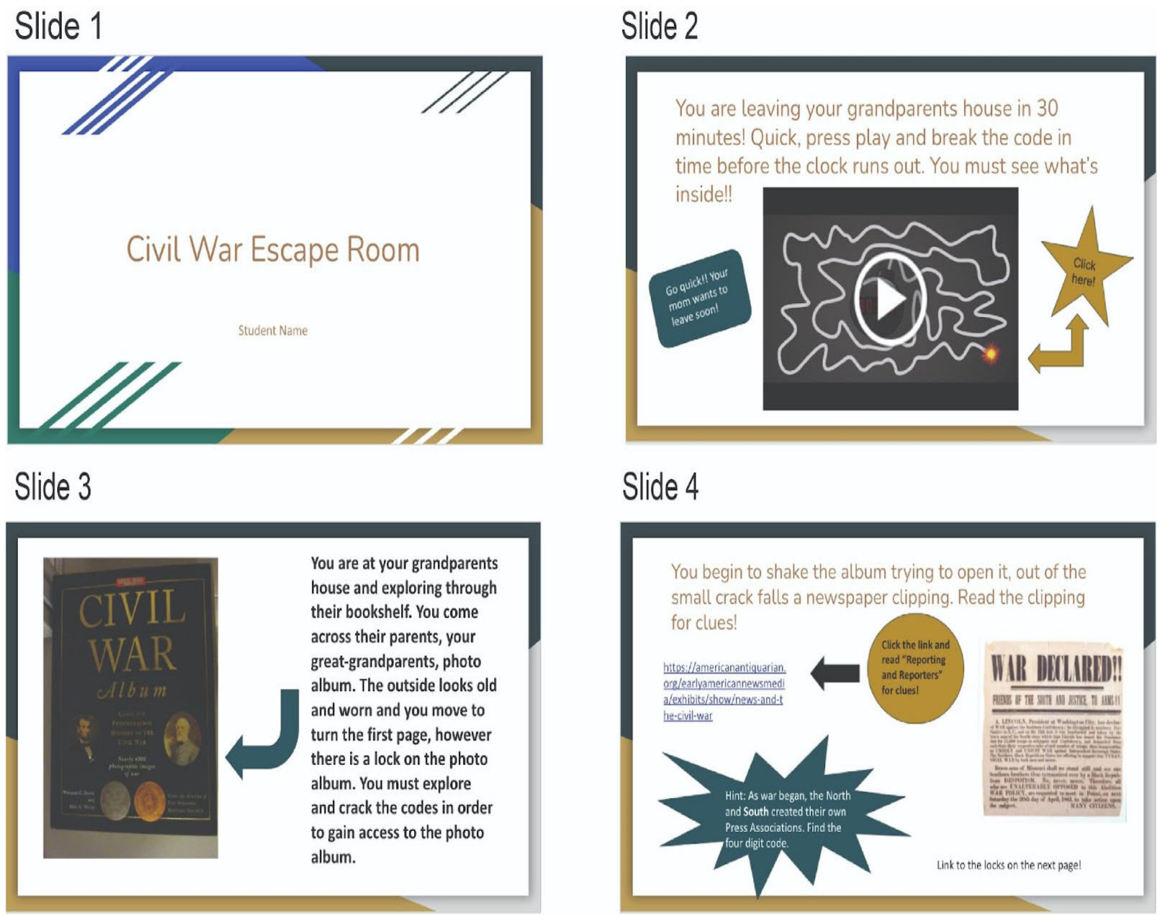
Example of student T-shirt Image

The next opportunity for the expression of student identity occurred during the second module of the course. Learners were tasked with creating their own digital Escape Rooms**.** This activity required learners to develop and create their own digital escape room based on a topic of their choosing (see Figure 3). Learners then shared their work with others in the course as well as friends, coworkers, and spouses to receive feedback and revise if necessary. At the conclusion of the assignment, learners reflected on their experience creating an escape room and how they anticipated this activity could be used in the future. They were asked to respond to the following questions:

- What did you learn as a result of completing the digital escape room?
- How can you use this innovative assignment now as a student?
- How will you use this assignment in the future with your own classroom?
- What did you improve as a result of the test/retest step in the creation of the digital escape room?

Figure 3

Examples of students' digital Escape Room Submissions



Data Analysis

After conducting a comprehensive literature review related to topics such as culturally relevant instructional approaches (CRIA), asset-based pedagogy (ABP). voice and choice in online learning environments, research questions were developed. In order to answer the identified research questions, a descriptive content analysis was conducted. First, learner assignments were curated from the Learning Management System (LMS). Data that met the following criteria were considered for analysis (a) submissions that evidenced learners' self-described identity in initial activity, (b) submissions that incorporated learners' identity and culture in the second activity and (c) reflections that included learners’ perceptions of the affordances of voice and choice in an online learning activity.

Next, submissions, artifacts, images, and reflections were coded, and a coding frame was constructed based on the data. After initial data analysis and coding commenced, general variables were determined by the research team to be included in the coding scheme. These included aspects of identity such as: (a) family, (b) country of origin, (c) faith, (d) personal affiliations, (e) affections, and (f) popular culture. Evidence of agency such as self-efficacy, choice, and collaboration were also considered as these themes frequently found throughout the data. Hashtags included as part of the t-shirt assignment were also collected and analyzed (See Figure 3). The following themes emerged through the coding process: (a) perseverance, (b) personal identity, (c) positivity, and (d) authenticity.

Figure 3

Student-generated Hashtags

Perseverance	Personal Identity	Positivity	Authenticity
#yougotthis	#gettoknowhannah	#goodvibes	#beyourself
#nevergiveup	#hippieteacher	#CAREFREE!	#Natural
#ambitious	#Articulate360Newbie	#Everythingisokay	#beintentional
#getitgirl	#organized	#bright	#truthful
#queenoffreshstarts	#Nurturing	#cares	#compassion (2x)
#determined (5x)	#lucky	#passionate	#authentic
#motivated	#wildchild	#blessed (4x)	#authenticity
#perseverance (2x)	#SweetAsPie	#easygoing	#BeHonestAndReal
#strong	#readmyface	#empathetic	
	#SapereAude (dare to know - learning and striving in education)	#ChooseJoy	
		#grateful (2x)	

Findings and Discussion

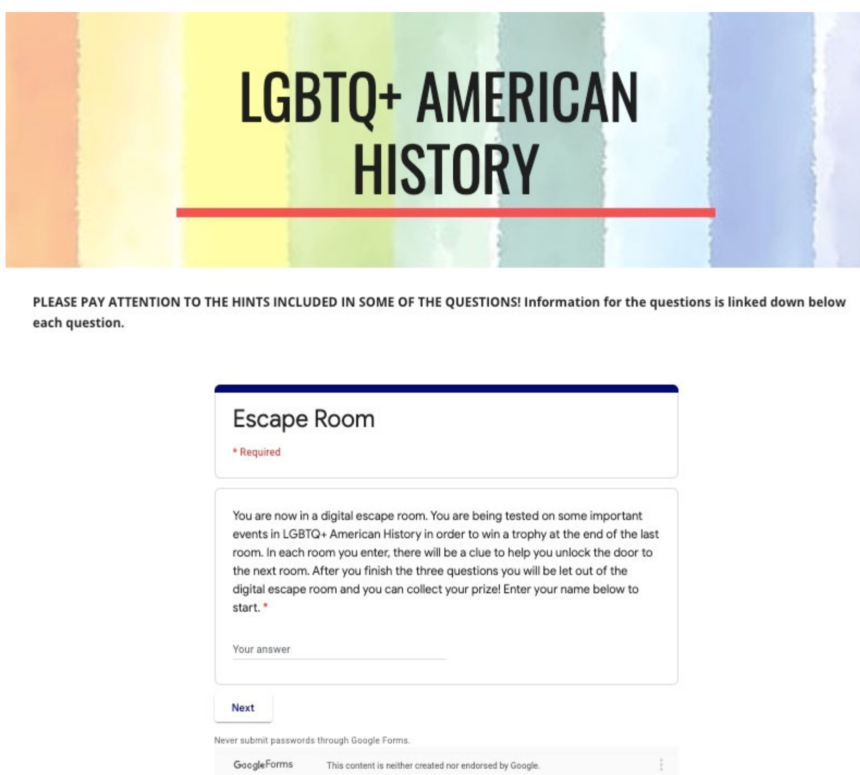
Based on the coding frame, 29% of the potential responses were related to self-identity and 27% were evidence of learners' acknowledging that they had a voice and choice in choosing the direction of their learning. Data from this study demonstrated that learners frequently made efforts to connect their work with their own experiences and funds of knowledge. When learners were given agency and the power to determine the topics for their assignments, many noted in reflections that it improved their learning experience. One learner made the following comment:

> The assignment was nice in that we were allowed to choose any moment in the United States of America to choose from for our escape rooms. I was glad we could be creative in choosing topics, riddles, and questions for our escape rooms. I look forward to making many more escape rooms!

The introductory T-shirt assignment detailed in this study presented a learning context that utilized technology to provide opportunities for learners to authenticity express their identities to their peers. Learners oftentimes chose to weave aspects of their identities into assignments that allowed for voice and choice throughout the course (See Figure 3).

Figure 3

Example of student identity across assignments.



In addition to aspects of identity and agency evidenced in assignment submissions, learners also frequently discussed how the opportunities for voice and choice embedded in the tasks positively contributed to their self-efficacy, creativity, and overall engagement in the course. The student who created the examples in Figure 3 reflected on the assignment and commented:

> The things I put on my shirt are what make me, me! On the left sleeve I have a rainbow heart because I am a very proud member of the LGBTQ+ community. This is something that is very important to me not only because it's a community that I'm apart of but also because I always want others to know that I will be supportive of them and that I am always a trustworthy person that they can come to. On the right sleeve of my shirt is a picture of my family and I because they are my everything. The top of my shirt has a headphone with music coming from it because music is my escape and something that always helps me when I'm feeling down, or even just happy! Below that is the beach because when I'm not doing school or watching my sister play softball, I'm definitely at the beach! …. And lastly, the hashtag I would use is #beyourself. I have struggled a lot with knowing when to be myself and when to kind of hide who I want to be from others but I'm proud to be me and I always want to be myself!

The Escape Room Breakout challenge provided multiple examples of identity expression as students choose which topics they integrated into their digital projects and the images and storylines they included. The Escape Room challenge utilized a problem-based instructional approach to provide students with an opportunity to apply their personal knowledge and lived experiences to design a problem, develop a storyline, work towards finding solutions, and reflect on the process as a whole. One learner remarked:

> While forming questions I would switch back and forth between the slides and the form to make sure everything lined up well and decided to make my last question about LGBTQ+ rights because those are especially important to me as a queer woman. So, I found a website that showed me a map of the penalties/protections different countries have in place for members of the LGBTQ+ community and asked participants to pick which two continents had the harshest consequences according to the map.

Providing opportunities for identity building experiences in higher education courses can encourage meaningful participation in course activities. The inclusion of problem-based learning challenges that utilize an asset-based approach can cultivate deeper learning by centering problems within a context that is meaningful to students (Baeten et al., 2010). Several participants noted their intention to incorporate asset-based instructional approaches with their own students in the future. One student noted:

> This digital escape room had myself, as the creator, thinking outside the box and using my creativity to enhance the design of it. This project expanded my knowledge in various ways, and I am becoming more comfortable in using these particular technological platforms.

The use of technology tools can support authentic identity expression and encourage learners to make connections to their own experiences and the experiences of others in the context of the course. Identity expression was evidenced across multiple assignment submissions throughout the course and students noted how the opportunities for voice and choice positively impacted their motivation, self-efficacy to use technology tools, as well as overall impression of the course.

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Design Guidelines for Integrating Entrepreneurship into K-12 Classrooms

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Introduction

Entrepreneurship is defined as the ability to turn an idea into an action using creativity to create value for others (Chen et al., 2001; McGee et al., 2009; Tsai et al., 2016). It is the driving force of our economy. Arming young people with an entrepreneurial mindset will promote future business creation and build a pipeline of entrepreneurial thinkers. Without the innovation and risk-taking of entrepreneurially minded individuals, we would not invent, empower, or thrive as a nation. Also, an entrepreneurial mindset helps increase creativity and self-confidence in every aspect of people's lives and is an essential driver of growth and sustainability (Neck & Corbett, 2018).

Entrepreneurship Education

Entrepreneurship education is needed to provide the necessary knowledge and skills for young people to launch innovative practices to be competitive in the world (Gargouri & Naatus, 2019). Entrepreneurship education provides students with a safe environment to experience what it is like to be entrepreneurs (Neck & Greene, 2011). Unfortunately, entrepreneurship education is underdeveloped in K-12 schools (Zhao, 2012a), even though teaching entrepreneurship in the K-12 sector can help build a generation of young people armed with an entrepreneurial mindset and become innovators, creators, and leaders in the workforce.

Purpose of this Paper

Teaching entrepreneurship in the K-12 sector can help build a generation of young people armed with an entrepreneurial mindset who become innovators, creators, and leaders in the workforce. The purpose of this presentation is to provide guidelines to integrate entrepreneurship into K-12 classrooms.

Guideline 1: Use a design-based thinking approach

Design-based thinking (DBT) is a cyclical process of observation, synthesis, generating alternatives, critical thinking, feedback, and creativity, similar to the entrepreneurial process (Daniel, 2016). The entrepreneurial process emulates the design-based thinking process, as they are both iterative and start with problem identification moving from ideation/brainstorming to prototyping and testing ideas (Neck & Greene, 2011). By approaching entrepreneurship from a DBT perspective, teachers can ask students to identify problems they want to solve, generate ideas, gather information from various sources to solve the problem, and launch their business.

Guideline 2: Promote students' entrepreneurial mindset

An entrepreneurial mindset is the state of mind that changes an individual's status to an entrepreneur. An entrepreneurial mindset concerns the analysis of the world, its opportunities and possibilities, and the understanding of how an individual can contribute to the progress of economic and social systems (Kouakou et al., 2019). An individual with an entrepreneurial mindset has a set of skills enabling him/her to recognize opportunities/identify problems that need to be solved, take risks, create value from opportunities, and overcome challenges (Fayolle & Gailly, 2015). Empirical studies show that an entrepreneurial mindset is a precursor for entrepreneurial behavior, intentions, and actions and indicates an individual's worldview (Daniel, 2016; E. Kim & Strimel, 2020; Korte, 2018; Kouakou et al., 2019; Popescu, 2014; Rae & (Daniel, 2016; Kim & Strimel, 2020; Korte, 2018; Kouakou et al., 2019; Popescu, 2014; Rae & Melton, 2016)

Guideline 3: Experience the entrepreneurial process from inception through implementation

This guideline is grounded on the experiential learning model. Kolb's experiential learning model focuses on experience as the main force driving learning because "Learning is the process whereby knowledge is created through the transformation of experience" (1984, p. 38). According to Kolb (1984), a person learns when he or she can progress through a cycle of four stages, including a concrete experience, a reflection on the experience, an analysis of the reflection, and an application of that analysis to future experiences. Empirical studies show that an experiential learning approach contributes to students' entrepreneurial mindset. For example, Bell (2015) found in her research that an experiential learning approach requiring students to pitch ideas, present findings and reflections, and work with community members while developing a business idea increased entrepreneurial mindsets. Lackéus (2020) found that experiencing a real-life business startup process increased student self-efficacy for entrepreneurship.

Guideline 4: Provide scaffolding

Vygotsky's Zone of Proximal Development (ZDP) provides underpinnings for this guideline. The ZPD is a construct that bridges the gap between what a student can already do and what he or she can do with assistance. The ZPD is the target area where scaffolds are the most helpful. Instruction focused within a students' ZPD provides just enough challenge to help them build the next skill level (Belland, 2014). Teachers provide adequate assistance to give students enough help to be successful while still challenging them. As students gain skill, teachers decrease scaffolding support until students can accomplish the task independently (Belland et al., 2013; Vasconcelos & Kim, 2019).

Entrepreneurship is inherently ill-defined as the entrepreneurial journey has many twists and turns and uncertain outcomes, providing challenges. For students will little or no experience in entrepreneurship, this process may seem intimidating. With appropriate scaffolding, students can progress so that scaffolds can be faded as students gain competence and confidence (Belland et al., 2008). Scaffolding strategies include highlighting essential task elements, questioning, modeling how experts solve problems, providing feedback, etc. (Belland, 2014). Teachers can scaffold entrepreneurial learning by modeling their thinking when describing new concepts. They can lead by example, demonstrating their thoughts and actions in the face of new information.

Guideline 5: Use authentic problems

Teachers' objective is to develop ways for students to experience the realities of starting a business in a risk-free or safe environment such as the classroom (San Tan & Ng, 2006). This way, entrepreneurial competencies can be developed that actively engage learners (Macht & Ball, 2016; Miles et al., 2017; Robinson et al., 2016). Authentically aligned activities should be used to enable the practical application of the same skills knowledgeable professionals apply when addressing similar activities (Fook & Sidhu, 2010; Macht & Ball, 2016). Authentic activities enable deeper learning by increasing students' motivation and engagement and supporting students' achievement. For entrepreneurial education, teachers can ask students to identify local problems, interview stakeholders to improve their business ideas, create a product to conduct experiments to test the product, and pitch their ideas to an authentic audience.

Iterative Design of a Narrative-Centered Learning Environment for Computationally-Rich Science Learning in Elementary School

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Abstract

Computational thinking (CT) has become an integral 21st Century skill that facilitates problem solving across disciplines (Grover & Pea, 2018). Thus, embedding opportunities and scaffolding for CT learning within K-12 education is now a focus for scholars and practitioners (Hsu et al., 2018). Recent progress in this area has primarily focused on middle and high school levels, where many students now have increasing opportunities to learn CT through designated computer science and STEM courses, while K-5 educators often lack the tools to support student learning of CT skills and practices (Code.org Advocacy Group, 2018). Additionally, an interdisciplinary approach to CT teaching and learning can be more effective than having students learn these skills in isolation from other subject matter (Sandford & Naidu, 2016).

K-5 teachers may be at an advantage for integrating CT across disciplines (e.g., ELA, math, science) and creating robust CT learning experiences, since they teach a variety of subjects

to the same students each day. However, there is a dearth of research that has focused on specific learning technologies and their respective in-platform supports that would help teachers seamlessly integrate CT into disciplinary content learning (Kale et al., 2018; Pila et al., 2019). In response to this need, we are iteratively designing and developing a narrative-centered digital learning environment to engage upper elementary students in computationally-rich science learning. Digital narrative creation offers students an interactive learning experience and enables the creative exploration of scientific phenomena (Henriksen et al., 2016), while also reflecting many CT concepts in the writing and story creation process (Parsazadeh et al., 2020).

Methods

To gather feedback from upper elementary teachers about our narrative-centered digital learning environment and its usability for classroom and distance learning settings, we conducted an online focus group in the fall of 2020 which examined teachers' perspectives on the learning environment's facilitation of story creation using custom narrative blocks as well as the efficacy of its integration of science, English language arts (ELA), and CT concepts. Our protocol included three components: 1) an introduction to the study and learning environment; 2) teacher experimentation with the learning environment; and 3) a post-experimentation focus group interview. The learning environment used in this study, INFUSECS, is designed to enable upper elementary students to create interactive digital stories and utilizes a custom-built narrative programming environment, where students use a block-based programming interface to create, revise, and visualize interactive narratives.

After a 15-minute introduction and icebreaker activity to help establish rapport within the group, participants were introduced to the overarching goals of the project and learning environment. The teachers were then randomly assigned to Zoom breakout rooms where they had 20 minutes to experiment with the learning environment and then share their perspectives on the learning environment, a narrative planning worksheet designed to facilitate story creation and embedded activities. A researcher observed each breakout room, answered participants' questions, and addressed any technical issues that arose. At the end of the think-aloud breakout sessions, researchers sought participants' permission to collect screenshots of the computational artifacts (Figures 1 and 2) produced during the sessions. Participants and researchers then rejoined the main Zoom meeting where participants shared their perspectives regarding the learning environment activities through open-ended interview questions. This portion of the focus group session lasted approximately 25 minutes and the interview questions examined participants' perspectives regarding the learning environment's ability to facilitate story creation, its usability, and the efficacy of its content integration.

The researchers held a debriefing session after the focus group to discuss and record field notes. The Zoom sessions, including breakout rooms, were transcribed and divided among the researchers for qualitative thematic analysis. The researchers discussed the qualitative results to reach consensus on the thematic elements of the data. Themes that emerged from the analysis provided impetus for refinements to our digital narrative-centered learning environment. These results are presented in the following sections corresponding to the overarching themes.

Figure 1: Narrative Designer Program Editor

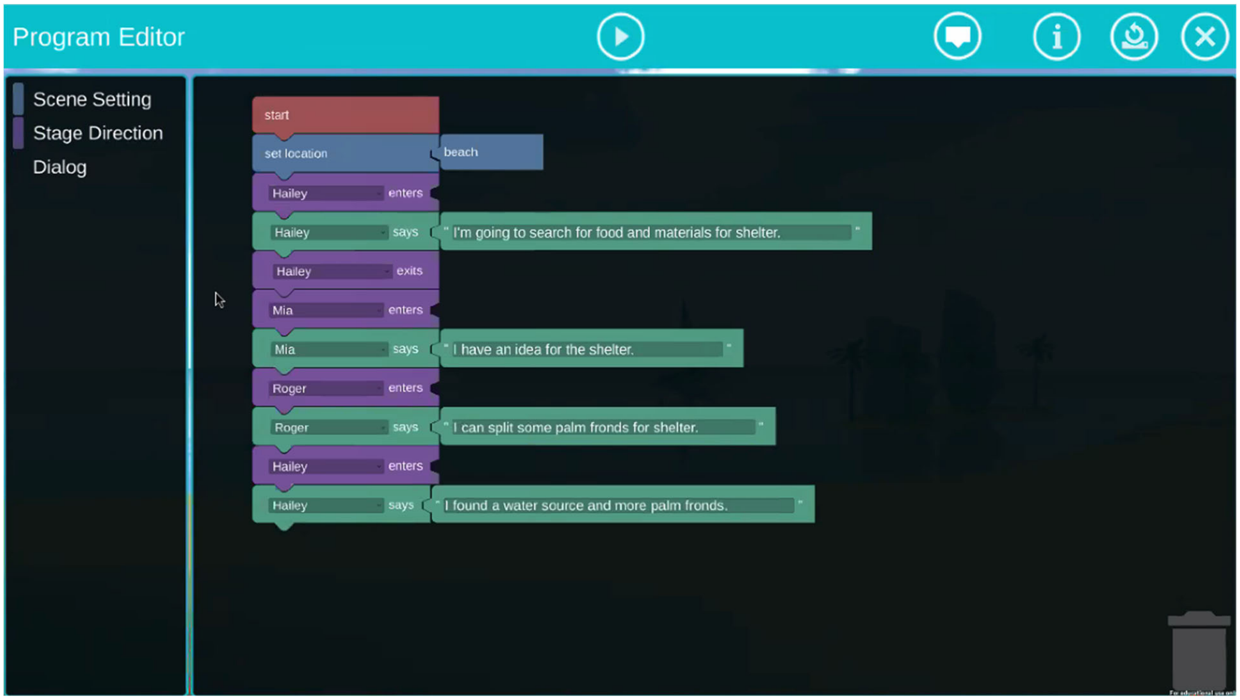
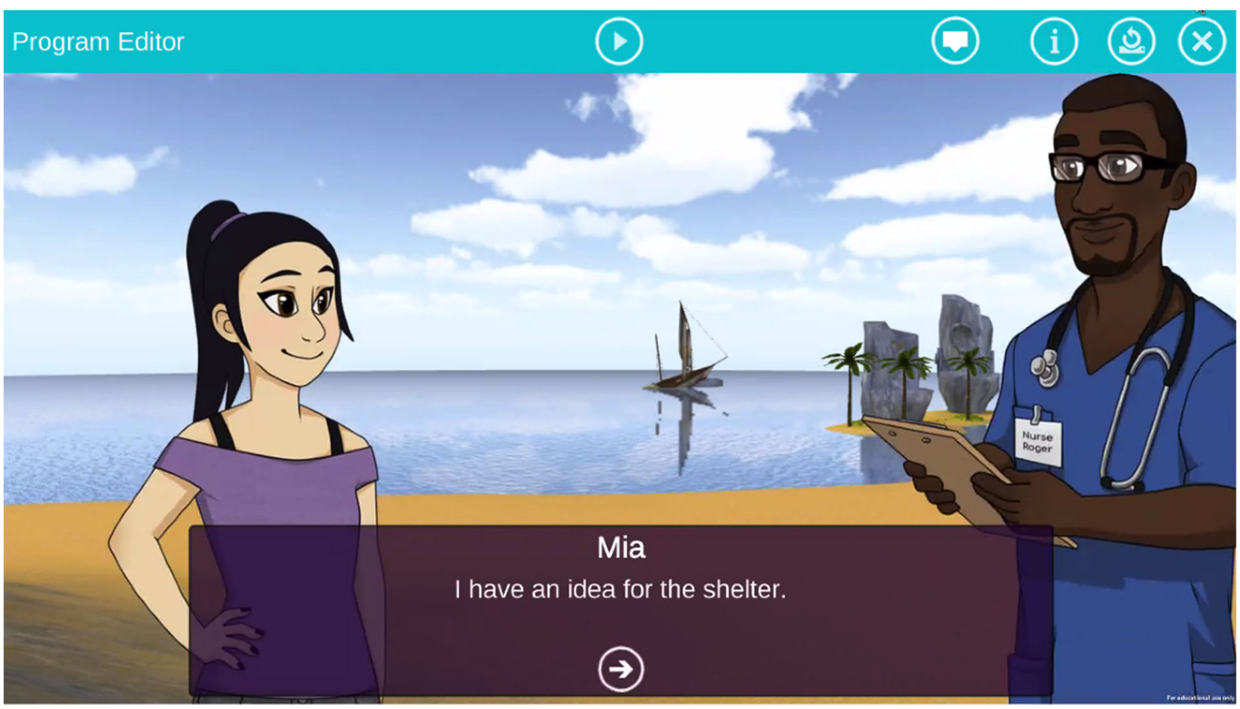


Figure 2: Narrative Designer Animation



Participants

During fall 2020, researchers conducted an online focus group with four 4th grade teachers. The sample consisted of instructors from Northern California, including 3 female and 1 male teacher. The participants were a convenience sample made up of 4 local retired teachers. All instructors had prior ELA and science teaching experience, with 75% of the teachers planning to cover physical science in their classrooms during the school year.

Researchers provided participants with a prior experience survey consisting of 3-point Likert items, ranging from "None" to "A Lot." Seventy-five percent of the teachers reported having "Some" level of experience using coding activities in their classroom. Twenty-five percent reported having "A Lot" of experience using digital narratives, while the remainder reported having no experience with digital narratives. Researchers collected data via the online Zoom video conference platform using the tool's main and breakout room functionality.

Findings

Our analysis suggested that teachers believed that the learning environment would facilitate creative digital storytelling with its custom narrative blocks and provide an engaging environment for students to learn science, ELA, and CT. However, teachers experienced some confusion in getting started in the integrated coding environment and difficulties with its accompanying instructional materials, which suggested that additional navigational and instructional supports were needed in the learning environment. Further, the focus group results prompted us to give more consideration to providing a better balance for the integration of the conceptual knowledge we aim to support in physical science with this platform. The following sections provide more detail on the overarching themes that resulted from our analysis.

Facilitating Story Creation with Narrative Blocks

A key aspect of the learning environment is to facilitate students' abilities to develop science-based digital narratives using custom narrative code blocks. Thematic analysis revealed that the learning environment's custom narrative blocks aided teachers' development of their digital stories. Teachers referenced the custom narrative blocks as they encountered them in their exploration of the learning environment and this seemed to spur the creation of their narratives. Teachers were also easily able to discern that story characters could be added using the character-focused custom blocks and without further prompting from the researchers, eagerly began incorporating dialogue blocks for their characters' interactions.

Teachers seemed to perceive the custom narrative blocks as intuitive and we observed that both groups of teachers spent the majority of their breakout session on the character dialogue of their digital stories. Despite some expressed frustration with typing their characters' dialog, teachers remained engaged in creating their science-based narratives. However, one point of contention seemed to arise from the appearance of characters not matching teachers' expectations of how their characters should look. A teacher in one group fixated on a male character offered in the learning environment that was dressed as a nurse despite incorporating the character into their story in another role. The teacher expressed some disappointment with the inability to change the character's appearance to match their expectation for the role they were assigning, but in this early stage of the learning environment development, the characters provided were not customizable. Finally, during the post-interview, teachers expressed that timing would be a key element to using the learning environment and associated activities in the classroom. The learning activities were perceived as enjoyable and useful to their students, but teachers suggested that they would need to spend some instructional time on ELA concepts before jumping into the learning environment for digital story creation. One teacher expressed the need to "lay out [a] lot of groundwork" and another expressed that:

> *"I think you'd have them work in teams and plan out the story? And they'd have to get some ideas, I think. So, you'd have to brainstorm, like she said and I'd see this being at least [a] week too and using a lot of language arts time before they dive into it. What a story should look like even."*

Usability of the Learning Environment

Data from the usability study indicated that teachers felt the INFUSECS learning environment operated according to specification. Specifically, teachers like the platform and reported that it was engaging and easy to use. While teachers needed some assistance with operating the technology or completing the narrative planning worksheet, teachers found that, overall, there were no issues with the fundamental platform operations, including coding block accessibility or the dragging of blocks and attachment of blocks.

Teachers were able to intuitively and cooperatively use the narrative blocks and planning document framework. The participants worked together to fill out the planning document and use the learning environment. The planning document 'dialog' and 'ask the audience a question' organization scaffolded the teachers' thinking during the story design process from a beginning stage, through to the middle and end. The platform code categories and naming of the custom narrative blocks helped teachers to identify the story creation components needed to develop their planned story:

> *"All right. Stage direction left, right, middle, Hailey exits, Hailey enters. Oh, Hailey enters stage left. Oh, I got it. I got it. I got it. Hailey enters stage left. Dialog, Hailey's going to say 'Oh my geezy, is everyone okay?'"*

Dragging the blocks onto the main work area was also seamless and the teachers easily attached the blocks together to create their narrative programs. Half of the teachers reached the point of running their narrative programs and seeing the corresponding narrative visualization, and when directed to, successfully observed the translation of their story into visual form.

Teachers did, however, have some difficulties. Participants did not grasp the interactive theatre nature of the platform and thus were not sure how to properly structure a 'theatre audience' question and response block. Participants also could not successfully edit the blocks in the question space of the planning document. The participants tried multiple times to click the question box and enter text, but the image formatting did not allow text entry. Within the learning environment, two teachers had initial confusion about what to do when they first opened the software. As a result, they sought researcher direction and support. In another portion of the session, half of the teachers had some difficulty navigating the integrated coding environment because they did not understand how to close/exit the code category sections of the workspace. One teacher expected the coding environment to be platform agnostic and unsuccessfully tried to access it using an iPad. Despite these challenges, with a small amount of feedback from the researcher and additional time, the teachers were able to move through each initial source of difficulty without further assistance.

Content Integration Efficacy

Our focus group findings indicated that the participants were able to make more explicit disciplinary connections to ELA in comparison to science and CT. Several teachers indicated that they would specifically dedicate ELA instructional time for the activities, in particular, allowing students a few days to draft and build their stories. One teacher felt the learning environment would be well-suited as a tool for generating the creative writing genre of playwriting and dialogue between characters while others remarked at how the built-in scenery of the narrative environment such as the waterfall could be sources of energy on the island. However, in the post interview they expressed some concern that students would need group brainstorming sessions to make these explicit science connections.

Finally, our investigation probed the participants to discern if they noticed potential opportunities for CT integration. Although teachers in our study never explicitly named CT concepts as a part of the learning experience, their practices exhibited CT elements that could potentially be integrated into their pedagogy with the platform through professional development and training. Moreover, the teachers suggested that graphic organizers could help students decompose and abstract the necessary story elements and scientific components that would be needed to compose their narratives. During the interview, teachers shared ideas to consider for the learning environment that aligned with CT. For example, one teacher noted, “I think you'd have them work in teams and plan out the story,” indicating he saw the environment fostered opportunities for collaboration. Another teacher discussed the learning environment’s value for creating artifacts:

> *“At the end when we saw what we created, that's why I feel like my kids would really like it. Because I see what the end could look like and if they can see what the end would look like, I think they would go crazy wild because it's great.”*

Our observations of teachers’ interactions with the environment also indicated that our participants saw the animation tool and the programming blocks as means for fostering CT concepts and practices like debugging, tinkering, and evaluation as we witnessed them engaged in these processes.

Iterative Development and Future Work

To address concerns raised during the focus group, we implemented an initial set of iterative refinements to the INFUSECS learning environment. The first refinement aimed to improve usability of the software. Upon logging in, users now encounter an overview map (Figure 3) highlighting key navigational features and an introductory video sequence (Figure 4) to help each participant connect the individual pieces of the environment with the overall goals and directives of the platform.

Figure 3: INFUSECS Overview Map

Figure 4: INFUSECS Introductory Video

The second refinement was the incorporation of the Science Content Explorer. This component teaches foundational energy concepts (Figure 5), engages users with an interactive simulation of energy conversion methodologies (Figure 6) and provides proximal learning opportunities through sense-making questions.

The interactive simulation feature also aims to bridge the gap between the learning environment's science learning objectives and the expression of energy conversion principles within students' digital narratives. Finally, a set of story starter blocks were added as a scaffold, enabling users to play a simple story animation and familiarize themselves with the instantiation and design of digital narratives.

Building on these refinements to the learning environment, future work will include conducting classroom feasibility studies. This will include both remote and in classroom studies as in-person learning becomes safe for students, teachers, and researchers. Feedback gathered from these studies will drive further refinement of the learning environment.

Figure 5: Science Content Explorer Foundational Energy Concepts

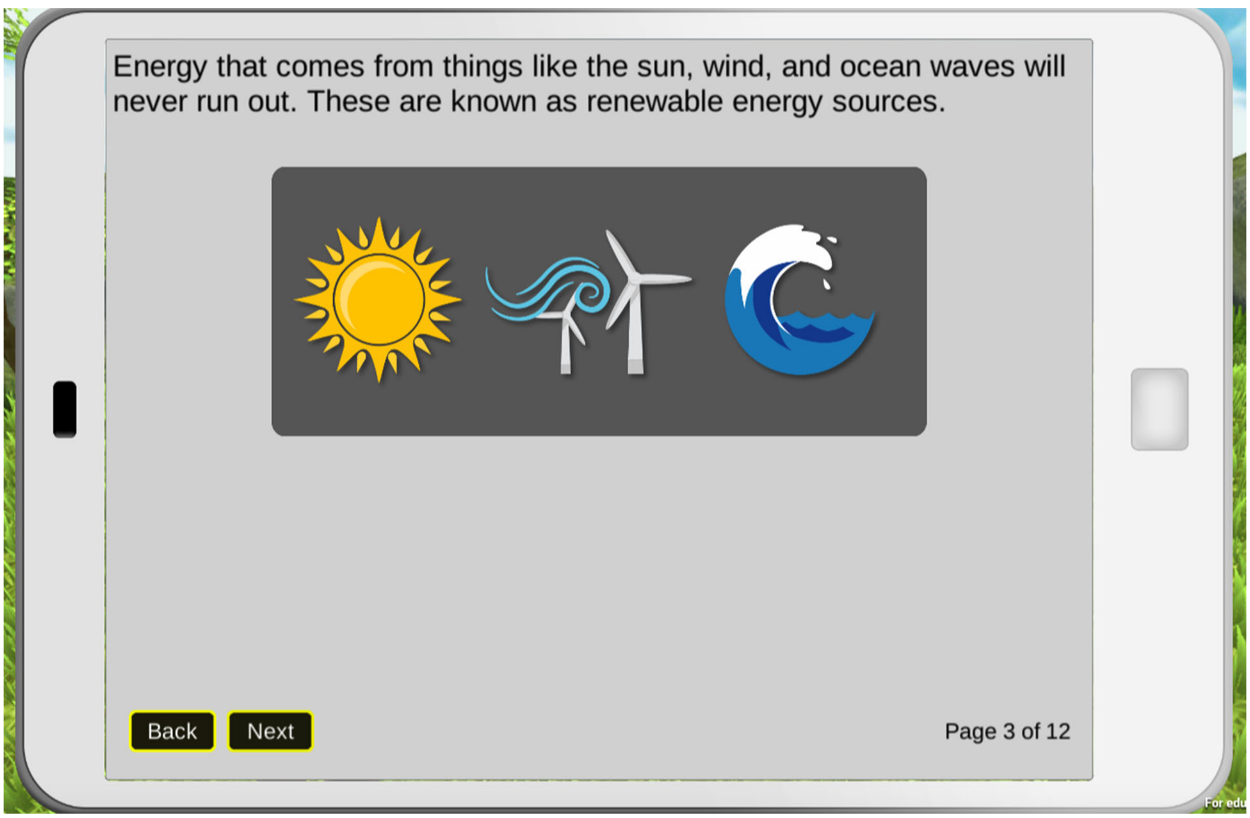
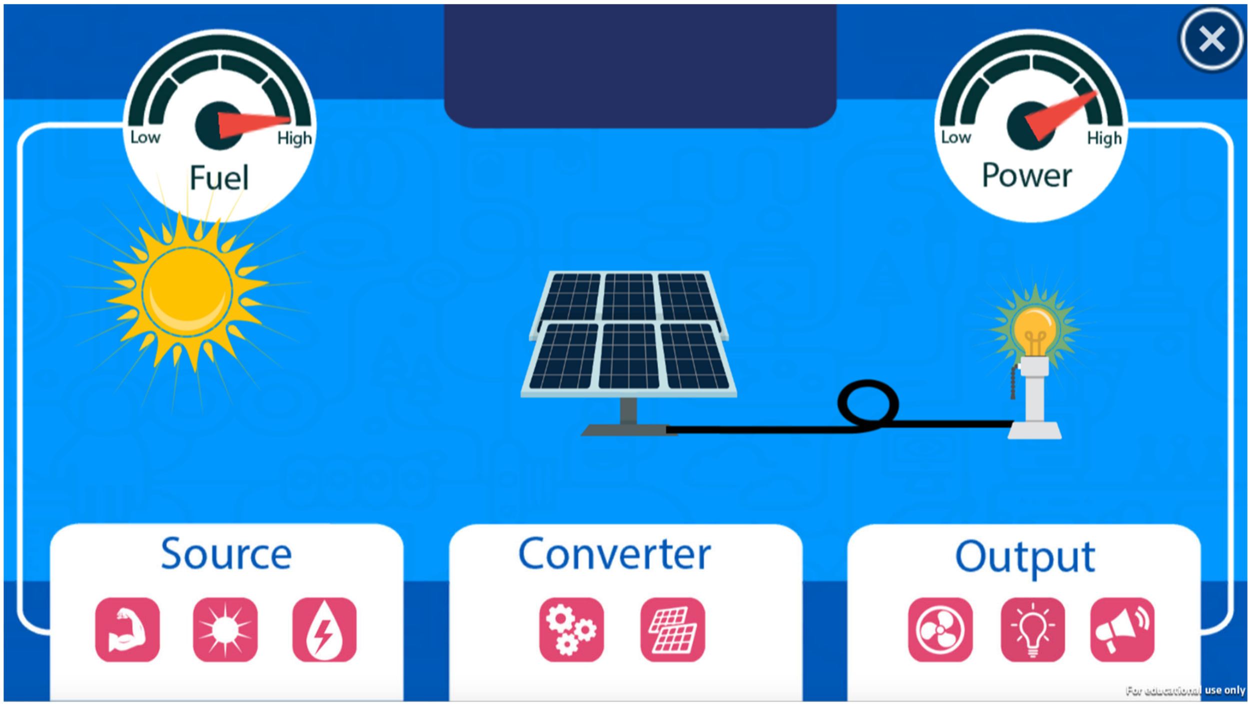


Figure 6: Science Content Explorer Interactive Simulator



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Flexible Assessment in Math During (and After) COVID

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Abstract

In this paper, we describe the design and development of a formative assessment plan with a mastery-based grading approach, implemented in one college-level math course offered during the pandemic, to reimagine the purpose of assessment in transforming exams into learning experiences. A retrospective study of this implementation indicates that this assessment strategy has psychological and academic impacts on student achievement. It enhances student learning by changing the negative perceptions of failure on assessments into an opportunity for growth. The outcome of the study also demonstrates how different groups across the university work collaboratively to innovatively implement teaching and learning strategies with effective pedagogical practice to promote student success. The working model can be generally applied to varying disciplines to support educational transformation in the post-pandemic era.

Keywords: mastery learning, mastery-based grading, assessment, mathematics education

Background

The Impact of the coronavirus pandemic on higher education

Institutions of higher education and enrolled students experienced substantial difficulties last year due to the COVID-19 pandemic. In response to this crisis, the shift to online learning preserved academic continuity. While this transformation has been challenging, much has been learned from this experience that can guide educators to rethink teaching and learning through the exploration of new pedagogical strategies and philosophies to progress through unprecedented educational disruption.

The quick turn-round to an online mode of delivery raised many concerns about the quality of education being offered. For example, the use of conventional assessments with high-stakes examinations to test remote learners lacks the flexibility that frustrated both instructors and students during the pandemic (Fuller, et al., 2020). High stakes testing has also been questioned in regards to the limitations of reliability and stability in accurately assessing student learning (Knight, 2002; Zimmerman & Dibenedetto, 2008). These deficiencies still remain within the context of online examinations.

In facing the uncertainties of such a global pandemic, educators must consider alternative methods to address potential problems when evaluating learning and offer required assistance in accordance with the skill level of the students to promote their success. Instead of relying heavily on conventional assessment approaches, it is imperative for educators to reimagine teaching and learning experiences to employ exceptional pedagogical practices to advance education to the next level.

Learning Assessment during COVID-19

Online assessment in the time of COVID-19 is an example of why educators need to integrate new methodological and technological strategies to provide flexibility in evaluating student learning outcomes, while also transforming assessments into learning experiences.

The traditional summative assessments at this time were faced with challenges of transferring in-class exams into online quizzes. As students shifted to remote learning, there was a greater need for flexibility, understanding, trust, and compassion to keep them engaged amid the COVID-19 pandemic. However, maintaining a more conventional approach to assessment, with limited schedules and means for students to access and respond to the questions, lead many students to struggle with taking online examinations (Fuller, et al., 2020; Tuah & Naing, 2021).

The scores for these high-stakes tests were also criticized due to issues of validity and reliability in determining students' performance (Tuah & Naing, 2021). The performance-oriented assessments focused heavily on memorization, rather than critical thinking and overlooked individual student differences in learning styles, as well as their varying levels of test anxiety (Harsy, et at., 2020). Students' perceptions of these examinations affected their study behaviors, encouraged them to overemphasize the importance of exam scores, and even worse, caused cheating on the test. This further demonstrates the issue of academic integrity, which remains a worry of educational equity in remote education (Gamage, et al., 2020; Lanier, 2006).

The faculty at our university revealed similar concerns about using summative assessment with high-stakes examinations during the pandemic semester. Their feedback, in conjunction with the existing barriers for summative assessments, highlights a need for alternative options that concurrently evaluate how students are doing with remote education and provide assistance for individual difficulties to support their learning. Developing such an assessment strategy that truly reflects student achievement with an emphasis on student well-being, ensures the quality of assessment, as demonstrated by this case at our university during the COVID-19 pandemic. The working model provides flexible, humanistic, and practical approaches to enhance learning innovation and support the transformation of higher education in the post-pandemic era.

This paper explores a theory-based practice derived from mastery learning that allows students to choose their own "adventure" and master the topics progressively with scaffolded feedback in the Introduction to Linear Algebra and Differential Equations course. This strategy aligns with the principles of empathy, flexibility, pragmatism, and simplicity to provide multiple opportunities and ways of learning to accommodate different student needs in preparing for the semester amid the pandemic.

This experience shows a deep collaboration between experienced instructors, academic researchers, learning designers, and learning analytics specialists in assessing the effectiveness of such a mastery-based approach to instruction and assessment. Through a post-course survey and students' performance, we derived the academic implications of this strategy through data-driven results. The findings can also inform ongoing improvement of mastery-based assessment to ensure its effectiveness and sustainability.

Transformation Measure to Turn Exams into Learning Experiences

Mastery learning

Given the evidence found by previous studies and our faculty members' feedback, traditional summative assessments with high-stakes tests did not align with our educational goals to support and enhance student learning during the pandemic. Finding an alternative approach to design a new assessment plan became critical. We began with a theoretical basis for the purposes of teaching and learning, finding a student-centered educational strategy called mastery learning to design the assessment activities. The idea of mastery learning is not new to Western educational thinking and the mastery-based approaches also have been implemented in pedagogical settings for many years (Block & Burns, 1976; Guskey, 2010; Kulik, Kulik & Bangert-Drowns, 1990). John B. Carroll (1963) initiated the conceptual model of mastery learning based on the premise that students can achieve the desired level of mastery in a given subject with sufficient time to practice. Then, Benjamin Bloom (1968) carried on and transformed this concept into a working model to outline a number of specific steps to achieve a distinct level of mastery. Other educators continued refining and elaborating on Bloom's Learning for Mastery model to make it more systematic and practical (Block & Burns, 1976).

Mastery-based assessment

In mastery learning, the assessment attempts to address students' deficiencies of needed concepts and skills through regular formative tests and provides them opportunities to develop proficiency and confidence to achieve the desired level of mastery on the learning topics (Block & Burns, 1976; Guskey, 2010; Kulik, et al., 1990). To gain such an improvement in student performance, a mastery-based assessment includes pre-and post-tests, formative measures, corrective instruction, and enrichment activities to scaffold student learning (Guskey, 2010). A well-designed assessment plan based on mastery learning could minimize individual differences in their aptitude for the subject and provide assistance to equip each student with a confident command of the fundamental concepts to progressively master the learning content at their own pace (Block & Burns, 1976). This assessment type is individually based and permits multiple chances for testing to cater to individual needs to support student learning.

Self-perceptions of learning

The essential criterion of success in mastery learning is how much improvement individual students display. Mastery-based assessments can mitigate the risk of test anxiety and related test perceptions on a student's performance in summative measures, such as final examinations and other end-of-instruction tests (Block & Burns, 1976). For students with a fixed mindset, the failure of those performance-oriented exams infers that they are not smart enough to succeed and then they quickly give up (Boaler, 2013). Therefore, the use of high-stakes examinations could aggravate the notions of limited intelligence or fixed ability in learning. The assessment in mastery learning is not a one-shot or do-or-die test experience. It focuses more on the progress students make in learning (Block & Burns, 1976; Guskey, 2010; Kulik, et al., 1990). The opportunities to grow help students believe their knowledge or skills can be developed via learning (Boaler, 2013).

Motivational and academic supports

In addition to encouraging students in the learning process, mastery-based approaches to assessment and instruction also have motivational benefits for instructors in connection to increased responsibilities for students' learning outcomes and higher expectations for students' academic success. (Zimmerman & Dibenedetto, 2008). The progress students demonstrate makes instructors feel rewarded and are then more willing to contribute their time and effort to help pinpoint topics that students struggle with and provide personalized instruction to support their learning. Furthermore, previous studies have indicated that using mastery learning techniques has positive effects on student academic achievement (Block & Burns, 1976; Guskey, 2010; Kulik, et al., 1990). Given the mental and academic benefits of mastery learning, this pedagogical approach could help address the challenges we faced during the COVID-19 pandemic in assessing students' performance while also preparing for the change needed to transform higher education in the future.

A Mastery Learning Intervention in a Mathematics Course

At our institution, two experienced professors from the Department of Mathematics proposed to initiate a new assessment approach using a mastery-based grading system to replace high-stakes testing for their Introduction to Linear Algebra and Differential Equations course (see Appendix A for more detail). The original assessment of the course was mostly based on a few high-stakes tests, including three midterm exams (20% each) and one final exam (30%). The instructors attempted to replace the existing assessment model with mastery-based assessment approaches to enhance learning and reduce stress in students during the pandemic. They provided a series of low-stakes quizzes for each topic to allow students to practice and used a mastery-based grading system to authentically evaluate student achievement. The design and development of this assessment model was fueled in the pursuit of an urgent need to ensure students were learning the requisite material while simultaneously maintaining student engagement, satisfaction, and access to quality assessment.

The new grading system, using more frequent low-stakes formative assessments with a mastery-based grading strategy, allows students to evaluate their own knowledge of learning topics and continue to progress toward proficiency to build the required math skills and understanding. Faculty engage students with performance feedback and provide assistance based on the students' level of understanding. This ongoing assessment and adaptation of support enabled both students and instructors to monitor progress and then the instructor was able to provide tailored feedback and scaffolds to help further learning. Scores in this model, unlike those of more traditional exams, serve multiple functions in communicating student performance. Scores provide motivation and feedback to students and guide faculty towards appropriate modifications to the course content and relevant instructional materials.

The implementation of this assessment plan adhered to the common essential feature of mastery learning, including clear learning goals and expectations, credit only for mastery, and multiple low-stakes tests to progressively reach mastery (Table 1). In this course, students took 13 quizzes, two take-home assignments, and one final reflectional quiz instead of midterm and final examinations. This low-stakes assessment strategy provided students with frequent opportunities to practice in order to develop and master the content. The professors graded student learning outcomes through a mastery-based grading system as opposed to a percentage grade of correct questions on each individual quiz. After each learning topic, students had six opportunities to demonstrate their understanding of the topic. They were required to achieve the desired level of mastery, which was at least four correct answers. Students could recognize earlier that they had a developing, but not proficient understanding of the objectives and the instructors offered extra instruction to scaffold students and then gave them additional opportunities to display mastery. This mastery-based grading technique was the assessment of learning objectives for each topic as a prerequisite for advancement.

Table 1
Summary of the mastery-based assessment method employed in the course

Low-Stakes Assessment	Mastery-Based Grading
• Based on frequent assessments with each counting less. • This course shifted to 13 quizzes, two take-home assignments, and a final reflective exam to make up 84% of the course grade. • Student effort is spread throughout the semester.	• Students had six different questions on each of 21 topics spread across at least three assessments during the semester. • They needed to get four questions right to have "mastery" of the topic. • Students received feedback after each quiz and then could improve for the next time they saw that topic.

Study Focus and Methodology

To examine the impact and perceptions on student success, retention, and satisfaction of the mastery-based assessment approach employed during the pandemic, we compared students' average GPA scores with the historical data from past course sections without a mastery-based approach to understand any changes in student academic achievement. We also surveyed the students and the instructors regarding their feedback on this course to explore the perceived impact of this assessment technique in order to answer the following research questions:

- Q1. What's the impact of the mastery-based grading approach with low-stakes assessments on student academic achievement in an undergraduate mathematics course during the pandemic semester?
- Q2. What were the perceptions of students regarding the use of low-stakes assessments and mastery-based grading approaches?

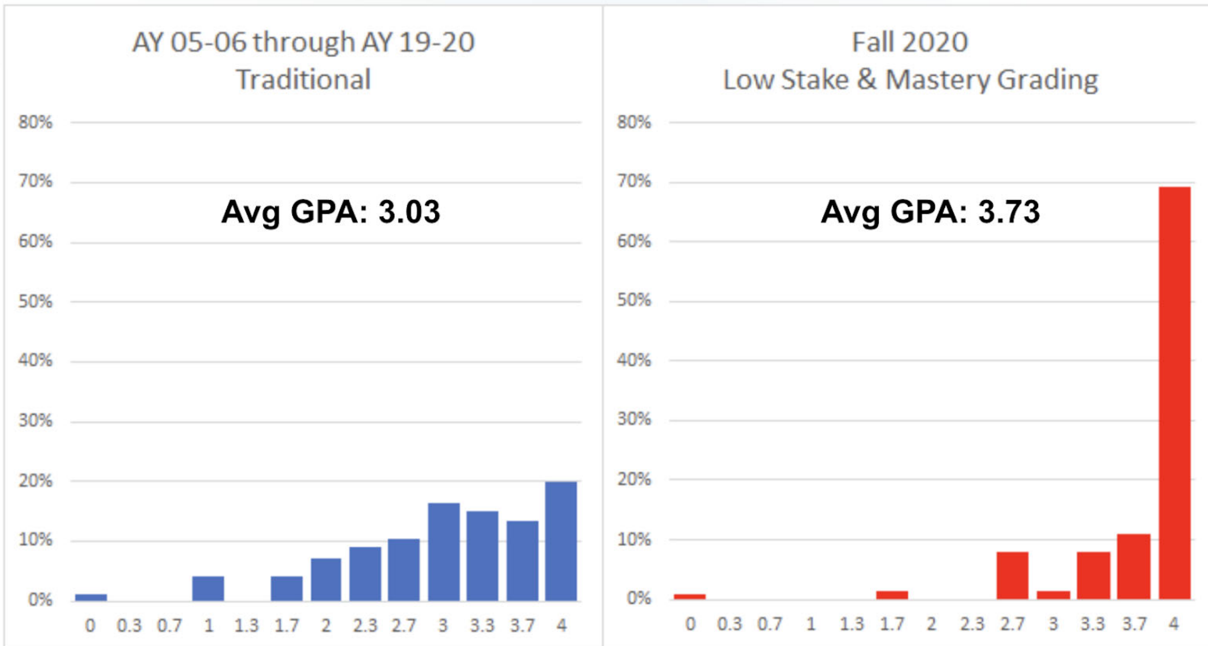
Results and Discussion

This mixed-method study was conducted to collect and analyse both quantitative and qualitative data to evaluate the impact of mastery-based grading with low-stakes assessments on student learning. We employed a descriptive statistics method to summarize the differences of the average GPAs between this course and past course sections without mastery-based assessment. The results help in showing whether this new assessment model could enhance student achievement. The data of the student survey and instructors' feedback were analyzed by experienced analysts to interpret the most common and overarching themes regarding both students' and instructors' experiences with this mastery-based assessment strategy to help understand the effectiveness of this approach from their perspectives. The main findings synthesized from both qualitative and quantitative data are presented in the following section.

Increased academic achievement

Based on the historical achievement comparison, the average GPA for the low-stakes and mastery grading class was higher than the previous courses, which used traditional summative assessment with high-stakes tests. When comparing cumulative GPA of the pandemic semester with the overall GPA of the same course from past semesters, the results (figure 1) show an improvement in students' academic achievement. The average GPA of fall 2020 (3.73) is 0.7 points greater than the average GPA (3.03) of the course from the past 14 years. This result echoes the argument from previous studies about the academic effect of mastery-based learning approaches on student achievement (Bloom, 1968, Block & Burns, 1976; Guskey, 2010; Kulik, et al., 1990).

Figure 1
Historical comparison of students' average GPAs of this course



Engaging learning experiences
To round out a thorough picture of the effects that mastery-based assessment strategies have had on student learning, we also analyzed student survey data to report the findings in more detail. We received a survey response rate of 41.91% (57/136). The findings revealed that students felt engaged with a mastery-based assessment approach. 97% of students considered this method to have had a positive impact on their learning (i.e., motivation, success, interest, confidence, fairness). 93% found it reduced stress, prevented procrastination, decreased test anxiety, and increased timely feedback. 79% reported they spent the same or more effort preparing for informative assessments as traditional high-stakes exams.

In addition, students studied more regularly in the semester and learned from their mistakes. For example, a student described this as follows: *"Getting questions wrong really is a chance to learn and improve, not just watch your grade drop."* The instructors also found students were more engaged and came to office hours more often and asked more questions outside of class. These findings were correlated to students' perceived usefulness of these assessment activities in the course in supporting their academic growth.

Implications (A Look at the Future)

The university was devoted to preventing coronavirus-related disruption for instructional continuity. The rapid shift to remote education challenged educators to maintain effective instruction using conventional pedagogical practices during the pandemic semester. For example, traditional summative assessment with high-stakes tests were criticized in regard to validity and reliability in assessing learning performance while also increasing anxiety in learning, which hurt student mental health.

Given consideration of the issues with a traditional assessment model, the instructors adopted a mastery learning framework to redesign the assessment plan for the Introduction to Linear Algebra and Differential Equations course. They utilized (a) formative low-stakes assessments, (b) a mastery grading framework, (c) administered using take-home and proctored assignments, (d) and longer cumulative opportunities to create a flexible assessment model. The flexible assessment model asks students to master or fully understand the concept of assigned topics at their own pace before moving forward. This learner-centered practice opens up personalized learning paths and pace and allows educators to better scaffold individual needs to build teaching resilience amid a pandemic.

This paper discussed how this new pedagogical practice was developed and delivered to improve the flexibility in assessment. The follow-up study conducted by the faculty and learning specialists from the teaching and learning institute, indicated that this flexible assessment model has an impact on student success, and can inspire alternative pedagogical strategies to advance teaching and learning. We believe what we have done cannot just help the university to continue educating during the pandemic, but also promote learning innovation that supports the vision for the future of higher education.

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Appendix A

The Syllabus: Assignments and Grading Policies

This course uses a grading system developed based on Standards Based Grading. This will be graded in a way that is significantly different from other math classes you may have taken in the past. We have identified 21 skill sets (or standards) that we wish you to master by the end of the course. Standards based grading is that you just have to show mastery of these skills to get an A. This will be evaluated with weekly quizzes during TUTORIAL and a timed take-home midterm and a final examination. You will not receive credit as a percent grade. Rather each question will be evaluating a particular skill set. Each question on the quiz will be clearly marked which standard (skill) is being tested. If you do the problem and use the skill correctly then you get a point in that skill. (For fans of video games, think of it as levelling up your character and you need to level up each skill of that character). In order to show mastery of a skill, you will need to demonstrate successful use of the skill 4 times. You will get at least 6 opportunities to demonstrate each individual skill. The final will test each skill at least once. It is your final opportunity to demonstrate mastery.

There are 21 standards (skills) each worth up to 4 points and the homework is worth a total of 16 points.

- 88-100 pts A
- 67-87 pts B
- 47-66 pts C
- 26-46 pts D
- Below 25 F

+/- will be determined by the end of the semester. That means if you have a 90, that could be an A or an A- depending on the final.
** Note that failure to do homework and attend class can lower your final grade by as much as a full letter grade.

The Skills you will be acquiring in this course are as follows:

1. Use Gaussian Elimination to set up problem and express solution in parametric form
2. Be able to add, multiply, transpose matrices
3. Decide something is or is not a Linear Transformation and be able to construct Standard
4. Matrix
5. Understanding Linear Combinations and Linear Independence

6. Basis of Column Space & Basis of Null Space
7. Coordinates and the Change of Basis Matrix
8. Identify Vector Space and it's subspaces and then find its basis and dimension
9. Abstract Vector Space is or is not Linear Transformation
10. Find Coordinates for Abstract Vector Spaces and find basis for Kernel and Range.
11. Compute determinant and its properties.
12. Finding eigenvalue and basis for eigenspace.
13. Determine Diagonalizability
14. Use Gram-Schmidt to compute projections using orthogonal basis
15. Compute Least Square Solutions and use least square solutions to compute projections
16. Checking solutions and checking autonomous solutions
17. Solve Separable Equations and First Order Linear
18. Solve Exact and Almost-Exact
19. Be able to model systems with DifEq
20. Solve 2nd Order Constant Coefficient Homogeneous Differential Equations
21. Solve 2nd Order Non-Constant Coefficient Homogeneous Differential Equations
22. Solve 2nd Order Nonhomogeneous Differential Equations

Pep Rally Using One-on-One Faculty Consultations to Promote Technological Pedagogical Content Knowledge

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Index words: TPACK, faculty consultations

Abstract

This paper provides explanation of the use of the Technological Pedagogical Content Knowledge framework (TPACK) and its role in the one-on-one faculty on the subject of instructional design (ID). Additionally, it explains the application of this theoretical framework to the faculty who are at the beginning stages of their consultations with instructional designers. Thus, such faculty has different expectations, and it is important to gauge their current pedagogical practices to successfully assist them. The peri-pandemic ID team applied such an approach through their experiences with faculty in the Business School. As a result, one-on-one consultations became a key solution for the relationship and course development with the faculty.

Introduction

The field of instructional design (ID) is a relatively new domain. However, the COVID pandemic emphasized the need for ID experts in higher educational institutions as the demand increased significantly due to a prompt transition to online learning in Spring 2020. The urge for creation of such departments have been greatly noticeable across various institutions. O'Keefe et al. (2020) stated that faculty did not have enough time to gradually transition their face-to-face classes to online modalities and in this case, the role and help of IDs was reiterated again.

Therefore, a new term Emergency Remote Teaching has been framed to properly refer to such a rapid transition (Hodges et al., 2020). The knowledge that instructional designers bring into the institutions is not limited by technological aspect of it. They are experts in the curriculum development, course design, and creation of training programs. However, there is still a lack of understanding of differentiation between instructional technologists and instructional designers due to the fact that instructional designers possess both a toolkit and pedagogical knowledge that can bridge the gap in the pedagogical practices of the instructors with the incorporation of instructional technology in their courses. Therefore, it is important to be in a close collaboration with the subject matter expert (SME), but to never cross the line of defining the subject content of the course (Halupa, 2019). Thus, ID Teams play a crucial role in course design, but such teams should always have a strategy that they follow in order to successfully implement their services at the institutional level.

Needless to say, that the duties of new instructional design teams are not well defined as such new departments are yet on the way of determining their role and significance at the institutions. Faculty may not always know what to expect from such collaboration and what resources instructional designers have to offer. Therefore, there is a struggle of establishing an effective collaborative approach with faculty that would benefit the faculty and students' teaching and learning experiences in the long run both pedagogically and technologically.

One-on-One Faculty Consultations

This paper focuses the development process and workflow of a peri-pandemic instructional design team in the business school setting and establishment of its collaboration with faculty. It provides insights to the important steps of ID team building and the approaches to one-on-one online faculty consultations since the launch of the new ID team was provoked by the pandemic. Thus, immediate steps were taken to engage faculty and facilitate their distance learning practices by initiating direct contact with the SMEs. Throughout the process of team development, instructional designers recognized that faculty members are at different levels of technology integration in their teaching which has an impact on their overall adoption of classroom technology and its use for online and hy-flex learning experiences. Soto & Smith (2020) define hy-flex as a model of instruction that allows both teaching in-person and online simultaneously. As a result, one-on-one consultations were offered by instructional designers in order to meet individual pedagogical needs of faculty members regardless of the mode of instruction or level of technology adaptation. It was important to ensure that all the faculty members are able to teach in the preferred modality. Thus, the team was able to promote instructional technology integration to complement the pedagogical practices and content knowledge of faculty members depending on their needs and teaching expectations.

Additionally, one-on-one consultations allowed instructional designers to build trustworthy relationships with faculty from scratch. Such close contact has been noted to be beneficial since IDs were able to cater to the individual needs of SMEs which vary across the disciplines. The team had to overcome the challenges associated with only online communication, considering the fact that IDs have not met faculty in person due to pandemic circumstances. However, the process was more complex since the team existed fully online and faculty members were not acquainted with the advantages of such collaboration. The team lead emphasized the need of notetaking regarding the faculty interactions which further led to the classification of the faculty based on their requests and level of technology use. In such a way, certain patterns and outcomes of one-on-one consultations were identified which provided a clearer direction for the IDs on how they can develop their relationships with faculty and take it beyond technology consultations which was still very beneficial for the faculty who were mostly holding synchronous online classes at the moment. All this work has been done considering the future work of the team. Faculty classification based on their technology adaptation level in online learning informed IDs regarding the trainings that meet the existing needs of faculty both in pedagogical and technological domains.

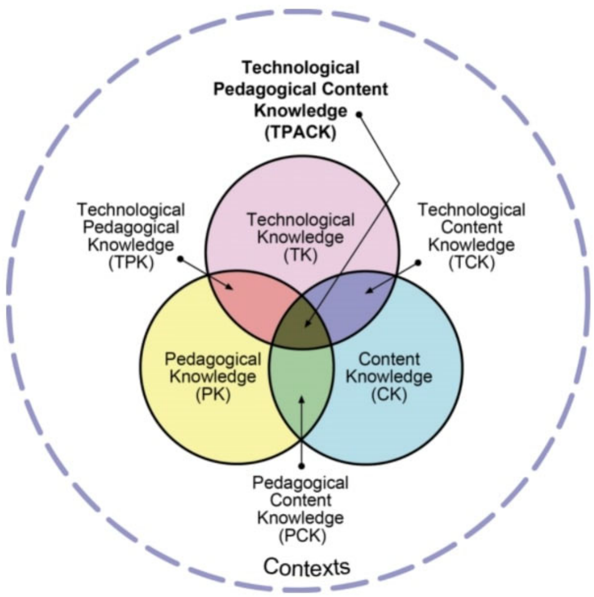
TPACK Framework

The active approach of the analysis that the team has taken led to understanding that it falls under the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2013) since IDs consider the technological readiness of SMEs and makes suggestions for the course design and activities. It is important to take it one step at a time and not overwhelm the faculty with the content throughout the consultations, especially when all the instruction took place online. Therefore, TPACK provides more clarity on the elements that IDs consider while conducting the consultation: technology readiness, pedagogical component, and subject content.

TPACK framework explains the interconnection of three knowledge forms: Technological knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK). This theory looks into the overlaps that such primary knowledge can create, and these overlaps are viewed as the most valuable practices in instruction: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK)

(Koehler & Mishra, 2013). It is important to understand at which level of TK every faculty member is and how an instructional designer can assist to incorporate the knowledge to potentially bring the course to the level at which all of the three primary pieces of knowledge overlap and create an ideal environment to improve teaching experiences for instructors and learning for students.

Figure 1
Visualization of TPACK



Note. Figure 1 shows the representation of TPACK framework by mkoehler. Reproduced by permission of the publisher, © 2012 by tpack.org (Mkoehler, 2011).

Thus, TPACK is often applied in professional developments for teacher education. Such complex relation between three types of knowledge emphasizes the importance of the relations that lay in between. In such a way, instructors are able to promptly adapt to the needs of the course and students' alterations. Mishra & Koehler (2012) explain that this model is an extension of Shulman's idea of Pedagogical Content Knowledge (1987). Thus, the current state of education requires instructors to leverage various knowledge types to promote the best practices of student learning even during the worldwide pandemic.

Three Consultation Approaches

Based on the TPACK framework, Koh (2020) identified three approaches that instructional designers implement during their one-on-one faculty consultations with faculty members: technology modeling for faculty without significant TK, pedagogical realignment for faculty with some TK knowledge, and deepening practice for faculty with vast TK. Likewise, the described instructional designer team has created a database of faculty that they worked with and was able to identify certain patterns in the nature of one-on-one consultations that adhere to Koh's approaches of implementation (2020). Based on the initial requests and consultations, IDs are able to identify which strength the SME possesses and build upon that skill in order not to overwhelm the faculty member with a lot of new information.

Technology modeling approach is used with instructors who use a very minimal amount of technology in their classes (Koh, 2020). One of the primary reasons for such behavior is the lack of experience and in this case, one-on-one sessions are a great opportunity to give a short demo for the potential application of the tool in the course design. Moreover, Koh identified that when the instructional design team carried several faculty workshops, it increased an interest in the work of instructional designers and improved collaborative practices. Likewise, a positive dynamic has been experienced by the team when the decision was made to take a gradual instructional design immersion with faculty who choose to stick to more basic online course design with the limited toolkit usage. It is important for the course designer to be able to preview the course before the one-on-one consultation in order to know which primary knowledge in the TPACK framework may be prevalent and which overlaps already exist. In our case, IDs noted that one-on-one demos of the use of the certain technology may not always be enough. Oftentimes, ID create recorded instructional videos addressing a specific faculty question or detailed instructions that are provided to the instructor, so they are able to take more control over the reoccurring issue. For instance, instructors could make a request to demonstrate how to use the university LMS for assessment purposes. Additionally, some basic technological requests included identifying location of recorded class sessions.

Pedagogical realignment improves the PCK area of TPACK framework (Koh, 2020). According to the author, such an approach is taken towards the faculty who are willing to try out new approaches and technology. In such consultations, the role of an instructional designer is to ensure that the learning takes a student-centered standpoint. Also, the learning is engaging in the classroom environment using interactive tools for formative assessments and incorporation of group work. If students are expected to submit a multimedia assignment, instructor is advised to provide clear guidelines. In this case, ID Team assisted more significantly with pedagogical content, once the technological needs were fulfilled, specifically for online courses. It was more important for the instructor to be able to navigate technology for the classroom purposes and be confident in using it. After that need was met, IDs suggested to assist in creating more various content for online classes, such as self-paced instructional videos that incorporated interactions. Additionally, IDs would provide more ideas on how faculty can vary online class activities in order to increase student engagement throughout the sessions.

Deepening practice is applied to the faculty with more advanced experiences in all the knowledge areas. Such faculty were offered additional options to incorporate more robust instructional designs in their teaching with technological integration. Such cooperation enabled some of the faculty to have hybrid-flex classes which allows to mix different teaching modalities and audiences (Beatty, 2019). During Spring 2020, the instructional design Team Lead in collaboration with the Information Technology Department created a physical space that can be used both for students who are taking a class face-to-face and virtually. Additionally, it is worth mentioning that Business School has students who are located on campuses overseas. Hybrid-flex modality allowed to combine students who are able to learn in person and who can only come to class through the virtual conferencing platform. One-on-one consultations help to create deep reflective sessions on the current teaching practices that help instructors to come to a potential solution through the series of questions. Additionally, instructors who incorporate deepening practices in their courses are invited to share their experiences with the peers throughout the workshop series. It is an opportunity to share and reflect on the ongoing practices. Currently, deepening practices allow IDs to revamp the courses for specific faculty. It is worth mentioning that adjunct faculty members are interested in ID help and they often utilize the team to bring new learning experiences to their students.

Benefits of One-on-One Consultations

The approach using three different types of consultations with faculty is based on TPACK and previous research. The ID Team identified a number of advantages that cause positive change in the collaboration with faculty. Such individualized approach allows IDs to create long-term collaborations with faculty that may go through all three stages of the consultations depending on the current concern of the faculty.

Instructors are able to improve their course materials with the help of technology. Oftentimes, they may not be aware of the possibilities and resources that are available to them. IDs work closely with faculty and point out technology that may assist in the course design content. Undoubtedly, some of the faculty do not prefer learning new technology. However, after ID demonstrated the improvement of course content and provides some initial trainings using the tool, such approach sparks further interest in collaboration and acquisition of new technology. Thus, IDs are often rewarded as faculty are satisfied with the overall improvement of the class materials or activities.

It can be challenging to work with the faculty on alternating their pedagogical approach. Due to emergency teaching practices, instructors did not have time to readjust their face-to-face courses and transform them into online sessions. Therefore, IDs were making attempts to help in the pedagogical realignment process by sharing the insights of the other faculty members with their assigned instructors. This ID Team takes advantage of the existing practices at school that already meet the needs and the goals of the departments.

More importantly, exposure to new technology often realigns the pedagogical strategies that are used by the instructors. Understanding that there are more opportunities to diversify the content enables instructors to consider active learning activities in their classes. It is beneficial since it allows students to be exposed to a variety of activities that are still beneficial for their learning practices. A lot of professors were able to adapt their novel emergency teaching for online environments in the current face-to-face classes, as well.

Lastly, many instructors considered updating their class materials, including PowerPoint presentations because ID Team led several workshops guided towards multimedia design. Instructors became more interested in making their slides more appealing to the students. Needless to say, that with such a rapid development of multimedia and technology, students have high expectations of the content that they are exposed to. Therefore, technological modeling approach plays an important role in the content improvement.

Disadvantages of One-on-One Consultations

From the overall experience, the ID team noted that it can be challenging to move away from the technological consultations and be perceived as a team that can contribute to the pedagogical domain, as well. Emphasizing the use of technology may disregard the focus on the pedagogical approach and it can be hard to achieve the overlap in TPK component of TPACK which leaves TK as a stand-alone knowledge that is not appropriately incorporated into the course design from the pedagogical standpoint. In this case, technology is used to its minimum potential.

Another concern that the new ID Team encountered is the lack of identity of the ID experts. In some cases, the team is mistaken for IT department. In this case, the talent of the IDs may not be used to the full potential. Expertise and assistance with technological issues misleads faculty and the communication becomes rather transactional, and it is limited to TK issues. It is important to have events that show the full potential of the team. In such cases, faculty gets a better understanding of the overall purpose of the team. As mentioned before, this ID team was created during the pandemic, and it is one of the reasons why there are some misconceptions regarding the purpose of the team.

Taking such an approach required better cooperation amongst the IDs to ensure that they provide services at the same level. The goal was to ensure that instructors have the same experience regardless of the ID that they closely work with. In order to quality check and synchronize the work of IDs, the ID Team was keeping records of the collaborations with instructors and discussing as a team each collaboration to ensure that instructors receive an appropriate consultation from each member of the team. This process is time consuming, but it allows IDs to provide peer feedback and identify the core values of the team that serve purpose to the faculty.

Conclusion

In conclusion, the use of TPACK in one-on-one faculty consultations help to improve the building of long-term relationships with instructors as the ID team takes them through all the areas to reach the final goal of the improved course design. It is quite challenging not to fall into the trap of focusing too much on TK during the pandemic as it was a necessary measure. However, these tendencies have been changing since a lot of instructors went back to face-to-face teaching and now PK becomes more of the priority. It is important to state that the pandemic itself has taken toll on IDs, instructors, and students. Thus, one-on-one consultations became a helpful way of creating a safe space for interactions that lead to fruitful collaborations. The ID team anticipates more improvements in their work with faculty as the transformations of their work together are still happening. Keeping track and records of the consultations allows IDs to reflect on their practices and ensure that they are successfully working towards the overall course design improvement as demanded by faculty needs.

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Evaluating Teacher Access to Online Professional Development: Establishing Access Patterns from User and Server Analytics

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Abstract

The COVID-19 pandemic has forced K-12 schools to seek professional development with online resources that address their professional needs while keeping health and safety in mind. In Missouri, approximately 250 school districts in the Network for Educator Effectiveness (NEE) have 24/7 access to the EdHub Library that provides more than 500 online self-paced professional development resources (Network for Educator Effectiveness, n.d.-a). Due to the pandemic, the EdHub Library has seen increased web traffic; this study identifies the most accessed resources by analyzing user and server web analytics to improve resource access. This study also identifies resource access patterns using the Apriori algorithm for association rule mining. The results pointed out that approximately 40% of the web traffic occurred among the EdHub Library homepage, Dyslexia activities, and resource page for Teaching Standard 1 (i.e., Content Knowledge and Appropriate Instruction). Along with the findings, recommendations for resource optimization by the Word Wide Web Consortium (W3C) are explored. The visualizations can be found on Tableau Public (Leung, n.d.).

Keywords: Teacher Professional Development, Educational Data Mining, COVID-19

Introduction

As the World Health Organization (WHO) declared the novel coronavirus (COVID-19) outbreak a global pandemic on March 11th, 2020, this study reports on the evaluation efforts for optimizing online resources for teacher professional development (World Health Organization, 2020). Since the beginning of the pandemic, 1.3 billion learners are still affected by school and university closures as institutions implement entirely online and hybrid solutions (UNESCO, 2020). As K-12 educators adapt their face-to-face curricula to distance and hybrid formats, the professional development needs of teachers have been neglected since the beginning of the pandemic. All in-person teacher professional development (PD) opportunities came to a halt, whereas fully online PD provided teachers access to online self-paced resources and synchronous webinars through web conferencing tools (e.g., Zoom).

In Missouri, the EdHub Library is an online professional development platform for K-12 teachers and school administrators as part of the Network for Educator Effectiveness (NEE), which is a comprehensive education assessment system (Network for Educator Effectiveness n.d.). While the EdHub Library provides teachers with 24/7 access to over 500 online resources, the platform has experienced increased web traffic since the beginning of the pandemic. The purpose of the study is to evaluate and improve access to online resources by analyzing user and server web analytics requests.

Literature Review

The following literature review describes the components of teacher professional development and recommendations for effective implementation. Research studies support positive outcomes and perceptions of online teacher professional development.

Understanding the Needs of Teacher Professional Development

Research studies have been conducted to examine the components of teacher professional development. Desimone (2011) described the core features of effective teacher PD in terms of (a) content focus, (b) active learning, (c) coherence, (d) duration, and (e) collective participation. Garet et al. (2001) examined the relationship between the characteristics of teacher professional development and teachers' self-reported outcomes. Three recommendations emerged from integrating effective professional development and self-reported outcomes: form, duration, and participation. Form refers to how PD activities are structured either as a "form" or "reform" type of activity. The first type of activity describes traditional workshops as episodic events, whereas "reform" activities are collaborative workshops. The second recommendation is the duration of these activities. When teachers are expected to participate in longer sessions, follow-up and continuous support are essential to effective PD. The third recommendation is participation. The researchers recommended that teachers and support staff be included in the activities that promote everyday teaching tasks. Garet et al. (2001) findings agree with similar studies on effective PD delivery in terms of (a) sustained time, (b) collaborative and active participation, (c) content-driven, and (d) situated activity (Archibald et al., 2011; Borko, 2004; Darling-Hammond & Bransford, 2006; Desimone et al., 2002; Elmore, 2002; Guskey & Huberman, 1995).

Effects and Perceptions of Online K-12 Teacher Professional Development

Yoo (2016) examined the effects of online professional development on 148 teachers' self-efficacy twice with a five-week gap after completing a learning module. In the analysis of the survey results, teachers reported professional enhancements through goal setting and concrete learning strategies, adjustments of their frame of reference in terms of their evaluation and understanding of a certain level of helplessness, and uncertainty in dealing with student and school factors, such as aptitude scores and curriculum guidelines. Whitaker et al. (2007) studied the effectiveness of an online platform called MyTeachingPartner (MTP) using web server logs, teacher evaluation survey responses, and focus groups on teachers' beliefs. The researchers reported that teachers looked for practical activities by understanding the needs of their students. Although the MTP materials were useful, teachers said that materials needed to be practical for their teaching. Rice and Dawley (2009) analyzed survey responses of 259 teachers using the online K-12 platform called "Going Virtual!" to understand the practices and models of online teacher PD. Despite well-established national guidelines, school administrators were aware of these guidelines but implemented procedures based on their teachers' needs.

The Need for Evaluation in oTPD

Studies have explored teacher professional development as a critical factor that impacts student achievement (Campbell et al., 2004; Darling-Hammond & Bransford, 2007). With the growth of educational technologies and teachers having less time for professional development, the rise of online teacher professional development (oTPD) allows for professional engagement in continuing education systems. Numerous research studies examined face-to-face teacher professional development. However, a few studies on oTPD examine online professional development programming and technical components behind educational systems.

Problem Statement

Dede et al. (2009) identified the lack of empirical evidence on effective online teacher professional development design. Current research on oTPD examines four aspects in terms of (1) program design, (2) effectiveness, (3) technical design, and (4) learner interactions. Program design refers to the evaluation of content and best practices in methods of delivery. Program effectiveness explores the short-term outcomes provided by oTDP, which are generally teachers' self-reports. Program technical design evaluates the effect of communication tools on specific goals. Learner interactions refer to the quality of participation in online communication and collaboration. While present studies explore the program design and effectiveness aspects of online teacher professional development, this study evaluates the use and access patterns of resources with web analytics for assessing the technical and learner interactions aspects of oTPD.

Purpose & Significance of the Study

This study seeks to identify the most accessed resources and develop user and server access patterns in online teacher professional development resources. The significance of this study involves providing improved access to resources, especially to rural regions in Missouri school districts. The study explores the following research questions:

- **RQ 1**: Which resources do users access the most based on *Page Depth* and *Time On Page*?
- **RQ 2**: Which resources have the highest *Server Response Time*, *Document Content Loaded Time,* and *Page Loaded Time*?
- **RQ 3**: What access patterns exist for users and server document requests?

Methods

This study uses exploratory analysis of 164,772 web resource transaction records from May 2018 - May 2021 using user and server web analytics metrics to identify the most accessed resources and develop navigation patterns using association rule mining. First, the study explores the most accessed resources using Google Analytics user metrics, including *Page Depth* and *Time On Page.* According to Google Developers, *Page Depth* refers to the average number of pages users visited within a 30-minute session. *Time On Page* is calculated by the time difference between the user's starting point on a particular resource and when the user moves on to the following resource (*UA Dimensions & Metrics Explorer*, n.d.). The study also uses Google

Analytics server metrics, including *Server Response Time, Document Loaded Time,* and *Page Loaded Time* to identify the most requested resources from the web server. To investigate resources that need to be optimized, *Server Response Time, Document Loaded Time,* and *Page Loaded Time* allow identifying specific elements (e.g., video, animation, text, scripts, and documents) in web resources that are highly requested in the server and loaded onto users' browsers. *Server Response Time* refers to the total time that the server takes to respond to the user's request. *Document Content Loaded Time* describes the total time that the user's browser and server take to render the documents with their respective style sheets and scripts. *Page Loaded Time* is the total time that it takes to render the whole resource page. To further explore user and server metrics, visualizations are published on Tableau Public (Leung, n.d.).

Second, the Apriori algorithm is a popular method for association rule mining that allows establishing patterns between antecedent (i.e., if) and consequent (i.e., then) components of frequent user and server resource access based on support, confidence, and lift measures (Harikumar & Dilipkumar, 2016). The support measure is the percentage in which web resource transactions contain a given web resource access combination. The confidence measure looks at the conditional probability in which a web resource is accessed. The lift measure describes the likelihood of web resource transactions occurring in pairs. For this particular study, the lift and support measures will be examined to determine the most accessed resources by users and requested server resources (e.g., HTML, CSS, images, videos, and PDFs) from the hosting server. Average user and server metrics are reported in milliseconds (ms). Because association rule mining is a computationally expensive method, the analysis considers all user types, including new and returning users.

Results & Discussion

RQ 1: Which resources do users access the most based on *Page Depth* and *Time On Page*?

In terms of *Page Depth*, the most accessed resources by users were related to exemplary teaching practices videos and classroom observation practice scenarios. The search engine function was also used to look for content associated with Teaching Standard 1.1 (i.e., Content Knowledge and Academic Language) and its scoring video examples, as shown in Figure 1. The most accessed content regarding *Time On Page* was the instructor-led principal calibration training and building instructional skills modules. Also, the most searched content included research-based practices, professional development processes, technology integration, and data-driven decision-making, as shown in Figure 2.

Figure 1

Average User Requests by Page Depth

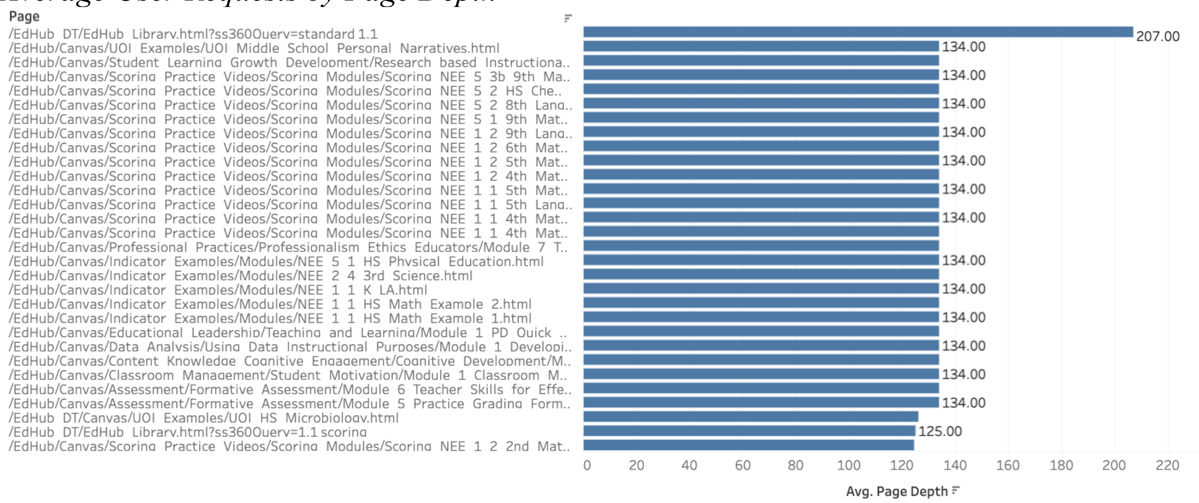
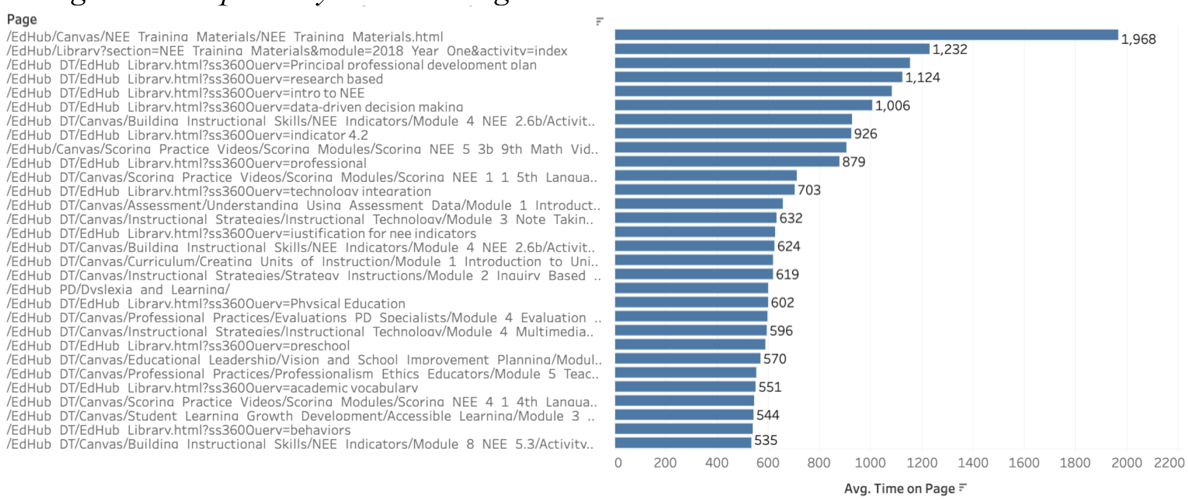


Figure 2

Average User Requests by Time On Page



RQ 2: Which resources have the highest *Server Response Time, Document Content Loaded Time,* and *Page Loaded Time*?

In observing Google Analytics server metrics, curriculum implementation, word problems, kindergarten, math problem-solving, technology integration, and physical education were the most solicited search functions for *Server Response Time*, *Document Content Loaded Time*, and *Page Loaded Time*, as shown in Figures 3, 4, and 5.

Figure 3

Average Server Requests by Server Response Time

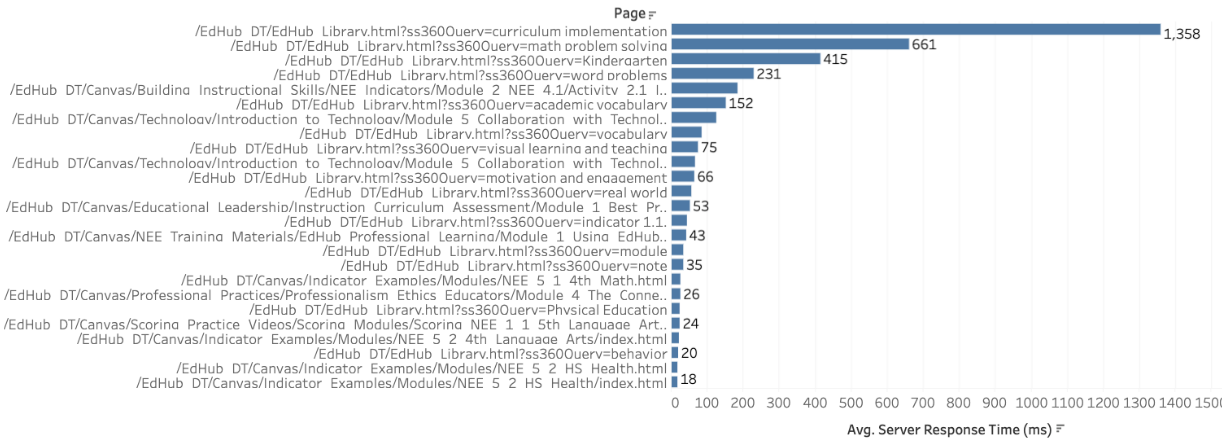


Figure 4

Average Server Requests by Document Loaded Time

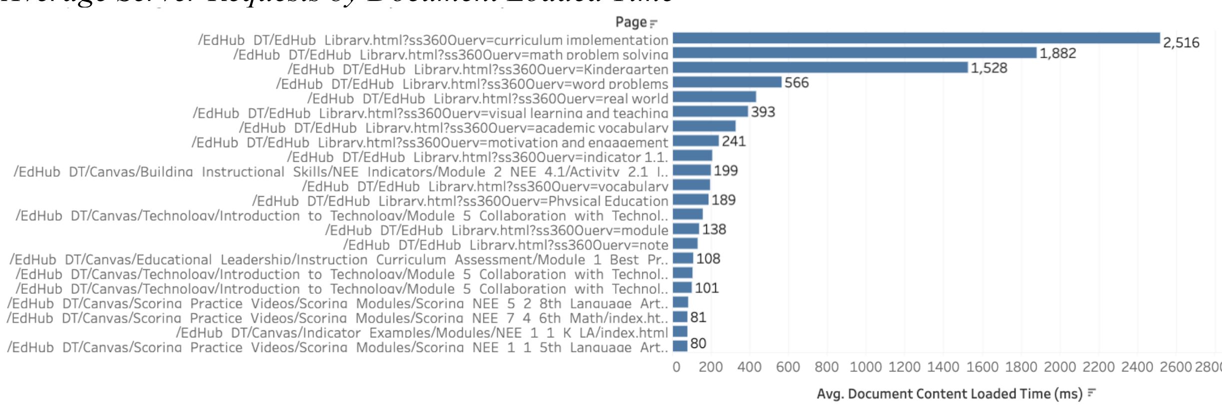
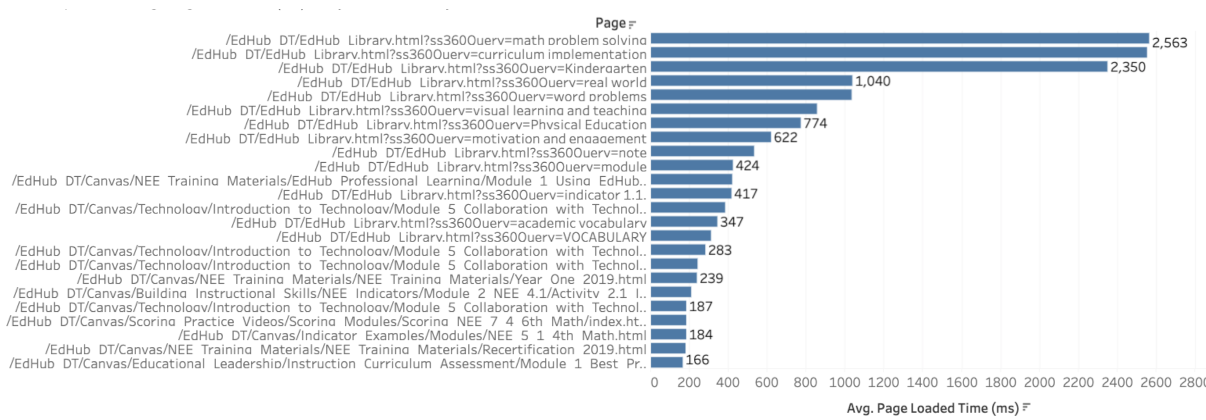


Figure 5

Average Server Requests by Page Loaded Time



RQ 3: What access patterns exist for users and server document requests?

User and server access patterns to online professional resources and search functions can be established by lift measure or the probability in which web resources are accessed together, and support measure or the percentage in which web resource transactions occurred in a specific combination.

User Web Analytics Metrics

In examining user web analytics metrics, specific patterns for *Page Depth* and *Time On Page* were found for all four Dyslexia activities sorted by the highest lift measures. In terms of the support measure, all four Dyslexia activities and the EdHub Library with a sitemap listing all resources related to Teaching Standard 1 (i.e., Content Knowledge and Appropriate Instruction) showed around 40% of users performed the given access patterns, as shown in Table 1 and 2.

Table 1

User Average Page Depth

Antecedent	Consequent	Support	Confidence	Lift
Dyslexia introduction activity 1	Dyslexia literacy activity 2	0.404	0.983	2.187
Dyslexia literacy activity 2	Dyslexia intervention process activity 3	0.409	0.973	2.099
Dyslexia intervention process activity 3	Dyslexia technology integration activity 4	0.402	0.900	2.039

Table 2

User Average Time On Page

Antecedent	Consequent	Support	Confidence	Lift
EdHub Library homepage	Dyslexia module page	0.486	0.534	1.09
EdHub Library homepage	Sitemap Standard 1	0.401	0.440	1.03

Server Web Analytics Metrics

Even though the highest lift measures could be found between the EdHub Library homepage and the dedicated listings of online resources, the support measures for *Server Response Time* and *Page Loaded Time* were around 1% of access to the resources as mentioned earlier, as shown in Table 3 and 5. In terms of *Document Loaded Time*, 40% of the navigation access could be found among the EdHub Library homepage, Standard 1, and Dyslexia module, as shown in Table 4.

Table 3

Server Average Response Time

Antecedent	Consequent	Support	Confidence	Lift
EdHub Library homepage	Sitemap Standard 1	0.017	0.088	5.156
EdHub Library homepage	Sitemap Standard 2	0.012	0.062	5.156
EdHub Library homepage	Sitemap Standard 4	0.018	0.093	5.156
EdHub Library homepage	Sitemap Standard 5	0.014	0.072	5.156

Table 4

Server Average Document Loaded Time

Antecedent	Consequent	Support	Confidence	Lift
Sitemap Standard 1	Dyslexia module page	0.405	0.760	1.354
EdHub Library homepage	Dyslexia module page	0.406	0.423	1.042

Table 5

Server Average Page Loaded Time

Antecedent	Consequent	Support	Confidence	Lift
EdHub Library homepage	Sitemap Standard 1	0.017	0.088	5.129
EdHub Library homepage	Sitemap Standard 2	0.012	0.062	5.129
EdHub Library homepage	Sitemap Standard 4	0.018	0.093	5.129
EdHub Library homepage	Sitemap Standard 5	0.014	0.072	5.129
EdHub Library homepage	Sitemap Standard 7	0.014	0.072	5.129

Discussion

For user requests, the most accessed resources were (1) the dedicated page related to Standard 1.1 (Content Knowledge and Academic Language), (2) principal scoring practice videos, (3) teaching best practices videos, and (4) walkthrough examples of classroom observation data collection videos. For server requests, the most requested resources were (1) search queries related to curriculum implementation, student motivation, kindergarten materials and word problems, (2) collaboration and technology, (3) NEE implementation, and (4) integration of technology tools.

Based on association rule mining, support and lift measures indicated approximately 40% of web resource transactions occurred on the EdHub Library homepage, sitemaps for Standard 1, and Dyslexia activities. Because of my current responsibilities as an Instructional Designer who has maintained and published online materials since 2014, I take into consideration seven best practices that allow resources to be accessible, including (1) avoiding unnecessary redirects of resources, (2) reducing the size of files, (3) designing for a variety of interaction methods (mobile and desktop) and internet speeds, (4) using adequate text size with minimal Cascading Style Sheets (CSS), (5) implementing high-quality graphics with a smaller footprint, (6) using cookies when necessary, and (7) reducing the size of HTML pages in terms the Document Object Model (DOM) to avoid rendering errors (*Mobile Web Application Best Practices*, n.d.).

Video materials from teaching best practices and walkthrough examples of classroom observation videos are heavily accessed by users. Based on the frequent requests found in server metrics, video materials can be optimized for different screen sizes. While video materials are already optimized for the web, a recommendation would be presenting three versions of the video for mobile, tablet, and desktop that accommodate different internet speeds and screens. The ideal scenario would be hosting video materials in a streaming server that automatically adjusts video quality based on the user's internet speed and device. Due to the high cost of streaming services and an extensive collection of video materials, these videos use progressive download to transfer digital media between the server and client before the user can render the full video. Because the length of the videos is on average less than 10 minutes, the progressive download occurs quickly.

Implications & Future Research

Based on user and web metrics, users performed generic keyword searches using the search engine from the EdHub Library homepage (e.g., "Teaching Standard 1," "real world," and "word problems"). It is also unknown if users were successful or unsuccessful in their searches based on the current dataset. The future direction of this study is to examine the users' keyword searches further from the search engine service, including the queries or keywords performed by users, the number of searches performed, unique searches, results presented to users, and clickthrough rates. Based on the user behavior when using the search engine, a recommendation would be generating curated lists of professional development materials for high-frequency search terms.

Conclusion

This study establishes navigation patterns using user and server web analytics data from 250 school districts in the Network for Educator Effectiveness. Based on association rule mining, almost half of the web traffic is attributed to the EdHub Library homepage, Dyslexia module, and Teaching Standard 1. After analyzing 164,772 web analytics transactions from May 2018 - May 2021, the study provides internal stakeholders with recommendations for improving generic keyword searches with curated lists of resources and optimizing current multimedia resources to reduce load times.

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Student Experience in an Online Maker Course During the COVID-19 Pandemic: A Case Study

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Abstract

This case study (1) describes how a face-to-face university maker education course employing a novel instructional design was redesigned to accommodate COVID-19 safety guidelines, and (2) presents an exploratory case study of how affordances of online learning were leveraged in the redesign impacted students' experience in the course. Online learning is a timely topic for educators and instructional designers to consider as the world grapples with options for maintaining educational standards during a global pandemic (Rapanta et al., 2020). Specifically, this study examined the following research questions: (1) How did students describe their experience of taking the course during Fall 2020 with the backdrop of COVID-19 and the impact of stressors that accompanied the pandemic? and (2) How did students reflect on their experience with maker-centered learning in an online learning environment versus an in-person environment?

Introduction

In March 2020, the home university of this case closed its doors to students and faculty and moved teaching and learning to an emergency online format due to concerns about the rapid transmission of COVID-19. As the pandemic continued, the university, a large urban institution in the Southeastern United States, physically reopened in Fall 2020 but continued with guidelines to limit the size of groups that met on campus. These guidelines made it necessary for university course designers to quickly develop blended or online courses to meet instructional goals.

The designers of this maker education course faced a unique challenge with this conversion, as the course normally employs a lab-based, novel instructional design based on a mastery orientation and flexibility in which students complete modules largely of their own choice at their own pace both in the classroom laboratory and outside of class (Cohen et al., 2019; Cohen et al., 2020). The redesigned course employed a personalized online format that included whole group synchronous online meetings, individual online conferencing and in-person lab work, and a learning management system (LMS) that provided open access to course materials.

The emergency shift to blended learning because of the COVID-19 outbreak and resulting school closure required the course designers to consider how online affordances could be used to support maker-based education. Decentering the classroom and fostering autonomy among learners is an essential tenet of maker-centered learning (Cohen et al., 2019). Design decisions were made to engender student autonomy and foster personalization, staying away from the typical approach of a teacher-centered classroom that relies heavily on lectures (Barab et al., 2001). Course designers embedded interactive learning activities and open communication channels within the whole group synchronous online meetings. Giving students a forum for sharing their work is another principle central to maker-based learning and was another key consideration as course designers shifted to an online learning environment (Reigeluth et al., 2017). In this shift to online learning, the course designers were deliberate in maintaining a learner-centered environment incorporating constructionist principles, empowering students to create tangible objects and share the experience of making in a collaborative environment (Cohen et al., 2019).

To understand how this modality shift impacted students' experiences in the course, this study explored the following research questions: (1) How did students describe their experience of taking the course during Fall 2020 with the backdrop of COVID-19 and the impact of stressors that accompanied the pandemic? and (2) How did students reflect on their experience with maker-centered learning in an online learning environment versus an in-person environment?

Literature Review

During the emergency response to COVID-19, most colleges and universities switched to an online format to continue coursework that began in person. Studies of students have suggested that academic communities experienced a unique constellation of stressors that accompanied both the pandemic and the academic response to the pandemic.

Students were reportedly less satisfied with courses during the COVID-19 emergency response, where most face-to-face courses were moved to an online format. A study of 86 freshman college students who attended classes at an urban university similar to the university discussed in this paper had 63% of their student respondents report that their experience with instruction was worse during the pandemic after the shift to online education (Bono et al. 2020). This survey, which began as a longitudinal investigation and shifted to allow for investigation into COVID-19 related inquiry, included two points of collection, the first collection done in January-March 2020, prior to the COVID-19 pandemic response and the second collection done March-May 2020, after courses went online because of COVID-19. Another survey of a random national sample of 1008 undergraduate college students developed by Digital Promise and Langer Research Associates indicated that 51 percent of students were very satisfied with their face-to-face courses, but only 19 percent of those students were very satisfied with their courses when they moved online in response to COVID-19 closures (Means, 2020). The participants in this survey began classes in person and shifted online as a response to the pandemic. There was one point of collection for this survey between May and June of 2020 when students were attending online courses due to the COVID-19 shutdown protocols enacted by their universities. Only 17 percent of respondents who reported being very satisfied with their classes before shifting online reported being very satisfied with how well they learned after COVID-19 (Means, 2020).

Aucejo et al. (2020) reported on the results of a survey that collected student experience and expectation data about the impact of COVID-19. This study collected responses from around 1500 undergraduate students at a large public university in the United States. Data from this survey indicate that learning during COVID-19 changed student expectations for graduating, with more than 13% of students reporting that they will delay their graduation dates. Eleven percent of students reported withdrawing from classes during the pandemic, and 50% of students surveyed reported that they studied less and were less successful academically during the pandemic. Students also experienced a reduction in their income during the pandemic, with 31% receiving fewer wages and around 40% of students losing a job or internship opportunity.

Most college students experienced both internal and external stressors that impacted their experience with teaching and learning during the COVID-19 pandemic (Bono et al., 2020). Stressors are identified as events or phenomena that negatively affect a person's wellbeing (Li et al., 2020). During the COVID-19 pandemic, students reported an impact on their mental health due to pandemic-related stressors. Students experienced the effects of quarantine isolation, illness of self or family members, and financial insecurity (Bono et al., 2020, Aucejo et al., 2020).

During the pandemic, students reported stressors related to technology issues that included hardware or software problems. Some students did not have equitable access to internet connectivity. Some shared a device with another family member or had to borrow a device from their university. Some students reported difficulty attending synchronous courses due to bandwidth issues caused by multiple users within their households. One-quarter of students surveyed by Means et al. (2020) reported hardware and software problems that impacted their ability to experience an online course.

The most pervasive problem reported by students during online learning during COVID-19 was the lack of motivation to participate in and complete the course (Means, 2020). Meeter et al. (2020) reported that students surveyed attended fewer synchronous class meetings, reported less engagement within those meetings, and tracked less time studying than they reported for pre-COVID 19 face-to-face courses. In the survey of students reported by Means (2020), 79% of students cited motivation as an issue. Fifty-seven percent of respondents indicated that maintaining interest in the course content was an issue during COVID-19.

Students in online courses reported feeling disconnected from their peers and the instructors in their online courses, specifically missing the chance to collaborate with peers and feeling part of the class community (Means, 2020). Students have expressed the importance of peers to support learning and engagement during the face-to-face iterations of the maker courses discussed in this paper. Past research on this maker course has discussed the vital importance of peer tutoring and other peer input in developing content learning and understanding the course's organization (Cohen et al., 2020). Collaborative learning, where peers equal in both knowledge and experience work together to complete a task (Damon et al., 1989), is another social aspect in the face-to-face maker course that students reported as important. Students formed learning groups in previous face-to-face offerings of the course and often worked together in these collaborative groups during the in-person lab sessions. Many students reported this sense of community and learning within this community as one of the most important takeaways of their experience with the course (Cohen et al., 2020). Students in face-to-face iterations of this course appreciated the opportunity to see what their classmates were making and using that sharing as an opportunity to inform their own choices in which projects they completed. Students eventually pushed one another to continue along a certain path or pursue a new skill (Cohen et al., 2019)

Methods

This research design is an exploratory case study, with the unit of analysis being the whole class.

Participants

This course included 13 masters and 9 undergraduate students whose career and education goals spanned from K-12 teaching to coaching sports to corporate instructional design. Ten master's students and 2 undergraduates consented to participate in the study. Many of the students also shared that they were either starting or managing small businesses while attending the course. Most class members did not have any experience with maker-centered learning at the outset of the course. Though most of the participants had previous experience with online learning and expressed comfort with the online meeting format, they were less familiar with the mastery-based nature of the course, the unique LMS used to manage course content, and the student-centered approach implemented by the course designers.

Data Collection

Data were collected during the Fall 2020 semester and primarily consisted of student writing and midterm one-on-one check-ins with the professor. Student writing was prompted within regular classroom assignments and final exams. Midterm check-ins were conducted by the professor via videoconference and were recorded and transcribed for analysis.

Data Analysis

Researchers used Dedoose, a web-based software product, to organize and code the qualitative data. Inductive line-by-line coding was initially done by two of the research team to identify major themes (Saldaña, 2021). The researchers coded sections of the data, engaged in a discussion to reach an agreement about codes, and then researchers coded the remaining data.

Results

Thematic analysis of the data revealed that COVID-19 related stressors, peer-based learning, making remotely, and navigating the unique course design were major themes impacting student experience of the maker course online during the COVID-19 pandemic closure.

COVID-19 Related Stressors

Participants shared issues related to health and wellness, stressors created by COVID-19 that impacted their experience of the course. Several students mentioned that they had been ill themselves and that their illness—though not serious—had hampered their ability to finish some of the module content. Many students mentioned that they had family members or friends who were ill with varying degrees of seriousness. Most students shared their experience with health-related issues and how they impacted their interaction with the course during the one-on-one midterm meeting with the course instructor. Some students shared their experiences in a course reflection:

> Unfortunately, I don't feel that much can be done for what I truly need to stay on track. It's because it's impossible to control, but I will still share what I need. I need the mounting deaths and loss that have occurred in my family to stop or at least slow down. You see, since the start of the class, I have lost about 15 family members. This week it was my dear cousin's wife, who is a pediatrician. Two weeks ago, it was my dear friend's mother. These losses have sometimes caused me to sit and do nothing. It has been overwhelming. What helps is having a moment to regroup, but it has caused me to fall behind with regard to deadlines.

While participants did share technology-related stressors that hindered their ability to fully participate in synchronous class sessions or manage their coursework, these remarks did not often appear in the data. Most students expressed being comfortable using the LMS for the course. Most students also expressed being well prepared with software, hardware, and internet connectivity for online work after their experience in other online courses throughout their college experience.

Peer-based Learning

Participants described satisfaction with experiences with decentering that were designed as part of the course. Still, many students shared what they perceived as missed opportunities for peer collaboration and tutoring that occur naturally in an in-person classroom environment. Past iterations of this course in a face-to-face environment have identified the importance of collaborative learning and peer tutoring to the students (Cohen et al., 2020). As one student expressed, the fully online format "limited the organic connection to my classmates and instructors."

Many students recognized that they would have benefited from peer collaboration during the course and missed that possibility during the online version of the course. Several students indicated that participating in class was difficult as they felt anxiety whenever they attempted to share and were interrupted by or interrupted another student. Some students mentioned that they would have liked to hear and see their classmates more and were disappointed that more people did not chime or turn on their video during synchronous sessions. Students felt that the synchronous online course meetings were not ideal for building collaborative relationships.

Several students mentioned that increased use of small breakout groups regularly may have increased their connection to their classmates and their comfort level in sharing during synchronous classes. One student remarked,

> I would have really benefited from more opportunities to collaborate and interact with my peers. I know that is a normal component of the course in the face-to-face setting, but I believe I had some really cool classmates and could have benefited from conducting more discussions and projects with them.

Some students suggested tools that they believed would help them communicate and collaborate with one another during the online course, typically a forum that "would be very helpful in case we get stuck in a module and need to reach out to our peers for help."

Experiences with Learning about Making in a Remote-Based Environment

Students overall reported a positive experience interacting with maker-based learning in this online version of the course. Several students pointed out that the pandemic had highlighted the need for schools to shift education towards a more student-centered approach. Some mentioned the need for more educational experiences that encouraged problem-solving and gave examples of how working through problems with both the modules and with logistical aspects of the course helped them be more engaged and motivated to complete the course.

Though the skill- and disposition-based benefits of making resonated with the students, the practical aspects of remote maker-based learning were more of a challenge. Students expressed that access to equipment, materials, and supplies did present a barrier that impacted their experience with the course. Many students voiced difficulty finding the time to come to campus to pick up kits for home use. Several also indicated travel, health, and wellness-related issues that kept them from making the trip to pick up supplies or schedule an appointment to use the equipment located in the lab, which was essential to completing many of the modules.

Nearly every student indicated that what they have learned about making will impact the way they think and how they will teach, learn, and engage in many other activities in their lives. In their final exam remarks, several students quoted a story told by a classmate that described a student who misbehaved in every class except when they were asked to work with others and complete hands-on activities. This story was used as an example by several students to show how they think making can empower students and help them learn

Experience with Course Design

Most students indicated a positive interaction with the course and felt that it was designed well for online learning even though they thought it would be better in a face-to-face situation. One student wrote:

> This was the best online class I have taken. It was very interactive and felt the most like the students mattered to the instructors. The struggle to transition an in-person class to

> feel natively virtual is difficult no matter how great the content. I am still learning how to do this and will be taking many ideas from this class.

Most students expressed appreciation for the modular design of the course and felt empowered by the ability to make choices about which modules they attempted. But many of the students who appreciated the autonomy of choosing their own modules strongly indicated that managing coursework within this course design required additional time and attention. Some of the students expressed difficulty tracking module completion independently. Several students detailed the management activities they engaged in to track progress and complete the modules on time. Some students made suggestions for strategies that the instructors could provide to help students remain on track to make adequate progress in the future. The following was a typical suggestion:

> One proposed idea is to have a weekly progress report that would give me guidance on the number of remaining modules in accordance with the time remaining for the semester. Also, the idea of a one-on-one meeting with the professor is great as it provides better feedback and makes room for a conversation to gain insight on the progress and potential questions.

Most students in the online version of the course indicated that time management on a personal level impacted their experience with the course.

Discussions and Implications

Data made it clear that students' experience of taking the maker-centered learning course and their interaction with making were impacted by taking the course online. Stressors that accompanied learning during the COVID-19 pandemic further complicated their experience in the course.

Experience with Maker-Centered Learning

While students reported enjoying the course overall and understood the skills and disposition-based benefits of making, they found it difficult to connect to the practical elements of making in the online environment. Students in the online version of the course expressed frustration with access to equipment and materials to complete the maker activities during the course. Students reported challenges to making appointments to visit the lab to pick up kits to use at home and also reported challenges to making appointments to do their work in the lab space. Students missed the opportunities to work with an instructor on challenging modules. Future maker-based learning courses should consider the accessibility of materials, equipment, and supplies and explore additional means to make the lab experience more accessible to students.

Collaborative Learning

In previous research into maker-based educator preparation courses, peer teaching and learning and collaborative learning were important elements that evolved throughout the course delivery and were highly valued by the students involved (Cohen et al., 2017; Wohlwend et al., 2018). Future research may examine ways to embed peer teaching and collaborative learning in an online maker-based learning course.

Many students in the course were disappointed the lack of opportunities for peer teaching and learning and collaborative learning that they experienced during the online version of the course. As online learning continues within the backdrop of COVID-19 and beyond the pandemic, course designers should consider the logistics and potential benefits of embedding peer-based learning experiences effectively into an online learning situation for a maker-based course.

COVID-19 Stressors

Concerns about travel, health safety issues, and scheduling constraints were all indicated as stressors that impacted students' perceived access to what they needed in order to complete the course. Students reported that personal issues had a real impact on their interaction with peers, teachers, and course instruction. These types of concerns were not echoed by students in the past, face-to-face, iterations of the course, but appear to be consistent with emerging research on the impact of COVID-19 stressors on students (e.g., Fruehwirth et al., 2021). Future research may focus on emergency situations like the COVID-19 pandemic response and consider ways that academic institutions can prepare students to better manage personal issues and stressors so they may reduce their impact on education.

Course Design

Data indicate that students were not hampered by the modular design of the course and were able to use technology effectively to join the class and to track and complete modules. Students reported satisfaction with the modular, mastery-based design of the course, and several indicated that the course was the gold standard for online learning in their experience. But some students self-reported that they lacked self-regulation skills to maintain progress and stay motivated to complete course materials. Students' difficulties with self-regulation in online learning environments is not uncommon (Cho & Shen, 2013), and further exploration of the nature of the issues impacting students' self-regulation—and potential design-based solutions—require further investigation.

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Connecting Students and Faculty Research Efforts Through the Research and Projects Portal (RAPP)

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Abstract

Developing projects is an integral task in course work for students at universities. Extensive projects span over semesters and hence are incrementally worked upon by multiple teams of students. Ideally, projects are documented and structured to be readily accessible to future students who may choose to continue the project, with features that emphasize the local community, university, or course structure. The Research and Projects Portal (RAPP) is a platform enabling students to post both their completed and ongoing projects with all the resources and tools used. Students can access RAPP to understand the contributions of past students and may choose to extend the projects that fall within their domain of interest. Industry collaborators and faculty from other departments could document their ideas on RAPP for students to engage in. Actively curated, the portal enables instructors to label the projects which helps students to filter and browse across the portal with ease. RAPP enhances the collaboration of students across semesters by supporting their documentation hence enabling longevity of projects.

Introduction

Students engage in multiple projects during their course work at universities every year. Most of these projects are later abandoned because the students ran out of time, or they could not accumulate all the resources they needed in a semester span. Inspired by “Communities of Practice” (Wenger, 2018; Wenger et al., 2010), this paper presents the idea and application that is developed at University of North Texas (UNT) to address this issue. A survey conducted on the campus indicated that projects done by students every semester are available on individual git repositories. New students, who are in the process of picking a project for the semester needed a common platform where all the past student projects of the department are archived along with their documentation. This lack of aggregation of resources hindered students to refer past work, track resources and choose to increment an existing project.

Students working on multiple projects had to navigate through multiple platforms to maintain documentation and track the status of each project. Recruiting, to onboard new students for a project was very elaborate where the concerned instructors and students sent out email communication along with putting up flyers on department dashboards. On the other hand, new students in search of open projects needed a community to tap into. Similar kind of communication was taking place with students needing funds for their projects or sponsors seeking good projects. Additionally, an interface that could bridge the gap between industry collaborators and the department student projects was not available. Industry collaborators, given a better communication platform could bring in value-added solutions, resources and provide a perspective on the current market necessities in any given domain (Silva et al., 2018; Fernandes et al., 2018). This survey led us to create a better design which addresses the challenges by having an archival of past projects, support organized documentation with all the relevant resources and tools, curate the project list for end users (refer Figure 1).

Figure 1. RAPP Features

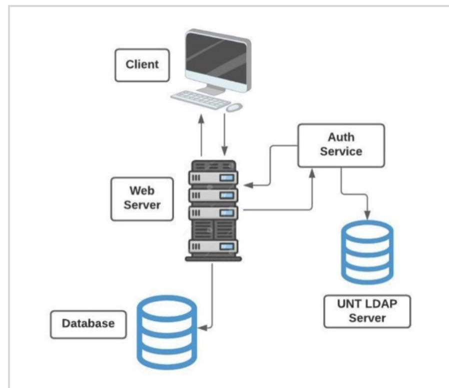


Figure 2. RAPP Architecture

The emphasis on having long-term student projects that span over multiple semesters was experimented at Grinnell college in Iowa. They have redesigned their ‘Software Design’ course to enable students to engage in multi-semester, community service projects (Davis & Rebelsky, 2019). These changes were done to accustom students to not just the development of real-time applications that served the local non-profits but also to introduce them to the terrain of software project maintenance. The student teams were using Git to maintain code versioning along with documentation. Alumni mentors were assigned to the student groups who help them navigate through design problems and advice on the optimal technical solutions. This line of work displayed promising results in increasing the technical and soft skills of the students (Davis & Rebelsky, 2019).

In recent years, significant work has been done on archiving, evaluating, and assessing student projects through various web portals (Li Li et al., 2007; Di Blas et al., 2014). At the University of Bradford, a knowledge portal was implemented to support the collaboration of MSc student projects (Munive-Hernandez, 2011). This portal supports monitoring of project tasks and tracking the milestones achieved. It also enables communication and feedback from supervisors. The portal is actively being used for project definition, project planning, literature review report, supervisor’s feedback, and development of knowledge repository. Similar efforts were initiated in 2003, at the University of Pretoria in South Africa. The web portal was a massive success and was also made the official architecture at the university (Pienaar, 2003). More recently in 2018, Monash University in Australia developed and launched an online research portal that grew to be accessed by almost ten thousand people and implemented throughout the campus (Rodafinos et al., 2018). Another example of the successful implementation of an academic research portal occurred at Vanderbilt University. Features of this portal included research support, and guidance for future projects (Harris et al., 2011). The success of similar efforts provides a reference for the future success of RAPP.

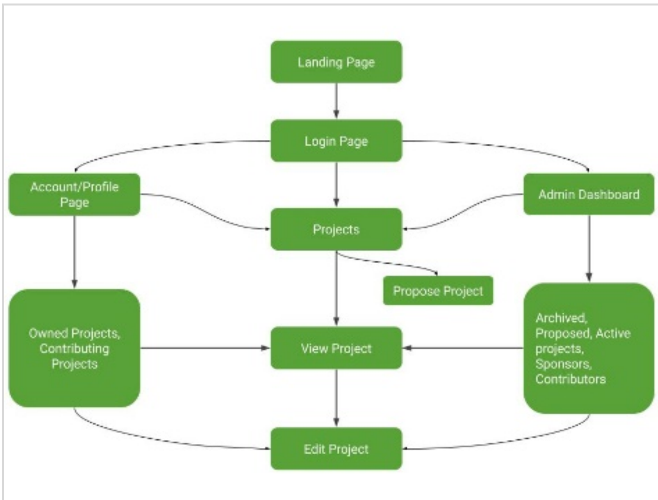


Figure 3. Application Workflow

Figure 4. Project Statuses

While many web portals lag in displaying incomplete projects, the goal of RAPP is to build a website that is actively curated with a list of student research projects that are active and well suited for students and faculty to continue. An archive is also intended to showcase the research and class projects that students work on to excite prospective students, interested faculty, and prospective donors (Rodafinos et al., 2018). The user-friendly graphical user interface of RAPP enables professors and students to spread awareness of what they are currently working on and tag their projects as "actively recruiting" to seek students. While at the same time, students can browse through to see the projects that belong to their specific domain of interest and find the materials to work with or a faculty member best suited to advise them.

While still in the formulation phase, an idea can be proposed on the portal to become a prospective project. This feature of RAPP makes it possible for students to collaborate with a professor and arrive at a project plan that best suits both parties. Furthermore, this invites industry collaborators to bring in their value-added suggestions to these proposals or proactively fund a project. The influence of university-industry collaboration on innovation has gained a lot of attention in recent times due to its positive impact (Barnes et al., 2000; Hansen et al., 2017; Kukreja et al., 2020; Szabo, 2014; Gorlatova et al., 2013). The portal's user community includes students, faculty, and industry collaborators.

All the users in the community should sign up to the portal to gain access to all the features provided. To add a new project, one should upload a brief description, source code link, documents, and output snippets of their projects. The portal then prompts the user to tag key names related to the project which are later used in filtering the projects list. Signed up users can browse through the list of projects and filter based on tags assigned to the projects. Students are benefitted by the portal, by being able to upload their ideas/projects and seek out projects that fall within their domain of interest. Faculty and industry collaborators are empowered by the portal to be able to reach out to students actively seeking projects and resources, by hosting projects that are to be worked upon.

Implementation and Methods

RAPP is developed using the MERN stack, designed to run on Node.js and Express.js for server-side operations (refer Figure 2 & Figure 3). The front end of this portal uses a react and redux combination. Redux is a predictable state container that handles server and client interactions. The client relies on the index.js file and app.js files for redux setup and client-side routing. The MongoDB is responsible for storing and serving all the user and project data. User accounts and project listings are stored on different tables within the database.

This portal leverages the EUID-based login (LDAP) system implemented by UNT, based on Microsoft Active Directory service. Using this unified login information service, any authorized user with valid UNT credentials will be able to login to the portal. Administrator role is assigned to users who are responsible for the maintenance and health check of the portal. An admin user is also accountable for reviewing the proposed projects. RAPP has a responsive web design enabling it to be rendered and fit into any screen resolution, size, and orientation of the user’s device.HTML5, CSS, JavaScript and Bootstrap v4.0 are used to enhance the frontend experience of the user. Bootstrap is the most popular CSS framework for developing responsive, mobile-first projects on the web.

Results

RAPP enables the user to navigate through multiple tabs that facilitate and host the features. This web portal allows any member of UNT to submit projects or ideas for review by a site administrator. Once an administrator approves a submission, it becomes visible among the list of all projects. This list has a robust set of search and filter functions, allowing members to view and share a completely customizable set of projects. Contact information is included with every project, so adopting an existing project is easy. Projects can be edited by their owners, and by site administrators, so changes in status and team ownership are easily updated. Administrator has a suite of tools to curate and manage the database of projects. These tools include approving or removing newly submitted projects, batch editing multiple projects, exporting the current database as a spreadsheet, and importing multiple projects at once from a spreadsheet. Administrators also can promote and demote other site users to administrator status.
Functional features available on RAPP are described below.

a) Add Project

A user starts with uploading his idea to the portal via this form. User is expected to feed in the information of the project (refer Figure 5.1 & Figure 5.2). Actively recruiting label, is a check box which lets the users understand if there are open positions in the project. GitHub link label is a text box to feed in the link to the source repository. Cover Image label is an upload option for a .jpg or .png file that serves as a cover image for this project on the portal.

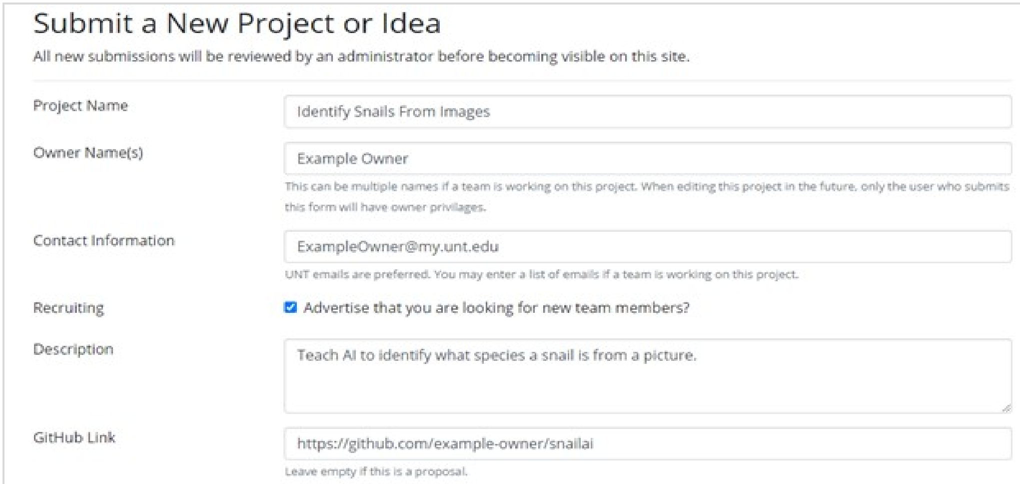


Figure 5.1 Add Project Form Part1

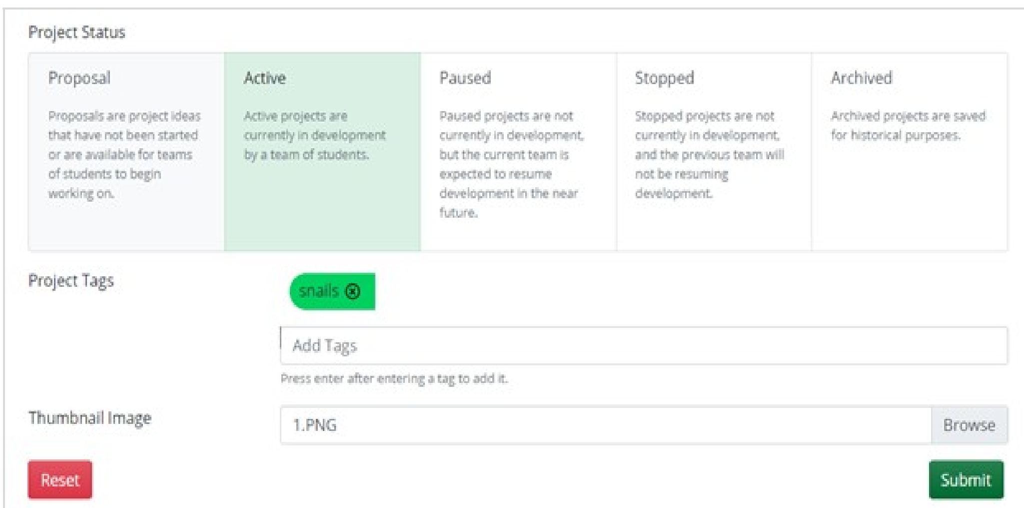


Figure 5.2 Add Project Form Part2

b) Edit project:

Users are provided with an access to update the projects owned by them. This serves as a crucial feature for the portal since these user activities help actively curate the project list. This form is same as the “Add project” form since the portal provides complete access to the user to update all sections of the project.

c) Dashboard for browsing projects:

A dashboard with all the projects listed except for the archived projects. The page comes with user-friendly interface for the user to be able to navigate through with ease (refer Figure 6.1 & Figure 6.2 & Figure 6.3). A search bar is available for the user to feed in the project name. This helps the application to find the desired user project from all the hosted projects. A list of project status filters (refer Figure 4) is provided to the user to choose from. The filters are segregated based on three categories namely, development status, administrator approval status and recruiting status.

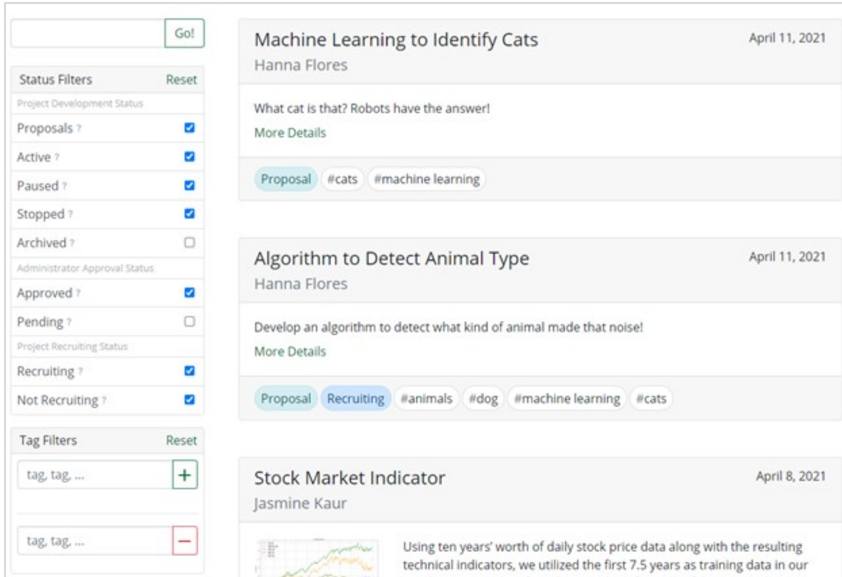
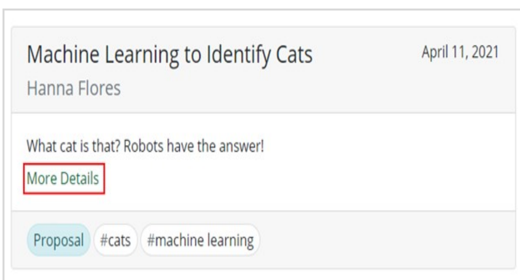


Figure 6.1 Dashboard to Browse Projects



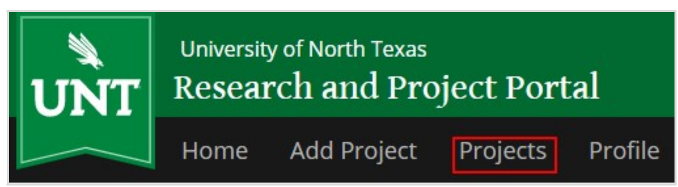


Figure 6.2 Project Tile

Figure 6.3 Application Menu Bar

The project development status reflects the implementation status of a project. The administrator approval status depicts whether the project had been approved by the admin of the portal or not. This filter is used by the user to check if the projects onboarded by him/her is approved by the admin. The user can leverage the filters in the project recruiting status section to filter or filter out the projects that are actively recruiting. All the projects, except for archived status that fit the search and filter criteria are listed. Each project in the list is contained in a tile which holds all the details of the project. The principal feature of RAPP is to curate the user content. To be more specific, projects that are recently updated, active or actively seeking resources will be prioritized and will be on the top of the list.

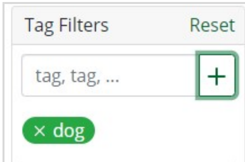
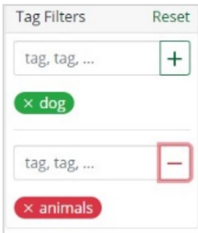


Figure 7. 1 Include Tag Filters

Figure 7. 2 Include Tag Results



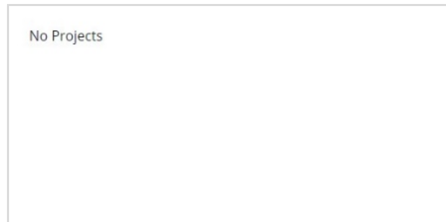
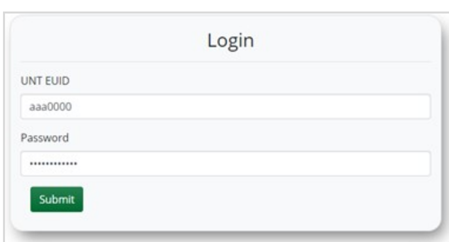


Figure 8.1 Exclude Tag Filters

Figure 8. 2 Exclude Tag Results

Each project tile contains a "More Details" link that when clicked upon would help the user navigate to a different page where more elaborate details of the project are available. Thumbnail picture attached to the project is projected on the project tile for a visual reference. Filters to search for projects by their tags. While creating a project, the user is entitled to assign tags to the project. These tags reflect the technology or domain specific keywords related to the project. Furthermore, the results can be narrowed by specifying tags you do not want to include (R\refer Figure 7.1 & Figure 7.2) and exclude (refer Figure 8.1 & Figure 8.2) in your search.



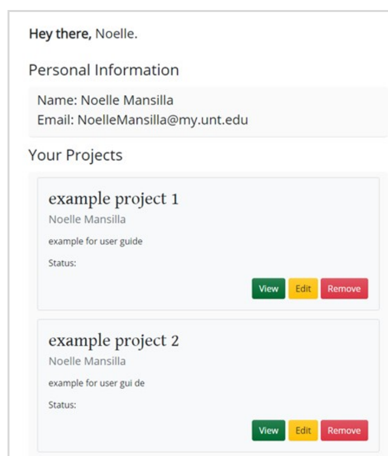


Figure 9.1 Login Page

Figure 9.2 User Profile

d) Maintain user profile:

The portal provides a profile page for the logged in user to display all the projects under the user's ownership (refer Figure 9.1 & Figure 9.2). This helps the user to track the statuses of all his projects and have easy access to navigate to those specific projects and update the content and details. The absence of this feature forces the user to navigate to the dashboard and search for these projects. From this profile page, the user can navigate (view), edit, and delete the project.

e) Admin Dashboard:

The admin privileges enable a user to have access to a set of features that help manage the portal. Admin features include import and export of projects; privilege to approve, deny and edit projects; view all the users and have the privilege to assign or revoke admin role to any user on the system. The Pending projects tab helps user navigate to the admin dashboard where a list of projects, that are to be reviewed by the admin are available (refer Figure 10 & Figure 11). Each project tile in this dashboard comes with an approve button and a reject button. Upon approval, the project will be made available to all the users on the portal. In case of rejection, the project is not available on the projects dashboard for the users to view and work on it.

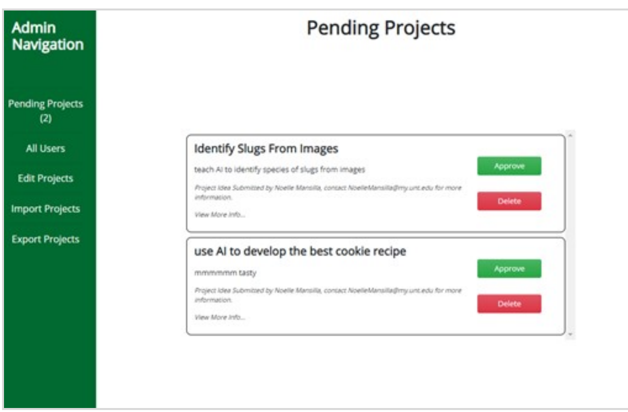


Figure 10. Admin Dashboard

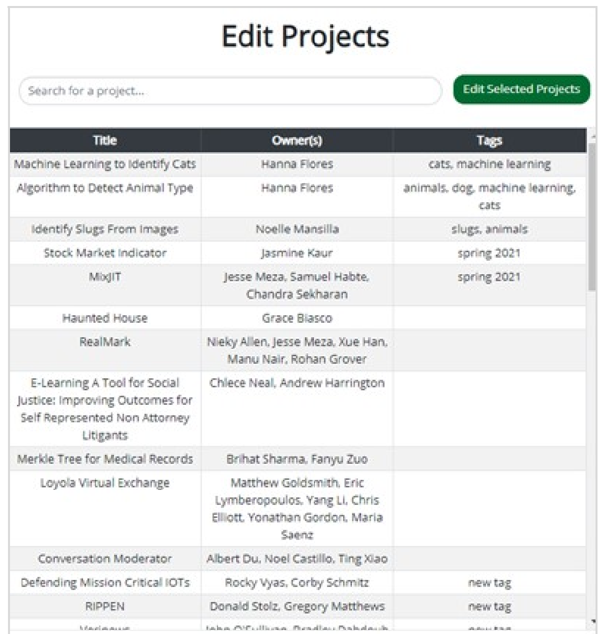


Figure 11. Projects Edit Page for Admin

When there are multiple projects that are to be onboarded to the portal, it is a tenuous process for the user to manually type in all the details and upload the project one by one. In such scenarios, the user may reach out to the admin and provide all the project details in an import template. The template is available for download on the import page. The admin is supposed to upload all the projects through the template alone for this bulk project upload to be successful. When changes are to be applied to multiple projects, it is ineffective for the admin to navigate to individual projects and update the changes. In such instances, admin has the flexibility to export all the projects and update the content in excel at ease. Post applying the changes, admin can import the same for the portal to reflect the updated content. The export also helps to take a backup easily, in case of system migration or upgrade.

The admin has a privilege to manipulate the tags on a project along with its status. An option to delete the project is also provided here (refer Figure 13). This gives the admin complete access over the projects, so that the portal does not encourage malicious content, projects on the portals hold relevant tags that enable effective filtering, and the status of each project is reflecting its needs or implementation status as expected. The admin user will be able to view all the users registered on the portal. This feature enables the admin to provide or revoke admin access to other users on the portal (refer Figure 12).

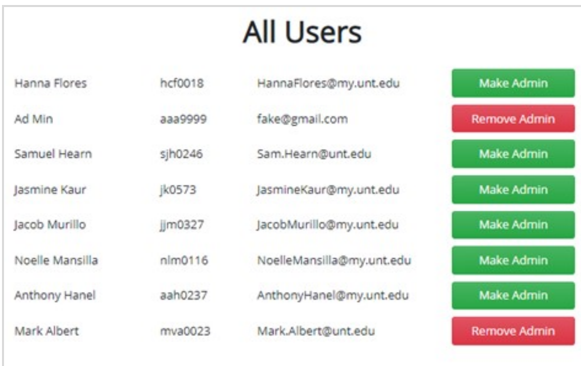


Figure 12. View Users

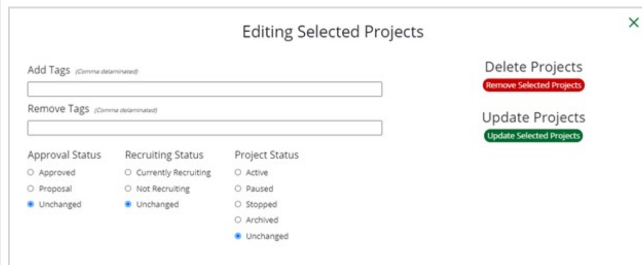


Figure 13. Admin projects edit page

Evaluation

The portal is launched in April 2021 with a primary goal to be available for the "bio-medical AI lab" summer program at UNT. The "UNT AI Summer Research Program" brings together students from a variety of AI-related academic programs to supplement their traditional course-based educational experiences with focused, project-oriented research efforts. Faculty and students with promising ideas uploaded their proposals on the portal. The members of the review panel were given admin roles on the portal to review the proposal submissions and approve them so that they could become prospective projects. The rejected proposals are not available for the users on the "Projects" dashboard. We had a team of students to administer a survey on the user experience of RAPP. This survey involved extensive feedback collection in weekly lab meetings throughout the summer program. The prime objective of this survey is to understand if the portal provides ease to the user while navigating through different tabs, if the forms provided were wholesome and relevant, if there were any glitches throughout the experience, if the filters and tags provide relevant curated content that helps the end user, if the aesthetics of the portal were appealing. The portal received an extremely positive reception.

Admin users were able to manipulate the tags on any given project with ease along with being able to edit the approval status, recruiting status and project status. This meant that they could refine the content with ease so that search results for the end users would be appropriately curated. Besides, the admins could monitor for any rogue tags and censor them to maintain the integrity of the portal. The import and export project options also received critical acclaim since the admin users were able to instantly onboard multiple projects effortlessly from past summer programs. With more proposal submissions, the admins were able to appoint new admins and scaleup the panel and remove their admin access when the workload receded. This was made possible with the 'Make Admin' and 'Remove Admin' options that are available on the "All Users" page accessible to all admins. Furthermore, the portal provided the admin with a prioritized queue of pending approvals that would make sure that the users who submitted their projects early would not have to wait for a longer period to receive the approval status. The survey proved that a feature as subtle as this could bring in a magnificent shift in user experience. Prior to this, the review panel had to track their mails and refer the tracker updated by the students and found it extremely tedious in identifying the order of approval. At times, this delay would lead to vexation of many proposers.

The faculty in the lab got back to the survey team that they were able to easily recruit students for open projects since it was as easy as marking the project as “Actively Recruiting”. Students were able to effortlessly filter out projects that had open positions through the portal and then reach out to the team with the contact information available on the project page. The well-organized portal facilitates grant writings for faculty since they could access all the resources in a centralized location. The fact that the portal does not need a separate registration process was an open invitation to people from all walks of academia at UNT, to propose ideas and manage their projects. This feature has created a substantial scope for the expansion of the portal to wider audience soon at UNT.

Discussion

Unlike GitHub, RAPP’s goal is to go beyond just hosting projects. RAPP allows faculty and students to connect over unfinished projects, while still being able to display completed projects. To achieve this goal, we used appropriate client-side design tools to make the collected data user-friendly for browsing. Current project features include adding, searching, viewing, and filtering projects. They can also add tags, images, GitHub links, contact information, and upload files to projects. The fact that RAPP provides actively curated content along with dynamic tags, makes it a robust application that brings in a difference to the user experience. Taking it further, RAPP could provide a feature for the user to compose and send out an email to the project team directly. A chatbot that interacts with the user and suggests filters or projects would enhance the user experience further. A feature that would enable all the logged in users to participate in a conversation via text messages could push the collaboration to the next level. Though RAPP is launched as a pilot for the summer research programs at UNT, the goal is to refine and expand this application to be used widely throughout the campus.

Conclusion

Student projects with a substantial scope need incremental development, that spans over multiple semesters. Lack of a well-built model to bridge these efforts could obstruct the continuation of the projects. RAPP addresses this issue by enabling students to host projects with documentation, and respective resources. While completed and paused projects help with retrospection, new and active projects could be tagged with appropriate labels that results in curation of content hence encouraging users to find most active projects or projects with open positions. These features help the university’s faculty and students to find resources and related work while at the same time they encourage industry collaborators to bring in contributions. RAPP has a profound impact on its user community by creating a sustainable and collaborative environment for student work to thrive.

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Iterative Course Development and the Creation of the User Story Approximation Model

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Keywords: Design and Development, Systems Thinking

Abstract

Continuing Education course development can be a complex environment requiring rapid response to change and development of multiple projects at once. This paper describes the development of an instructional design model based on a series of decisions made during the design of an array of six pregnancy and postpartum fitness courses for different sets of learners with specific identities and learning goals and objectives. The collected data of the projects from task logs, project management documents, communications, and project reflections of the natural work setting were interpreted and generalized to make causal inferences. In this context, behavior patterns of the instructional designers emerged. This design case presents the action-oriented process of inquiry employing Soft Systems Methodology (SSM) to structure discussion about the situation and identify the repetitive procedural decisions to develop an instructional design model for higher education that could systematically guide instructional designers through rapid iterative development that employs user stories and Weick's sensemaking. The precedent is revealed in the User Story Approximation Model (USAM), which when replicated will result in newly designed outcomes in drastically reduced production time.

Introduction

Seeking knowledge to develop new competencies is no longer a sporadic activity in our professional lives. Shifting trends in skill acquisition to increase employability have created a demand for high quality continuing education courses and programs at colleges and universities. The instructional designers working at small institutions often have the unfortunate task of serving two masters: degree programs and continuing education programs. Further, course development can be especially chaotic in the continuing education environment where the potential for development is endless, and where any number of stakeholders and their requests can create challenges in managing priorities. The result is time constraints on the design and development process that ask instructional design units to find ways to shorten the time of course development. For continuing education programs to be successful, learning design must be structured to allow for flexibility and entrepreneurial thinking. Because of the need for design methodologies which are more efficient, while maintaining or enhancing effectiveness, rapid prototyping (RP) was evaluated as an instructional design strategy in the 1990's and numerous studies since that time have indicated that rapid prototyping improves instructional project quality and customer satisfaction while reducing production time.

In the discussion of RP, the use of reusable learning objects (RLOs) in course design usually reflects a conversation about reusable content. Learning objects that are made agnostic in such a way as to make the learning object viable in more than one course or program involving an interdisciplinary thought. The idea behind this approach is that the viability of the learning object is extended by the design decisions made in the development of the object which reduced the time to production. These decisions when formalized can be replicated to create RLOs. This approach to reusability focuses on "filling the closet" with a myriad of choices to use in each newly designed course. Unfortunately, this approach "fills the closet" or RLO repository with objects that need to be ordered, organized, and maintained, which may not produce the reduced production times some instructional design units require.

With the acceptance of our need to work faster, we sought a development model and a technique that would increase our production. Torrence's *Agile for Instructional Designers* (2019) borrows heavily from the AGILE approach developed by Sutherland and Schwaber, which relies on a philosophy, or "Manifesto" as Sutherland and Schwaber call it, and which Torrence modifies for use in instructional design. This manifesto guides all decision making. AGILE instructional design represents a form of development where design teams apply project management methodologies originating from software development to the practices of instructional design to rapidly develop courses. Emphasized in these practices is an iterative process which provides the opportunity to use collaboration, feedback, and iterations (versions) to reduce time while producing a more successful and valued product.

Course development is framed from the perspective of the learner. The course plan addresses the needs of the learner and how they will engage and interact with the course. The creation of the course is divided into modular elements or chunks. The individual modules are designed, and these portions are reviewed early on by the collaborators to produce a higher quality course more quickly while reducing the need for last minute revisions.

Most instructional design models devise the design of learning objects as new designs from the "blank page". We propose the implementation of a rapid prototyping approach through the construction of course modules from reusable component templates. This concept of reusability was first introduced in instructional design processes with an object-orientation where a system of best practices and design principles guide the development of reusable objects (Boyle, 2009). We proposed a further modification of the design principles based on Atomic Design (Frost, 2016) that allows atomic construction of design templates for use in course development which creates course prototypes within days of initial meeting with SMEs rather than weeks and full production to launch to occur within weeks.

Once a course has been constructed, an iterative cycle may begin to create successive versions of the course for other programs and other users. This process begins with a reconsideration of the "user story" and provides an opportunity to employ Weick's sensemaking (Mills, et al, 2010), which "is about understanding how different meanings are assigned to the same event," to revise the course. Weick's sensemaking guides the revision and how collective decisions are made at each stage of sensemaking to re-envision the course for a new user story—a new set of learners. Through these critical design decisions an array of courses that address different sets of learners may be rapidly constructed.

The purpose of this design case was to describe the development of an instructional design model to guide designers systematically and effectively throughout the design and implementation process of modular design with reusable design objects (RDOs) employing AGILE decision-making principles and Weick's sensemaking to rapidly produce courses. This user story design model is intended to result in an array of rapidly created continuing education courses with an appropriate blend of individualized content and learning activities that coherently provide meaningful learning experiences for multiple user stories and contexts.

> "Models make possible a systemic approach to design in that they intentionally lead designers to balance considerations of varied critical factors. Models incorporate both theoretical and empirical research in related fields. Further, the iterative process of evaluation and modification leads to improvement of practice, pointing to the potential design to stimulate continued progress in a larger context" (Lee, et al, 2017).

The design model was developed interrogatively. It questions who, why, and how particular reusable design objects (RDOs) should be designed, selected, or modified in a learning arrangement. Until now, no prior instructional design models have investigated the identification of user stories to develop multiple variations or versions of courses in succession through modular design and sensemaking. The process for constructing a user story design model reported in this design case, and its implications for improvement of continuing education course-level development and instructional design practice are considered to contribute to the growing literature of learning design.

Conceptual Modelling

Conceptual modelling may be defined in the simplest terms as the process of developing a graphical representation that provides an understanding of collaborative problem solving within a system for the different stakeholders involved. Conceptual modelling requires decision making to identify the scope and level of detail, aspects to include and exclude, and the objectives, inputs, outputs, content, assumptions, and appropriate simplifications to be contained within the model. A well-designed conceptual model establishes a common language among stakeholders that facilitates planning, design, and evaluation.

What is a conceptual model?

According to Powell-Morse (2017), "a conceptual model is a representation of a system that uses concepts and ideas to form said representation, [and] is used as a way to describe the physical or social aspects of the world in an abstract way." Since a conceptual model may incorporate representation of both behavior and data at the same time, it should fulfill four fundamental objectives in its construction:

- Enhancement of understanding of the representative system,
- Promotion of efficient conveyance of system details between stakeholders, including the key entities of the system (person, place, concept, event, and relationships),
- Provision of a point of reference for designers to gather concepts and sub-concepts, and
- Documentation of the system for future reference.

Conceptual models may serve to regulate behavior within a process and establish entities and concepts that help eliminate unsuspected outcomes. They define scope which aids in time management and scheduling, and serve as high-level understanding for managers and executives who may not be familiar with the minutiae of the design process (Powell-Morse, 2017).

Development of a Conceptual Model

Though there are many approaches to the development of conceptual models, Soft Systems Methodology (SSM) provides a systems thinking approach to operationalizing conceptual modelling. SSM is an action-oriented process of inquiry for addressing multiple views of reality in a situation to derive purpose from actions to inform processes (Checkland & Poulter, 2020). Kotiadis and Robinson (2008) derived a three-stage process and accompanying sub-processes for the creation of conceptual models from SSM. When employed, these processes create the interactions necessary for conceptual model construction. The stages included in the processes are knowledge acquisition, model abstraction, and arbitration. Knowledge acquisition (KA) may be divided into two parts and their resulting sub-processes. KA begins with constructing a rich picture that is a holistic representation of the situation under scrutiny. Key elements include descriptions of the processes, procedures, and stakeholders.

The second part of KA may include three analyses: role analysis, social system analysis and political system analysis. These analyses provide information about decisions made and what part behavior played in the success of the process described in the model. Role analysis requires consideration and exploration of "the role of the client (who has caused the study to take place), the role of the 'would be problem solver' (who wants to do something about the situation) and the role of the problem owner [who would like the process to be documented for future use]. All or some of these roles may overlap" (Kotiadis & Robinson, 2008). The goal is to answer the key question--why is this model necessary to the stakeholders. Once roles are determined, social system analysis should take place. Social system analysis considers "the changing interactions of roles, norms, and values". The goal is to answer what affect, actions, and outcomes has each role provided.

Finally, political system analysis enables an understanding of "how power is expressed in a particular problematic situation." Who made key decisions and from where did decision making derive? Where were the points of review, evaluation, and approval within the mapped process? "Understanding the roles within a problem situation, typical behavior of the stakeholders and the allocation of power can mean that the modeler can manage the stakeholders during the conceptual modelling process and arrive at a conceptual model that is agreeable to all, desirable and feasible" (Kotiadis & Robinson, 2008).

Once KA is complete, abstraction, the process of simplification to identify purposeful actions, may be made from the collected data. When a resulting origination of workflow of purposeful actions is identified, an initial iteration of the conceptual model is created and serves as a partial representation of the system description. Simplification is achieved by reducing the level of detail to behaviors that may be categorized according to scope. The difficulty in abstraction remains developing a balance to provide an accurate portrayal of the situation and model objectives.

The final stage in conceptual modelling is arbitration. The subject matter experts debate the situation, using the draft models to provide changes which may improve the process and are desirable and feasible, and accommodations between conflicting interests are made, which will enable improvement in the process. Once a consensus is reached, the modeler may draw the final rendering of the model to be conceptualized.

Results

Research on instructional design models may be classified into three different types: model development, model validation, and model use. This design case was concerned with model development and followed the process methodology designed by Kotiadis and Robinson (2008) from SSM and utilizing criteria to establish validity defined by Richey & Klein (2014) who noted that ID models may be developed from practical means, utilizing real-life design projects. The user story design model in this design case was developed from real-life design project data.

Participants

The conceptual modelling involved participants composed of the members of the ID team (one subject matter expert, two instructional designers, and one administrator). The SME was a graduate student and fitness professional with 15 years' experience in the fitness industry. The first instructional designer had 10 years' experience as an instructional designer and 5 years' experience as an instructor in higher education. The second instructional designer had 20-years' teaching and curricular design experience and 10 years' experience as an instructional designer. The administrator previously completed instructional design work as a 20-year faculty member.

Knowledge Acquisition, Part 1: Holistic Representation

The collected design projects of an array of six pregnancy and postpartum fitness courses were profiled in scope, resources, and roles. Records of key project data including work logs, project management documents, and in progress communications were collected. Extracted from the resultant data were timelines of tasks completed, decisions made, people consulted, resources used and the extent to which instructional design and institutional standards were addressed and met. Problems in the development cycle such as confusion over processes, directions, and language were described including constraints, conflicting information, failures, and miscommunications.

Knowledge Acquisition, Part 2: Analyses of Culture and Disposition of Power

Roles were explicitly defined from the perspective of expectations, job descriptions, prescribed actions, and actual performance. The key roles were identified: role of the client (the SME), the role of the problem solver (the ID), and the role of the problem owner (the administration). Reactions and opinions from all roles including the amount of time spent in problem analysis, how problems and design decisions were addressed through the development process, and the combination of decisions and interventions to solve performance problems were mapped in the workflow.

Social system analysis identified interactions between roles and the extent to which roles, behavioral norms, and values shifted. The effect that the disposition of power through the implementation of AGILE communication processes was defined and how these processes affected communication and decision making in development were explored. The influences of organizational climate and the impact of the role supervisors had in the development process were also explored. Cyclical behaviors were typified including the design, development, and review of iterations and versions, and the design behaviors were described through sensemaking of successive iterations, and the language of all interactions was clarified.

Noting that "data triangulation is especially critical in design and development studies based upon participants' recollections of already completed projects" (Jones & Richey, 2014), a design case paper describing the workflow was written as a reflective exercise to understand the implications of the findings and situate the learning for conceptualization. The design case served as a confirming process for the researchers to validate the work completed during knowledge acquisition.

Abstraction

The scope and level of detail identified in the system description provided by the subject matter experts was simplified to task categories often found in instructional design models. A textual outline of processes was created. To consider graphical representation of tasks, a set of questions was developed to guide the mapping of specific design details as presented in Table 1.

Table 1

Interrogative Framework to guide mapping of purposeful actions
1. What should students learn about this topic?
2. Who are the students for this information (career orientation)?
3. What are the desired results for each user story?
4. How will the content be developed?
5. How will learning objects be modified for each user story?
6. How will each user's learning be accessed?
7. What is the order of course development?
8. How does rapid prototyping occur?

The base design was created by mapping the specific design details on the Successive Approximation Model (Figure 1), which served as a base model for graphic design and a starting point for arbitration. The graphical representation of the base model is shown in Figure 2.

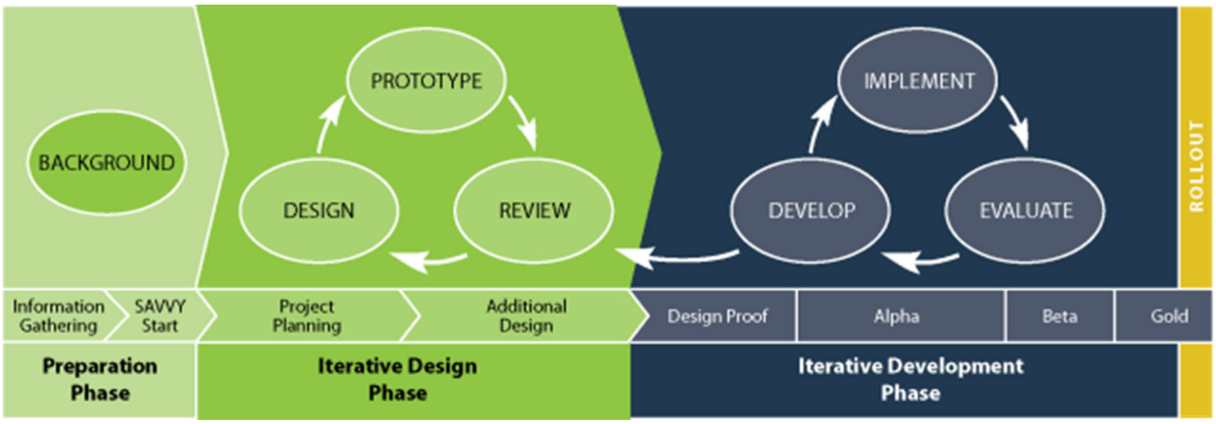

Figure 1. Successive approximation model version 2 (SAM2) process diagram. Adapted from Leaving ADDIE for SAM: An Agile Model for Developing the Best Learning Experience (p.40), by M. Allen, 2014, Alexandria, VA: American Society for Training & Development. ©2014 by the American society for Training & Development.

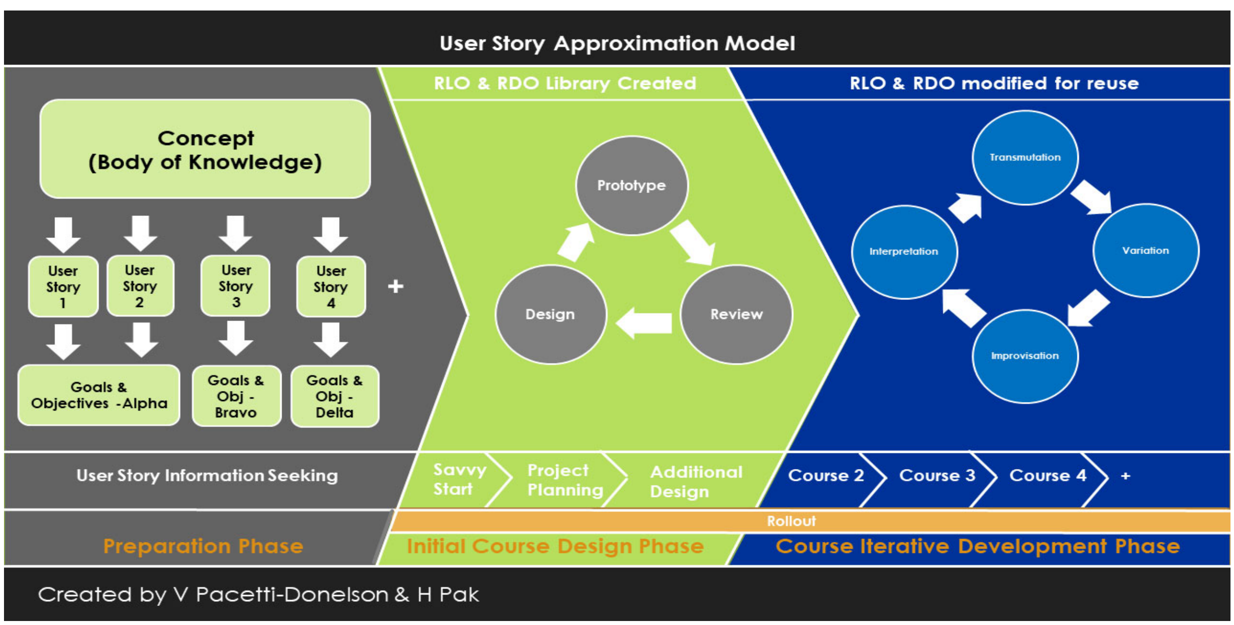

Figure 2. Base model draft to be used for Arbitration.

Arbitration

The ID team conducted a retrospective meeting to evaluate the base model draft in comparison to the design case. The instructional designers debated the situation as compared to the draft model to provide changes which would more accurately reflect the process as it was completed. The discussion included recognition that not all process elements are cyclical and not all process elements are linear, but a combination of both. A consensus was reached, and a final rendering of the model was made, as seen in Figure 3.

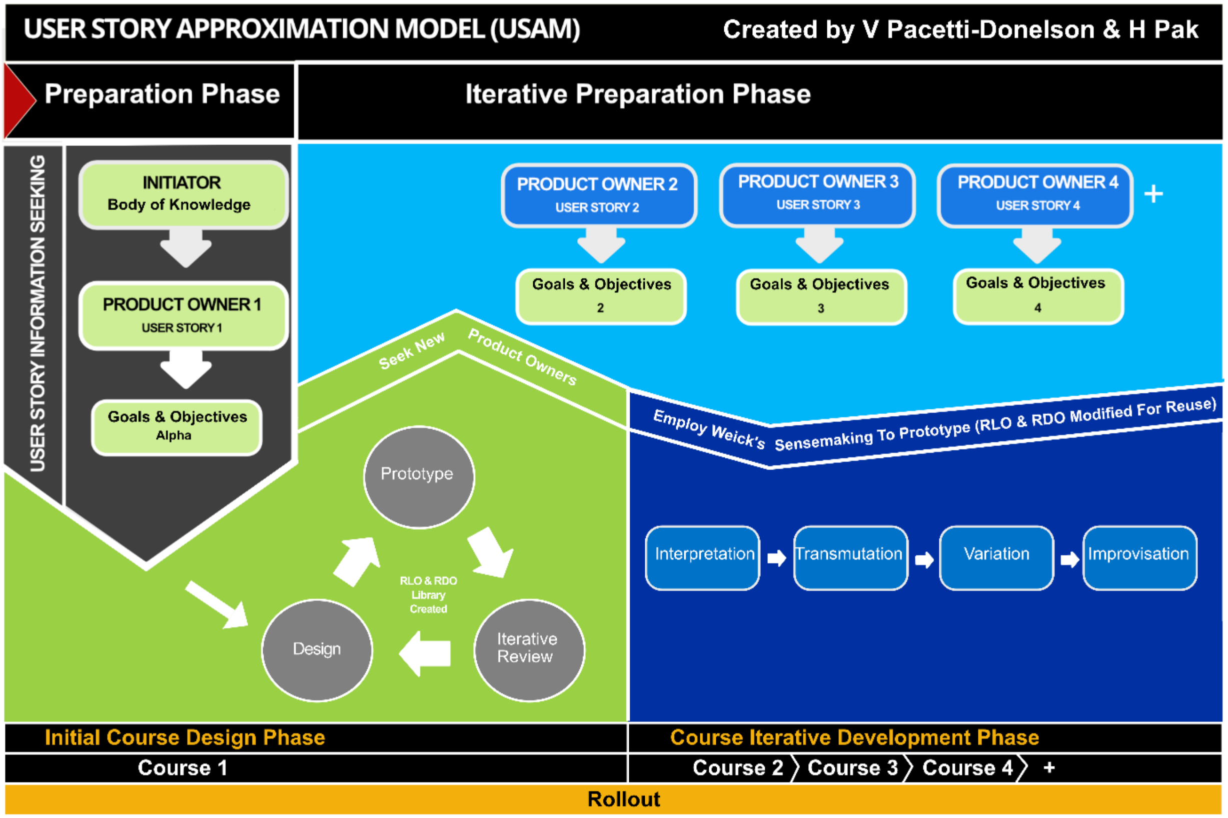

Figure 3. Final rendering of the User Story Approximation Model (USAM).

Discussion

Design and development processes are particularly difficult to navigate and manage, especially in environments coping with scarcity of resources and other limitations. These processes may be more effectively understood, improved and supported through the development of conceptual models. As this model demonstrates, design and development processes involve significant amounts of novelty, complexity, and iterations. The model is described in Figure 4.

The assumptions of the model

- The users of this model are an instructional design team (SME, instructional designers, and an administrator) for continuing education courses.
- Courses are designed in 5 modular units with rapid prototyping techniques through AGILE instructional design processes.
- In the context of the model, "Goals" refer to what students need to achieve in their real-world context after completing the course. "Objectives" refer to what skills and knowledge students will acquire after completing the course.

Description of the Model	
1. Preparation Phase 1.1 Initiator delivers a Body of Knowledge. The SME provides course idea and core knowledge and works with instructional designer to develop course name and description.	1.2 Product Owner provides relevant information to construct user story, which includes contractual obligations set by partner institution and their cultural context. 1.3 Goals & Objectives Instructional designer constructs overall goals for the course, which should address what skills students should exhibit in career performance.
2. Initial Course Design Phase 2.1 Course design Instructional Designer analyzes content and creates course outline by distributing topics into modules. The overall structure of the course is determined. Time plan, instructional methods, multimedia assets, feasible learning activities, and formative and summative assessments are planned. 2.2 Prototype Development Instructional Designer develops prototype, including syllabus, course layout and modular design, reflecting ID team and institutional standards, and the contractual obligations. Instructional designer decides on specific learning content to be delivered and through what means. Various materials including lectures, presentations, images, tables, and figures are developed. Instructional designer works with SME to produce video assets and prepares them for embedding in the course.	Instructional Designer and SME work to develop formative and summative assessments that relate to career orientation of the course, and they are placed within the prototype. 2.3 Iterative Review Prototype is reviewed by stakeholders and after discussing appropriateness with ID team, revision occurs. Process is repeated until the ID team and institutional standards have been met, contractual obligations have been met, and the SME has verified all course content is appropriate and accurate. 2.4 Alpha Course is completed. Course is delivered to stakeholders. Upon successful implementation, course review survey data is reviewed by ID team for future improvements and/or course developments.
3. Iterative Preparation Phase (repeated phase) 3.1 Seek new product owners. The administrator reviews the course and attempts to identify other partners for course implementation. 3.2 Product owners provides relevant information to construct user story, which includes contractual obligations set by partner institution and their cultural context.	3.3 Goals & Objectives Instructional designer reviews goals and objectives from Alpha course and revises overall goals for the iterative course, which should address what skills students should exhibit in career performance.
4. Course Iterative Development Phase (repeated phase) 4.1 Alpha Course is duplicated. At this phase, the Alpha course prototype is reviewed in terms of achieving new learning goals and objectives. 4.2 Weick's sensemaking is applied. Instructional designer and SME check to confirm if course materials will cover new learning objective, if there are new objectives to consider, items to remove, new items to develop, and items to modify.	4.3 Iterative Review Prototype is reviewed by stakeholders and after discussing appropriateness with ID team, revision occurs. Process is repeated until the ID team and institutional standards have been met, contractual obligations have been met, and the SME has verified all course content is appropriate and accurate. 4.4 Successive Courses are completed. Course is delivered to stakeholders. Upon successful implementation, course review survey data is reviewed by ID team for future improvements and/or course developments.

Figure 4. Description of the Final User Story Approximation Model

Conclusion

Conceptual models define scope and aid in time management in the design and development process. Conceptual Modelling activities utilizing the actual task logs kept by designers, developers, and even clients and SMEs are invaluable as they provide a record of the purposeful actions and decisions made and allow modelers to conceptualize a workflow more reflective of documented practice. The final USAM created in this design case evolved gradually from the reflective practices associated with AGILE project management communications. The target users, scope, and design context were revealed in the model assumptions and description.

Model development is an iterative process. This model may be limited in that it was developed from a single case at a small regionally accredited institution with one instructional design unit serving degree and continuing education course development needs. Also, since the design case specifically focused on the development of an array of continuing education courses at a special focus university, the model may include some features that are specific to the career context of sport and working with regional, national, and international partners, stakeholders, and SMEs.

Further, every design and development process involves a degree of uncertainty. Validation of this model may reveal new activities typically discovered during implementation. New complexities may be revealed and should be considered, which will generate and communicate new conceptual insights into the design and development process, which may contribute to a better depiction of best practices and contribute to new knowledge in the growing body of conceptual models for instructional design.

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Identifying Knowledge Dimensions for Program Design in Continuing Education through Bodies of Knowledge (BOK)

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Abstract

In learning design, it has been long understood that a body of knowledge (BOK) is the complete set of concepts, terms and activities that make up a professional domain. The literature describes the purpose of bodies of knowledge in their role as a requirement for professional identity, the development and furtherment of professionalism, and the acclamation and dissemination of knowledge to embody shared values and practices. Professional status requires the field to monopolize a discrete BOK, but how this knowledge is organized varies from profession to profession which may present difficulties in the development of conceptual frameworks for continuing education course development where courses are frequently created and aligned to developing trends and issues in the field. In this paper, a matrix of professional knowledge aggregates in the form of subject matter experts is presented and their expertise is considered from the perspective of Anderson and Krathwohl's (2001) Knowledge Dimensions. Five (5) approaches for the development of continuing education programs based on the BOK presented by the subject matter expert at the beginning of course development will be shared. The benefit of this design approach is to create continuing education programs more successfully aligned with professional practices.

Introduction

In learning design, it has been long understood that a body of knowledge (BOK) is the complete set of concepts, terms and activities that make up a professional domain. The literature describes the purpose of bodies of knowledge in their role as a requirement for professional identity, the development and furtherment of professionalism, and the acclamation and dissemination of knowledge to embody shared values and practices. Professional status requires the field to monopolize a discrete BOK, but how this knowledge is organized varies from profession to profession which may present difficulties in the development of conceptual frameworks for continuing education course development where courses are frequently created and aligned to developing trends and issues in the profession.

The world and cultures in which we live, and experience are constantly changing. Continuing education course work and certificate programs allow workers to stay current with the latest developments, knowledge, skills, and technologies of their perspective fields. Some professions also require the completion of continuing education coursework to comply with laws governing licensing and certification within the profession. In the creation of continuing education programs, as in the construction of any coursework or program, most instructional design models begin with an evaluation of the structure of the knowledge and skills. Structure is determined and instructional content, activities, and assessments are developed. "This may seem quite straight forward, but the designer faces a problem: the different instructional design theories do not show much similarity in the way they describe 'knowledge and skills. Sometimes even the labels 'knowledge' and 'skills' are not explicitly used" (Dijkstra, 1991). More still, the identification of knowledge and skills for subject matter experts in the development of coursework and programs may be hampered by the limitations of their own evolving knowledge of practice within the field, and the expectations of course development at the institutional or organizational level. The successful identification of knowledge and skills upon which any coursework and programs will be based is the first step in developing successful continuing education programs. An identified BOK and its organization and resulting skill development may inform the selection of an approach for course and program design and more information about how knowledge is organized should be a part of the instructional design process.

Continuing Education Programs

The development of continuing education (CE) programs, which for the purposes of this paper will be considered workforce learning outside of traditional degree programs and trade schools, was born from a demand by enterprise as early as World War II for "employees to be knowledgeable, skilled, and responsive to social and professional changes" to enable employers to compete in the marketplace (Mizzi, et al, 2020). The public policies of the Roosevelt era emphasized workforce education and training would be necessary for Americans to join the new developing economy (Roumell & Martin, 2020). Public policy continued to herald this need. In 2014, the Workforce Innovation and Opportunity Act reinforced the purpose of continuing education programs as an opportunity for access to education and training needed to be successful in the labor market.

At the same time professional organizations during the 20th century and to this day have spent time in the development of "boundaries" surrounding their professional practice. Most professional organizations determine what formal education and entry requirements are necessary for the profession and exercise autonomy over the conditions and terms of ethical practice; and, with this process, the organization develops a monopoly over a discrete body of knowledge and related skills (Morris, et al, 2006). How each organization disseminates that information among its membership, including education and training, which results in continued membership, certification, and licensure varies from profession to profession and, sometimes, by level of government oversight.

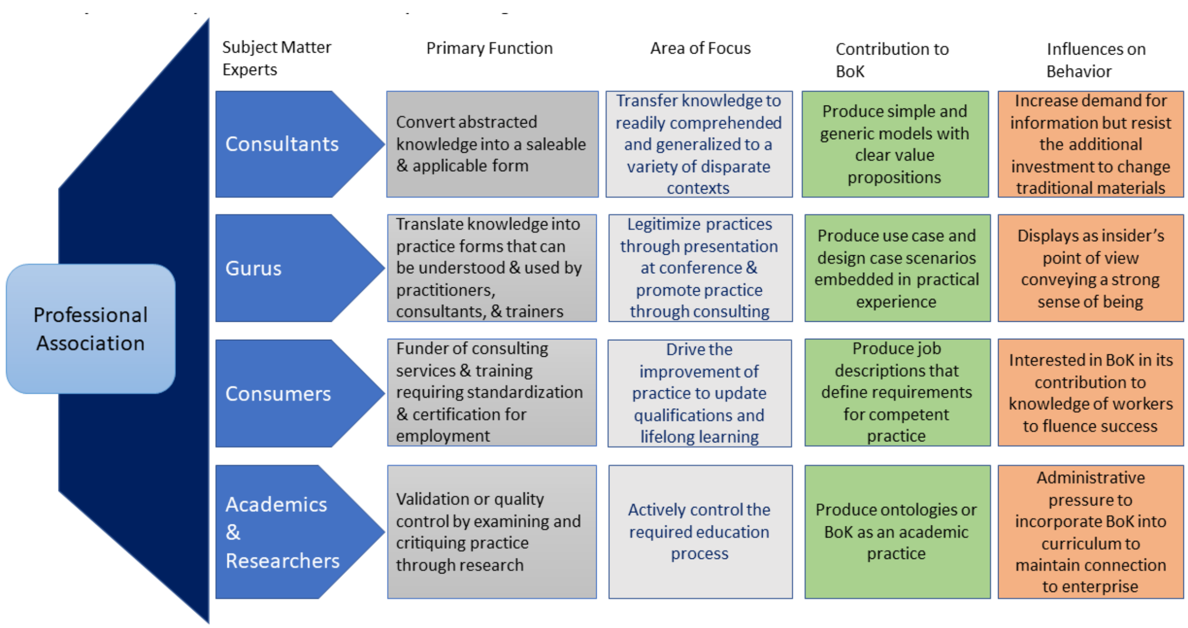
Subject Matter Experts

When attempting to serve the profession through education and training, educational providers seek to access the BOK of the profession frequently through subject matter experts (SMEs). What information these SMEs provide about the BOK of any given profession varies according to the skills, knowledge, and training they possess. In seeking to develop courses or programs for continuing education, instructional designers may be tasked with determining an organization for the knowledge presented by the SME. At this time, there is no systematic process or conceptual framework for evaluating a BOK presented by a SME. This circumstance may present a challenge to organize the presented knowledge effectively for learning design. Further, the perspective from which a SME may deliver a given BOK for course development may also affect the quality, type, and depth of knowledge received by the instructional designer further complicating the process of knowledge organization.

Morris, et al (2006) expressed concern about the focus and function of SMEs in the effective delivery of knowledge in their explorations of the BOK associated with project management. The authors noted that from the "socially constructed viewpoint of knowledge, one cannot avoid reflecting on the power relations" of the actors on a BOK. In Figure 1, the matrix of SMEs that serve as professional knowledge aggregates is an interpretation of these roles.

Figure 1

Subject Matter Experts as Professional Knowledge Aggregates



In their case study, these authors recognize the complexities and different functions that associated SMEs have in relation to the BOK (Morris, et al, 2006). The professional organization serves as the coordinator of the collective group of SMEs exercising regulation of the community of practice through registering participants and providers, sponsoring conferences, and funding research. It is common practice among professional organizations to view the identification of a BOK to which the organization will subscribe as a steppingstone in unifying the community of practice.

Within the professional association, consultants and gurus find their opportunities to affect the BOK through participation in the organization, though their purposes, focus, and function are different. These motivations accompanied with other influences on their behavior affect their contribution to the BOK. Consultants ensure that knowledge is easily comprehended and generalized for the community of practice and those attempting to join the profession while gurus legitimize practices and demonstrate expertise. Combined with the function and focus of enterprise and government serving as consumers, a provider/consumer relationship is recognized within the community established by the professional organization. Academics and researchers provide the quality control and validation for the BOK, which affords control of the educational processes of the profession. Morris, et al (2006) also acknowledged that there was a balance struck among the SMEs that sustained the BOK within the community of practice.

A well-established professional organization with an intent on regulating or establishing the boundaries of professional practice is positioned to provide governance and regulation to the development of the BOK. Standards of Practice are often the result of this governance and regulation. It can be equally effective for instructional designers in the role of organizing knowledge provided by a SME for course development to recognize the SME's role in the profession and therefore their approach to the BOK as well. Their approach to defining the BOK for a given profession may provide insight into the assessment of given knowledge and its organization.

Categorizing Knowledge for Organization

How we define a BOK varies according to who is defining. For the academic, a BOK is the complete set of concepts, terms and activities that make up a professional domain, its ontology. According to Oren (2005), it is the "structured knowledge that is used by members of a discipline to guide their practice or work." Dijkstra (1991) acknowledged that "there are differences in the ways that the description of knowledge and skills for purposes of instruction can be described" but also acknowledged that "these differences were not much help to instructional designers". To define knowledge organization for instruction, Dijkstra borrows labels for knowledge types from cognitive psychology. Knowledge is broken down into three types--conceptual knowledge, causal knowledge, and meta knowledge—and associates a problem as an interrogative statement and connects relevant skills to the knowledge type, as seen in Table 1.

Table 1

Dijkstra's (1991) Types of Knowledge, Related Problems, and Relevant Skills

Knowledge Type	Problem	Relevant Skills
Conceptual Knowledge		
Fact	What is the name of this single symbol, object, event?	Recognition
Concept		
Class concept	To which category does this object belong?	Identification operations --Categorization
Relational concept	What is the relationship between these objects?	--Application of problem-solving procedures
Causal Knowledge		
Conditions and biconditions (series of events, process, causal chain)	What will happen after a certain time lapse?	Making predictions by application of the lawful relationships
Meta Knowledge		
Plans, Strategies	How to plan, how to attack a problem?	Thinking skills, self-regulatory skills

Anderson and Krathwohl (2001) categorized knowledge, separating facts from concepts into factual knowledge and conceptual knowledge staying abreast of changes in cognitive psychology, as seen in Table 2.

Table 2

Anderson and Krathwohl's Knowledge Dimensions

Factual Knowledge	Essential facts, terminology, details to understand a discipline or to solve problems within it.
Conceptual Knowledge	Classifications, principles, generalizations, theories, models, or structures that enable function.
Procedural Knowledge	Information or knowledge, methods of inquiry, specific skills, algorithms, techniques, and particular methodologies establishing criteria for action.
Metacognitive Knowledge	Reflective knowledge about how to go about solving problems, cognitive tasks, including contextual and conditional knowledge, thinking about the thinking of practice.

It is when we combine the SME function, focus, and contribution as knowledge aggregates with the four dimensions of knowledge, as seen in Figure 2, that we may have a method for categorizing the knowledge presented by SMEs for continuing education program development.

Figure 2

Subject Matter Expert Primary Function and Association Knowledge Dimension

Subject Matter Experts	Primary Function	Area of Focus	Contribution to BoK	Knowledge Dimensions
Consultants	Convert abstracted knowledge into a saleable & applicable form	Transfer knowledge to readily comprehended and generalized to a variety of disparate contexts	Produce simple and generic models with clear value propositions	**Factual Knowledge** Essential facts, terminology, details to understand a discipline or to solve problems within it.
Gurus	Translate knowledge into practice forms that can be understood & used by practitioners, consultants, & trainers	Legitimize practices through presentation at conference & promote practice through consulting	Produce use case and design case scenarios embedded in practical experience	**Conceptual Knowledge** Classifications, principles, generalizations, theories, models, or structures that enable function.
Consumers	Funder of consulting services & training requiring standardization & certification for employment	Drive the improvement of practice to update qualifications and lifelong learning	Produce job descriptions that define requirements for competent practice	**Procedural Knowledge** Information or knowledge, methods of inquiry, specific skills, algorithms, techniques, and particular methodologies establishing criteria for action.
Academics & Researchers	Validation or quality control by examining and critiquing practice through research	Actively control the required education process	Produce ontologies or BoK as an academic practice	**Metacognitive Knowledge** Reflective knowledge about how to go about solving problems, cognitive tasks, including contextual and conditional knowledge, thinking about the thinking of practice.

If we consider the role from which a SME may approach the profession and the knowledge dimension they provide within the BOK, instructional designers may develop approaches to knowledge organization to inform course development for continuing education programs that more closely align course goals with desired outcomes. In this way instructional designers also acknowledge that SMEs do not demonstrate command of the body of knowledge with the same focus or contribution. Understanding what a SME may contribute also supports our understanding of the role of knowledge aggregates defining the boundaries of the profession.

Approaches for Developing Programs from BOK Knowledge Organization

With the understanding of the SME's contribution and what knowledge dimension is represented by their work, an approach to program planning may be made. Each approach focuses on the contribution of a specific SME and how that knowledge may be developed into a context for learning. Examples of suggested approaches are provided.

Approach 1: Foundational, Introduction to Profession

Knowledge is curated concepts and nomenclature, essential facts, terminology, details to understand a discipline or to solve problems within it, as most often created by consultants.

Example. Most continuing education courses found on Linkedin's Learning platform.

Approach 2: Role of the User, Organization or Project

From the field of practice, conceptual knowledge consisting of best practices provide the framework for the program of study or analysis of case studies to identify relevant professional skills (Romme, 2016).

Example. Web Accessibility Certificate

Approach 3: Levels of Implementation

This approach is developed from procedural knowledge and the most used for professional continuing education courses associated with the licensing of service providers. This information can be drawn from professional organizations (INFORMS, 2009).

Example. Project Management Professional (PMP)

Approach 4: Levels of Performance

This approach is most often used in technical trades, generally providing a three-part advancing model (Oliver 2012), which incorporates factual knowledge, conceptual knowledge, and procedural knowledge.

Example. Beauty School/ Real Estate Certificate

Approach 5: Competency Construction (Modified Degree Model)

Developed similarly to degree construction but stripped down to identified competencies based on meta knowledge for shortened time experience while focused skill acquisition development.

Example. Teaching Certificate Redesign: Making a Flexible Program for Future Faculty

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Design Case: Rapid Prototyping of an Array of Continuing Education Courses

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Abstract

This paper describes a series of instructional design projects focused on the design and development of successive pregnancy and postpartum fitness courses to provide continuing education courses for sets of learners with specific identities and learning goals and objectives. Taken as a series of decisions and actions employing the modular rapid prototyping techniques borrowed from Atomic Design and the collective decision making of Agile development, a design object-oriented approach to rapidly produce an array of continuing education courses is described. In this context, an instructional design team was able to redesign learning objects to meet the criteria of each specific learner identity, or "User Story." This design case presents the critical design decisions made during each course development iteration, the reasons for those decisions, failures in which the design did not work as planned, and reflections on the design and development process to establish the precedent revealed in a new instructional design model, which when replicated will result in newly designed courses.

Background

Continuing Education (CE) course design is an area of Instructional Design that requires constant modification and technological implementation to meet the competitive demands of the global marketplace. The ability to produce CE course content in a timely manner is a key factor in creating sustainable revenue for any institution. According to Adnan and Ritzhaupt (2018), there is an increasing demand for instructional designers to create high-quality instructional solutions in a variety of settings using more effective approaches. Adnan and Ritzhaupt suggest that the integration of software design principles into Instructional Design processes are a pragmatic approach that can make the creation of courses more productive and efficient.

Borrowing from manufacturing processes, one technique of interest for producing essential and accessible content in a fast-paced environment is Rapid Prototyping (RP). Through modular design and employing the Successive Approximation Model (SAM), developed by Michael Allen, instructional designers have been able to move away from the linear, time-consuming, waterfall design processes and quickly and cost-effectively produce content (Desrosier, 2011; Sites, Allen, & Green, 2014). Using this technique allows iterative design practices to drive the creation of a fast and more cost-effective production of course and content. RP can be practiced with AGILE project management principles that allow for increased communication between the stakeholders, contributing to a more successful delivery of the product. In small institutions, CE course development may be more effective with the implementation of AGILE design principles because of the constantly changing course demand and the need for quick turnaround time for courses under contract.

In this design case, we will describe how one course development process considered the development of user stories to produce multiple iterations of the course content, tailored to the needs of each user. This process decreased the production time of CE courses and produced an array of fully developed course products for multiple audiences.

Institutional Context

This design case details the experience of the initiation of a CE course by a Subject Matter Expert (SME), the design and creation process, implementation, and further iterations of the original course. The layout for the design process and the rationale for the use of the Successive Approximation Model (SAM) in this process are explained. The outcomes and reflection process are shared to reveal a series of decisions that led to the development of a new design model – the User Story Approximation Model (USAM) and the implementation of a best practice methodology.

The university that employed the designers of this case is a fully online degree-awarding institution that also offers CE courses to professionals in the field of sport. The CE department provides certificates and courses for domestic students as well as international partners. Most of the contracts for CE are with international organizations and institutions so the timeline for course development is much shorter and the design more situation-specific than that of domestic continuing education.

The university's Instructional Design department had previously used a linear, waterfall approach to project management and course design. This process created lengthy design times, difficult communication, and course revisions. Using the linear ADDIE approach, course production covered months of development time, while content moved from one person to another. The department underwent a change in management and the new director shifted this process and implemented Agile principles and a Scrum methodology. The department then began to use the SAM model to develop course components quickly, which decreased production time substantially. Designers completing other courses found utility in the reuse of components from this course. It served the department's functioning to make the course components a part of design element library that was collectively used for decreasing the amount of design time and creation while building courses.

Using the SAM model for iterative development, we were able to work with modular units and standardized design elements to provide a flexible framework for all continuing education courses. This framework was easily accessed by the team of designers, managers, and SMEs to rapidly create and edit course content. The design element library was housed on a shared drive in which all designers accessed. Once the initial course had been created, the modular components of design and content were then used to create multiple course iterations to meet the demands of other programs and product owners. This systematic approach to course design based on atomic design principles from software design practices allowed a small team to produce more courses in a shorter period (Frost, 2016).

First Iteration (Alpha Course)

The development of the Alpha course began with a Subject Matter Expert (SME), who was a graduate student and fitness professional who was contracted by the university to develop the concept of a maternity wellness course that incorporated personal fitness exercises to create for domestic CE course. This course was intended to serve as an informative progression through pregnancy to aid women and interested individuals in identifying the transformative changes and safe exercises during pregnancy and the postpartum period. The SME created an outline for the course and provided a plan for instructional videos that she would be recording to demonstrate the exercises. The instructional designer met with the SME. The course objectives and desired outcomes, flow of the modules, existing media, and resources were determined for the course. The SME agreed to write content for the unit pages. The course modules were developed in a branded format. The course elements were added to pages and content was added in a successive fashion as the SME provided it.

The design for the course consisted of a five-module structure, including an introduction, content pages, reading material, auto-graded knowledge checks, and video resources in each module. The modules corresponded with each of the three trimesters, postpartum fitness, and associated resources. The modules included content pages with a title that described the key concepts found on the page. The course detailed the safety of exercise and the changes of the human body during and after pregnancy. The SME provided specialized content of an interview that she conducted with a professional in the medical field, which was included in the first unit. The instructional designer filmed and edited the instructional videos in the university's recording studio, and the videos were added to the modules. The instructional designer also located an actor with a baby to demonstrate postpartum exercises for video production as well.

The course was completed in one month, from design to creation, and then moved to sale on the university's CE website. Once the course was live for enrollment, the marketing department advertised the course to increase enrollment and interest in the course. The visibility of the course to multiple university partners attracted interest in modified versions of the course.

Successive Iterations

An inquiry was made by a Global South institution about creating a Spanish version of the course. The ID team met with the stakeholder to discuss the existing course and possibilities of translating the course to Spanish. The stakeholders provided documents describing content that they would also like to see implemented into the course. The scrum process that was used by the ID team. A retrospective identified deficiencies in the Alpha course for the new iteration. Goals were set so that a backlog of the tasks could be created to establish design priorities and work was completed through a task to time assignment arrangement called a sprint. The ID team completed the revision of the Alpha course through an implementation of Weick's sensemaking to orient tasks to the new user story established by the stakeholder. Content was expanded and new media was created and added to meet the demand of the user story. The stakeholder reviewed the course and provided translation documents to orient the course to the Global South partner's dialect. At this late stage, the stakeholder sought renegotiation to include branding images within the course content. Once these items were added to the course, the course then moved from development to sales and marketing on the university's CE website.

It was determined by sales to offer the Alpha course as a complimentary course on the university CE webpage to highlight new multimedia implementation for internal stakeholders and to offer a valuable resource to the local community. This complimentary iteration of the course supports a portion of the university's mission to provide free education to the public. The first iteration in English became a course for domestic sales and the Spanish translated iteration became a sales offering to Global South partners.

The ID team was then notified about an inquiry from a US partner institution that wanted to purchase a course that provided training in pregnancy and postpartum fitness for nursing students. The introduction of this new user story for the course sparked the next scrum meeting for the ID team to identify other user stories that could benefit from a course in pregnancy and postpartum fitness. The ID team identified the target audiences, their individual needs and developed multiple user stories for iterations of this course. At the end of the planning meeting, a total of five courses were identified with separate user stories (audiences). The user stories determined the successive iterations of the Alpha course each time implementing Weick's sensemaking to meet goals and outcomes established by the user stories.

The content expanded after developing learning outcomes for each course. Outlines for each new pregnancy and postpartum fitness course with components aligned to the user stories were created for delivery to various institutional clients in tandem development processes. The ID team's rapid prototyping through repurposing learning and design objects and AGILE collaboration on the course design led to production ready courses within two days.

The process began with the duplication of the Alpha course into successive course shells and labeled for each new user story. Page elements from the design library were added to ensure accessibility, brand, and consistency. The ID team then edited the course content through Weick's sensemaking. The content was considered and then modified through four critical processes of interpreting the content for the new user, transmuting the structural elements, providing variations to focus on the user's needs, and finally improvising any missing content that would complete the learning goals and outcomes. The instructional designers created or modified media and graphics for each successive iteration. Media was created with reusable design elements that provide a standardized and branded look, while making production time minimal. Once the courses were complete, the primary shells were duplicated, and each given a unique course name and number to identify the audience. The SME was then asked to review each iteration to make modifications to content according to audience and to the interactive learning components and assessments to meet the specialized interest of the stakeholders, thereby producing the final version of the six courses, which were delivered within a two-week period.

Reflection on the Process

The ID team realized that they had created a series of decisions that through their documentation would create a set of best practices for rapid design and development. Creating an array of CE courses through the identification of user stories served as a benchmark that led to the development of an instructional design model. The use of AGILE practices allowed for collaboration that eliminated the need to pass content in a linear fashion, cutting down on the time needed for creation and revision, and allowing for multiple iterations of courses to be identified and created. The final retrospective of this development cycle led to plans on how to improve the quality and effectiveness of the new design process. The ID team found a common feeling of motivation from collaboration and communication. Collaboratively processing course design at the same time, using video conferencing as the work was being completed, allowed for decisions to be made in real time. The use of modular design and a design element library allowed for quality content to be produced and branded in an efficient and lucrative manner. This set of process helped define a best practice for converting alpha course content into multiple iterations. The feedback from the stakeholders was also incredibly positive and in the case of one stakeholder, additional course contracts were negotiated for other content areas. The process of RP of course content has shown to be cost-effective and essential for a small institution with limited staff and budget.

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Personalized Learning in Higher Education: Low-, Mid-, and High-Tech Strategies

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Abstract

This session includes justification for personalized/customized learning assignments in higher education; some benefits of using this approach; and a discussion of how such assignments promote critical thinking skills as students work within the higher levels of Bloom's Taxonomy. Low-tech, mid-tech, and higher-tech differentiation strategies are discussed via examples of these types of assignments that the presenters use in their own classes.

Introduction

Differentiated learning. Personalized learning. Choose-your-own adventure. Choice boards. These concepts have long been discussed and implemented in the K-12 environment (Coppens, 2021), but their adoption in higher education has been slower.

Why should professors implement customized or personalized assignments in their classrooms? The reasons are many. Most people like talking about themselves and enjoy integrating their experiences into assignments. Students appreciate relating their schoolwork to something practical. Instead of wondering when they will use an assignment in "real life," students find themselves using, applying, and making meaning of topics immediately. Personalized assignments give students ownership of their work, cut down on cheating, and encourage students to perform at the higher levels of Bloom's Taxonomy (Armstrong, 2010). Instead of working within purely knowledge-based assignments, personalized assignments can help students produce artifacts in the analysis, synthesis, and evaluation spheres.

What can (or should) be personalized?

Personalizing assignments can initially feel overwhelming. A professor might wonder, "Am I supposed to make a unique assignment for every student in my class?" Instead of the onus for personalization falling solely on the teacher, however, consider the role of the student in personalization. The students may have great ideas about how to personalize assignments to their current jobs, classes, or future careers. Remember that not every assignment needs to be personalized. Some assignments should be completed word-for-word, step-by-step by every student so that every person has the same basic understanding of introductory material. Such knowledge-level activities, designed to help students remember content, are at the lower levels of Bloom's Taxonomy and may not lend themselves as well with personalization. Often, students must pick up the background knowledge about a subject before they have the big-picture perspective to be able to personalize anything. Admittedly, some subjects or projects may lend themselves better to personalization than others. Professors must embrace the discomfort of having students submit assignments that may look different than what the professor envisioned. Often students may submit assignments that are better than what the professor envisioned!

Having a high-quality rubric for any assignment that a student can personalize helps to reduce (unwanted or poor-quality) surprises with the end product.

Professors tend to approach differentiation in one of three ways—they may disregard it, adapt to it, or transform the process (Boelens et al., 2018). Professors who do not offer any customization in their assignments would fit under the *disregard* category, and professors who allow a great deal of differentiation/customization in their assignments would fall under the *transform* category. While neither end of the spectrum is "right" or "wrong," it is important to self-reflect and think about which end of the spectrum one currently falls.

Ways to Personalize

Professors must first decide, for a given project, if the format or the content is the most important piece for the students to master. If one matters much less than the other, then that is the area that may be best for personalization. For example, if a teacher's goal is for a student to learn a specific technology—say, Flipgrid—then the format matters, but the content (what the student discusses in his/her Flipgrid) doesn't. This professor can give the students agency in the topic, style, and presentation of the Flipgrid. A biology professor may want his students to learn the basics of mitosis—the content is non-negotiable—but the format in which the student relays the information about mitosis can vary from student to student. Modifying content may not always be possible due to industry standards, but professors can consider ways to modify their process and product to the benefit of the students (Pham, 2012).

Simple ways to personalize assignments are as follows. Professors can offer choice boards. These boards are like tic-tac-toe boards, and students must complete X number of assignments, of their choice, to submit for grading. For example, an instructor could allow a student to demonstrate mastery of a topic through writing a poem, drawing a poster, creating a PowerPoint, writing an essay, filming a video, performing a skit, making a brochure, making a children's book, etc. The student could choose three of these activities (each of which has a well-developed rubric) and submit the artifacts that s/he finds most relevant, interesting, or relatable. Even on a single assignment, such as a paper or discussion board, students can choose a prompt to which to respond, offer their own prompts, or include a section about how the subject material relates to their lives or future/current careers. Campbell and Cox (2018, p. 11) noted that "digital video was an authentic and personalized learning experience that fostered personal choice and voice and peer collaboration." When students have agency in their assignments' parameters, they feel more competent, autonomous, and related to the group (Danley & Williams, 2020). When preservice teachers have professors who provided differentiated learning experiences, they themselves are more likely to differentiate to their own students when they enter their own classrooms (Joseph et al., 2013). Marghitan et al. (2016) note that students' intrinsic motivation and final grades increase when the students are offered choices in workshop and lab opportunities.

Examples

The authors of this paper both teach primarily graduate-level students in instructional technology classes. Many of their classes are project-based, and the majority of the students work full-time and attend school part-time. It is the goal of the professors to have the students create artifacts that demonstrate specific competencies that they can use in their daily jobs as opposed to assigning “busy work.” Here are some specific examples of assignments they use in their classes that allow for customization or personalization from the students.

EFD 552: Diversity in the Classroom

This class helps current and aspiring teachers understand the backgrounds, needs, and strengths of children from diverse upbringings. Students create a Schoolwide Diversity plan for their capstone requirement. In this project they use findings from scholarly research along with data from the school at which they work to identify underachieving student subgroups and present ways their school can better address these student needs. They author a paper, create a PowerPoint presentation, and record a screencast of them presenting their ideas to stakeholders where they discuss their ideas. They are encouraged to share their findings with principals, fellow teachers, parents, school boards, and other stakeholders so that their carefully researched suggestions might be considered for implementation locally, leading to positive change at their schools.

EIM 504: Learning Through Interactive Technologies

This class is project-based, and students experiment with different emerging or established educational technologies. Each technology learned is then related by the student to a standard they teach, or an ISTE standard. Since students have varying proficiency levels, more advanced students are allowed to explore technologies not covered in the class so that they are still learning new things. Students are encouraged to incorporate their certification field, grade levels, and school policies into all artifacts.

EIM 505: Digital Literacy in the Classroom

In this class, current and aspiring teachers learn how to evaluate digital sources, implement them into their classrooms, and teach their own students how to think critically. Students “choose their own textbook” for the class from a list of popular nonfiction books. They select an Alabama Virtual Library database of choice to teach to classmates, and they curate digital literacy resources in a class wiki and post to a shared class blog. Each student brings his/her own knowledge and expertise to these tasks and takes ownership for passing that knowledge along to other class members.

EIM 517: Designing Virtual Learning Spaces

Students in this class design, built, and deploy online courses in a learning management system. They get to choose their topics, subjects, grade levels, etc. For those who are current teachers, they can use existing assignments, or they can use this class as an opportunity to also create new assignments more suited for the virtual or blended environment. Ideally, the students will take what they created in the class and deploy it in the near future to “live” students, especially relevant in the era of pandemic teaching.

EIM 555: Instructional Design

This class covers high-quality design standards, whether in-person or online. Students pick a passion project unrelated to K-12 teaching and design, from the ground up, a complete mini-class on the topic. Students produce Gantt/PERT charts, infographics, rubrics, lesson plans, objectives, needs/task/learner analyses, and more. By having the students pick a fun, "non-school" topic, they can remove preconceived notions about lesson planning and focus on creating a high-quality instructional project based on something they love, such as travel, baseball, or gardening.

EIM 610: Emerging Technology and Collaborative Tools

This class is for students earning their educational specialist degrees. All students are current fulltime teachers across various disciplines. They research podcasts, assemble social bookmarks, and create YouTube channels about their discipline and share their findings with the class. They learn to differentiate among low-, mid-, and high-tech solutions in their discipline, and they train other students about technologies specific to their discipline.

UH 101: Priming Students for Study Abroad

This class is taught to college freshmen and sophomores and is intended to support first-generation college students, or those who have traveled little, in their quest to become study abroad participants. During the class, students plan/budget domestic and international trips. They complete a study abroad application and a study abroad scholarship application based on their ideal study abroad location. They choose 2-4 activities offered around campus that get themselves out of their comfort zone (such as trying a cardio fitness class, attending a lecture on a topic they wouldn't normally find interesting, or taking an Uber); complete these activities; and reflect upon them.

General Ideas for Personalization/Customization/Extension

In any class, students who author exceptional papers can be encouraged to submit them for publication. This leads them to investigate journals in their field and become more involved professionally. With interview assignments, allow students to pick their own interviewees and craft their own questions. Consider a statement in syllabi to the effect of, "If you have a better idea/way to approach/implement this, suggest it for approval!" If students in your classes are already experts on a specific unit, engage their help in teaching the unit, tutoring others, or demonstrating practical applications of the topic. In some classes, students who already possess mastery of a unit can design their own alternative learning experience and submit it for approval.

Roundtable Questions

The following guiding questions will serve as a starting point to promote discussion at the roundtable. The session will be designed to solicit input and engagement from the attendees, as we value their input and look forward to hearing ideas about how they customize or personalize assignments in their own classrooms. The roundtable will be a springboard of ideas and also serve as a "genius hour" of sorts as like-minded professors share personalization strategies that they use in their own classes.

1. Please share with the group any ideas you have about how to customize or personalize class assignments.
2. What classes or subjects do you think work best with customized assignments? What classes do you feel would be difficult to allow personalization in assignments?
3. What pros or cons do you feel exist with this style of teaching and assessment?
4. Brainstorm ways that a professor could offer personalized or customized assignments in the "difficult" subjects.
5. Brainstorm how you can give fewer multiple-choice tests in favor of more authentic, personalized assignments.

Conclusion

Although examining the literature regarding customized and personalized learning is useful, it is also very beneficial to have face-to-face discussions with professionals in the field. Learning what others do well, and then seeking to do it oneself, is a way that professors can increase their scholarship of teaching. Using guided questions, this roundtable will provide a forum for these conversations.

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A Project-based Experiential Learning Approach To Cybersecurity And Biometrics

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Abstract

In this case study of a course on Cybersecurity and Biometrics, we explore the effectiveness of project-based learning using a makerspace combined with the 5E Instructional Model. We describe the course design and its objectives, the project itself, and the makerspace facility where students undertook the project. Using a pre- and post-project student survey, we examine changes in student perceptions over the course of the project. We uncover some interesting insights relative to the use of a project as a learning tool in technical courses such as this, particularly regarding pedagogy, teamwork, incorporation of a makerspace, and online learning.

Section 1 - Introduction

A Cybersecurity course is challenging to teach and learn. Bridging the gap between theory and practice is problematic due to its abstract and highly technical content, and online teaching adds to this complexity. With this in mind, we conducted an experiment using a makerspace for experiential learning in conjunction with a project-based approach and the 5E Instructional Model to bring theoretical concepts in a Cybersecurity Biometrics course to practical implementation.

To study the effectiveness of our experiment, we used a case study approach where 35 students in an online Cybersecurity Biometrics class were grouped into teams for a semester-long project to integrate theory and practice by building a working prototype of an optical fingerprint reader using a Raspberry Pi, an Internet of Things (IoT) camera, a glass prism, the National Institute of Standards and Technology (NIST) Biometric Image Software (NBIS) modules, a database, and a 3D printed case to integrate these components. Each team followed project management processes and designed their own 3D case, database and program interface. The makerspace provided students the opportunity for ideation, prototyping, learning from failure, and creativity. Pre and Post surveys, employing a modified 7-point Likert Scale ranging from Strongly Disagree to Strongly Agree, were used to explore our research questions and assess the effectiveness of a makerspace project-based experiential learning to teach cybersecurity and biometrics concepts through an online modality.

In section 2 of our paper we review principles and related work on the 5E Instructional Model, project-based learning, and the utilization of makerspaces as a learning tool. Section 3 describes the methods and details our approach with 5E, project-based learning and structure, technical specs and biometric concepts of an optical fingerprint scanner, makerspace lab resources, and pre/post-survey sections. Pre and post survey data of key results and analysis is discussed in section 4 and section 5 contains a brief conclusion of our study.

Section 2 - Related Work / Literature Review

Instructional models are effective at helping students learn STEM concepts through inquiry and experimentation (Bybee, et al., 2006). The 5E instructional model consists of Engagement from prior experiences, Exploration through inquiry of past knowledge, Explanation of what the student understands, Elaboration of understanding through new experiences, and Evaluation of the student's own understanding. The BSCS 5E Instructional Model was developed in the late 1980s and have been used broadly and effectively across multidisciplinary STEM curriculums and professional development (Bybee, et al., 2006).

Research and case studies on the utility and implementation of the 5E model have been shown to be effective in many disciplines and settings such as teaching Physics and Newtonian mechanics to over 150 undergraduate students (Bahtaji, 2021); at the elementary and middle school levels to teach STEM, buoyancy force problems (Çepni & Şahin, 2012), mathematical modeling of geometric objects (Tezer & Cumhur, 2017), or exploration of concepts and solutions of STEM problems affecting local communities (Bybee, Using the BSCS 5E Instructional Model to Introduce STEM Disciplines, 2019); online hybrid teaching modality for Special Education Teachers (van Garderen, Decker, Juergensen, & Abdelnaby, 2020); and at the graduate level in a Network Security course (Olimid, 2019). Although the latter represents an example of a successful implementation of the 5E Instructional Model for teaching Cybersecurity, this is a rare case study because the 5E Model has not been widely researched or applied in teaching Cybersecurity shown by the limited published research.

Project-based Learning provides a structure, processes, and workflow for students to gain deeper knowledge through creative and critical thinking, and manage uncertainty with real-world problems through communication and teamwork while learning professional skills (Anazifa & Djukri, 2017; Johnson, 2019). This approach is commonly used in teaching Cybersecurity. It keeps students engaged, focused on specific tasks, and directs the learning process through the development of diverse solutions to real-world problems (Sherman, et al., 2019).

Makerspaces are venues for carrying out do-it-yourself (DIY) activities. They typically are home to various machines and hand tools, including 3-D printers, laser cutters, vinyl cutters, vacu-formers, sewing and embroidery machines, among others, and laptop or desktop computers with design software. In the education realm, they are used to give students the opportunity to engage in ideation and to build prototypes, as part of a project-based learning component of a given course. As of 2020, there were over 2,300 makerspaces globally (hackerspaces.org, 2021).

Makerspaces are the physical manifestation of the maker movement, considered by some to be the most important economic movement since the Industrial Revolution (Anderson, 2012). It represents a migration away from mass production in factory facilities to small-scale manufacturing often by end users. Makerspaces have been found to promote creativity and innovation and makerspace projects frequently lead to new business startup (Halbinger, 2020).

Section 3 - Methods

Section 3.1 - 5E Instructional Model

The 5E instructional model was used an online asynchronous Cybersecurity Biometrics class. Lectures on fundamentals of biometrics were delivered through Zoom sessions. These lectures were used to engage the students through discussions of project management, computer science and cybersecurity topics such as teamwork and communication; the security triad of Confidentiality, Integrity, and Availability (CIA); Authentication vs Authorization; Identification vs Verification; programming languages/libraries; and databases. These discussions also provided an opportunity for the students to explore their understanding of computer science and cybersecurity concepts from previous classes and how these can be applied to the assigned project. At the end of the semester students were required to produce a written report with analysis of their project results and provided a presentation to the class. This process allowed them to explain their understanding of the cybersecurity and biometric concepts and elaborate on their newly acquired insights based on the analysis of the project results. Evaluation of the student's own understanding occurred as other groups presented their report and analysis of their project and the students were able to compare and contrast their personal understanding with that presented by their classmates.

Section 3.2 - Project-based Learning and Teaching

In this case study, students were instructed to form groups of four or five and were provided detailed project instructions to create a structured project approach. Instructions included coming up with a team name, selecting a team leader, identifying student's technical skills, defining roles and responsibilities, creating a schedule of tasks and timelines, and agreeing on a communication plan and meeting frequency.

Defining a team name to help enhanced their perception of identity and belonging to a group. Students approached this project with a competitive spirit; this was an unexpected side effect observed through student comments throughout the semester and during the presentations. They also showed pride in their project solution during the presentation by sharing personal experiences on how they overcame specific challenges.

The selection of a team leader is an important step to define roles and responsibilities and create an organizational structure to manage the project. The team leader managed project tasks schedule and communicated with the team and the stakeholder (instructor). Team members helped define the expected timeline and effort to foster a sense of responsibility and ownership. Team leaders were tasked with identifying each team member's technical skills and defining their roles and responsibilities. This is a critical step in the team formation to ensure everyone in the team understands their contribution and what the team expected of them. This approach was derived from the organizational development literature on team building, and particularly the work of Richard Beckhard (Beckhard, Optimizing team building effects, 1972) (Beckhard & Harris, Organizational transition: Managing complex change, 1987). Beckhard was the co-developer of a model for team building called GRPI (goals, roles, processes, and interpersonal relationships), which he asserted were the keys to successful and high-performing teams. Team leaders met biweekly with the instructor for mentoring on technical challenges, team dynamics, and share ideas and provided a written progress status.

Section 3.3 - Cybersecurity, Biometrics, and Optical Fingerprint Reader

Each team was instructed to design, develop, and implement a Biometric System for an optical fingerprint reader. Students were introduced to the concepts of biometrics and key factors that makes a biometric system functional and secured through a series of online lectures. Students were provided a project description to guide them through a set of requirements and asked to be creative and design a working prototype that is technical, functional, and secured.

The National Institute of Standards and Technology (NIST) Biometric Image Software (NBIS) is an open source biometric software that can be used to analyze scanned fingerprint images for image quality, minutiae detection, classifications, and generate fingerprint matching with a low rate of False Acceptance Rate (FAR) and False Rejection Rate (FRR). This software was developed for the Federal Bureau of Investigation (FBI) and Department of Homeland Security (DHS) (Ko & Salamon, 2010). Students used this open source software to match captured fingerprints and perform their statistical analysis.

Packages containing a CanaKit Raspberry Pi 4 Model B with 4GB of RAM, 32GB MicroSD card, a 250GB USB drive, a 1.25” x 1.25” prism, and an autofocus camera attachment were supplied to each student. Detailed instructions were given on how to assemble and connect the Raspberry Pi to the autofocus camera. The Raspberry Pi OS (32-bit) version was downloaded and installed in the MicroSD card and the 250GB USB drive was used to store the NBIS libraries, programs, and database.

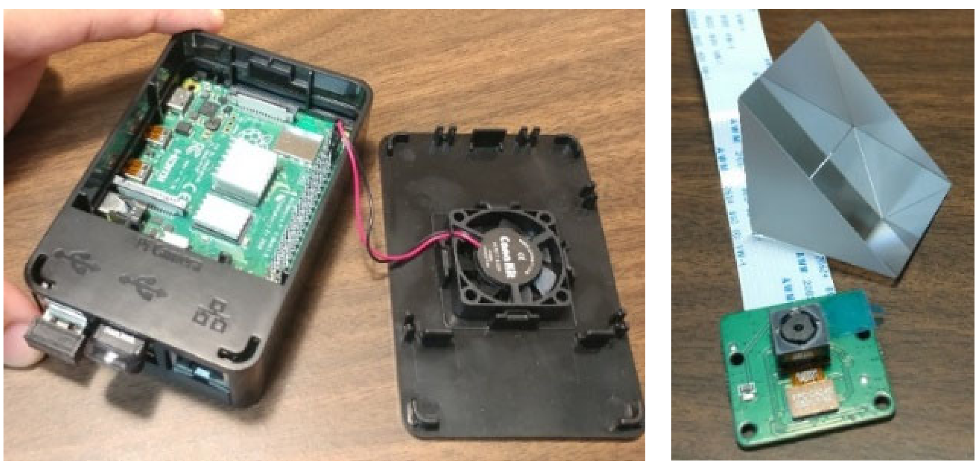


Figure 1 - Assembled Raspberry Pi 4, prism, and autofocus camera

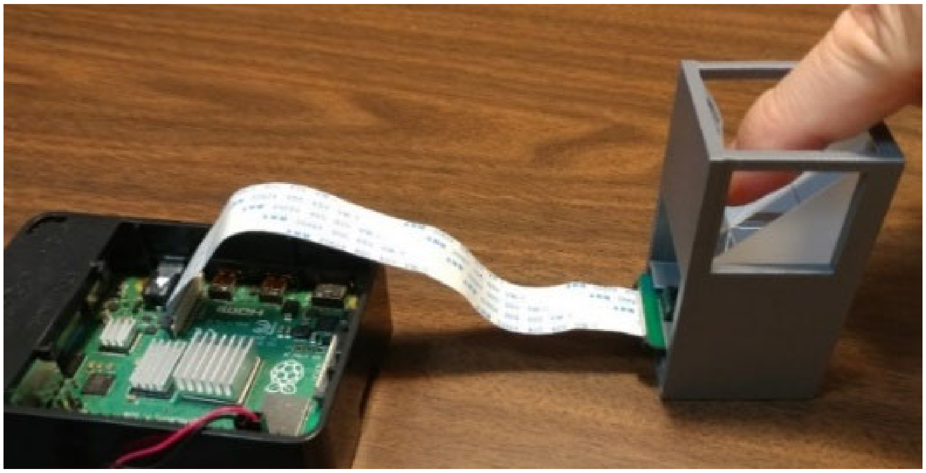


Figure 2 - Raspberry Pi optical fingerprint scanner

Section 3.4 - Makerspace

The Hatch It! Lab makerspace at the Center for Innovation and Entrepreneurship at the University of Tennessee Chattanooga served as an ideal space for prototyping the fingerprint reader. It houses six 3-D printers and the requisite design software for their operation. The makerspace is staffed by trained student workers, called Makerspace Managers, who troubleshoot, provide assistance in using the equipment, and police safety protocols. Students in this course received required training in the safe use of the makerspace.

The makerspace is not merely a place to build a prototype. It is a safe space for experimentation. Students were able to fail in their efforts, reflect on what went wrong, and pivot to test a new approach. In this way, both the principles of the scientific method and the necessity of having an entrepreneurial mindset could be taught simultaneously.

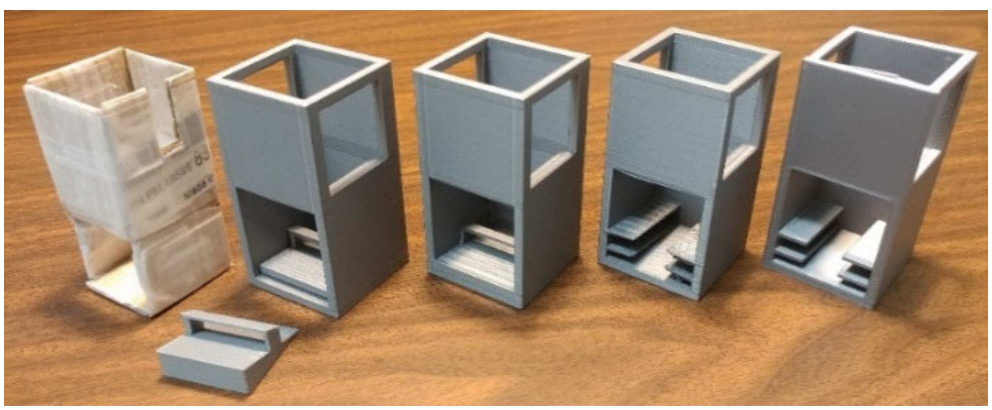


Figure 3 - Prototyping progression from cardboard to final 3D case

Section 3.5 - Online Learning

This course was taught during the spring of 2021 with an online synchronous modality due to the constraints imposed by COVID-19. Weekly class meetings were conducted over Zoom twice a week. Teams often met online to work on their design, presentation, and report. They occasionally met face-to-face on campus at the makerspace lab to print their 3D design and discuss improvements.

This online modality was challenging for the students and instructor. Difficulties included coordination, communication, and meeting to collaborate in the project. A major contributing factor to these challenges was credited to the online component and inability to have impromptu meetings before or after class because students were not physically in the same room.

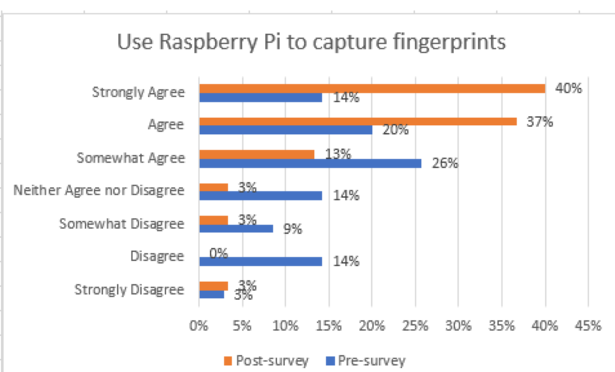
Section 3.6 - Pre and Post-Surveys

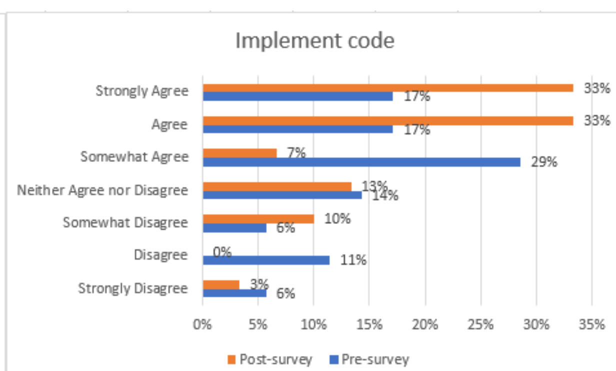
In order to better understand the impact of our approach on learning of the students in this cybersecurity course, an anonymous pre- and post-survey was used to bookend this case study. The pre-survey sought to derive student perspectives on several topics prior to beginning the project. The post-survey had the same set of questions plus several additional sections with a slant on post experience and lessons learned. These additional sections were added to gather data on the student's learning process and perspective on cybersecurity concepts, online learning experience, makerspace experience, and open-ended questions. This method permitted us to gather quantitative and qualitative data on topics such as student's understanding of the learning objectives, teamwork, engagement, and demographics. A seven (7) point Likert scale was used to gather the quantitative data while specific questions and open-ended questions were designed to gather qualitative data. The class consisted of 35 students and 31 responded to the surveys. The pre-survey provided a baseline measurement and the post-survey data allowed for a delta analysis.

Section 4 - Results

Section 4.1 - Learning Objectives

The surveys show that student's confidence in their ability to meet the learning objectives to use the Raspberry Pi and the NBIS libraries to design a biometric system and 3D case to capture and analyze fingerprint images significantly increased by the end of the project. Most notable changes can be seen in the use of Raspberry Pi, code implementation, and use of NBIS libraries where it changed from 34% to 77%, 34% to 66%, and 29% to 74% in the agree/strongly agree ratings respectively. We also saw a shift in the 3D case design response from 11% to 43% in the strongly agree rating and can be attributed to increased confidence on themselves as shown by the changing numbers from pre and post-surveys in the somewhat, neither, and overall disagree ratings.





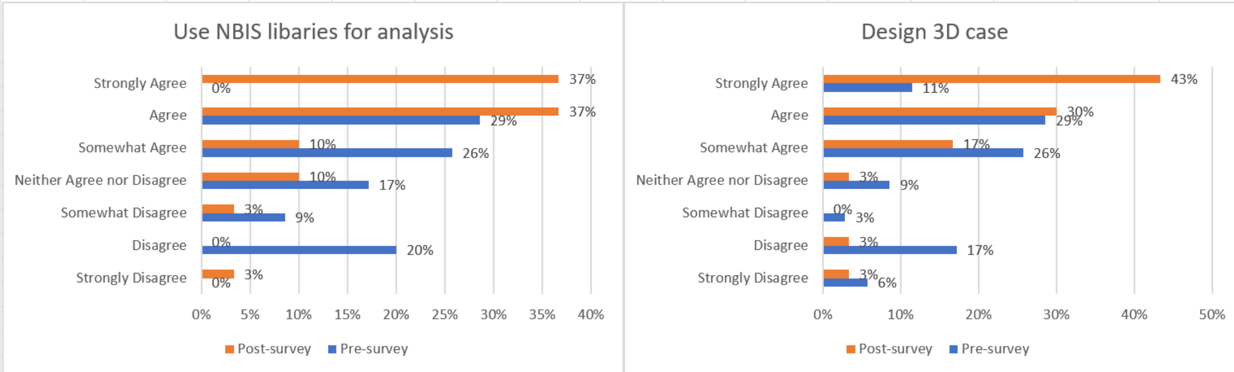


Figure 4 - Pre and post-survey Learning Objectives

Section 4.2 - Teamwork

In the pre-survey, students came into the project with a very strong positive perception of working in teams and their ability to do so effectively. Seventy-seven percent (77%) agreed (somewhat agree, agree or strongly agree) concerning the value of working in teams. The great majority of students saw themselves as potentially strong contributors to a team who would always come prepared and complete tasks on time (97% agreed). Students were almost equally confident in their ability to work well with teammates, understand the importance of team management (specifying roles and responsibilities), and understand the importance of communication in teamwork (94% agreed).

In the post-survey, students largely perceived that they worked well with their teams (70% somewhat agreed, agreed, or strongly agreed), and that team members worked well together (74% agreed); however, in both cases, 20% or more disagreed. Students perceived that they were strong contributors to their teams (83% agreed) and that they completed tasks on time (90% agreed). By smaller majorities, respondents perceived that their attitude toward teamwork had improved (53% agreed) and that their team's attitude had also improved (63% agreed); although, 23% disagreed that the team's attitude had improved. Most students felt that they came prepared (90% agreed) and worked well with their team (83%). Sixty-four percent of respondents reported a positive feeling of accomplishment working with their team.

While still positive, attitudes about teamwork in general, the ability to complete tasks on time, and being prepared all fell. It would seem that reality weakened perceptions of teamwork – its desirability and efficacy – to some extent. Overall, though, students were more positive than negative about teamwork at the end. Expectations for the power of teamwork can be inflated as individuals enter a project. Preparation by teams relative to establishing goals, roles, processes, and relationships may vary from team to team by the quality of the effort put into it. It is encouraging, however, that students concluded the project with a net positive attitude toward teams.

Section 4.3 - Engagement and Learning Experience

Student's views that this was a good learning experience and motivation/interest dropped from 94% to 80% and 88% to 67% in the agree/strongly agree rating respectively. This change could be attributed to their experiences and challenges in teamwork as discussed in the previous section. Another contributing factor could be their technical preparation prior to this course. It changed from 18% to 39% in the overall disagree rating. Despite these changes in the negative, 84% feel motivate to continue learning about biometrics, 73% felt this was a good and effective learning experience, 66% recommend this project, and 76% felt the level of effort is adequate. An 87% of students believe this project improved their theoretical and applied understanding of cybersecurity and biometrics while 93% believe their critical thinking skills improved.

Based on responses to the survey, students felt challenged by the project. For many, it was perceived to overtax their skillset. The anxiety produced by this challenge may have caused the drop off in the number of students who believed the project provided a good learning experience and was motivating for the rest of the course. Nevertheless, a significant majority of the class reported that they were more confident about meeting the course learning objectives after the project than they were before it began. Ultimately, two-thirds of responding students indicated that they would recommend a project like this one as a learning experience.

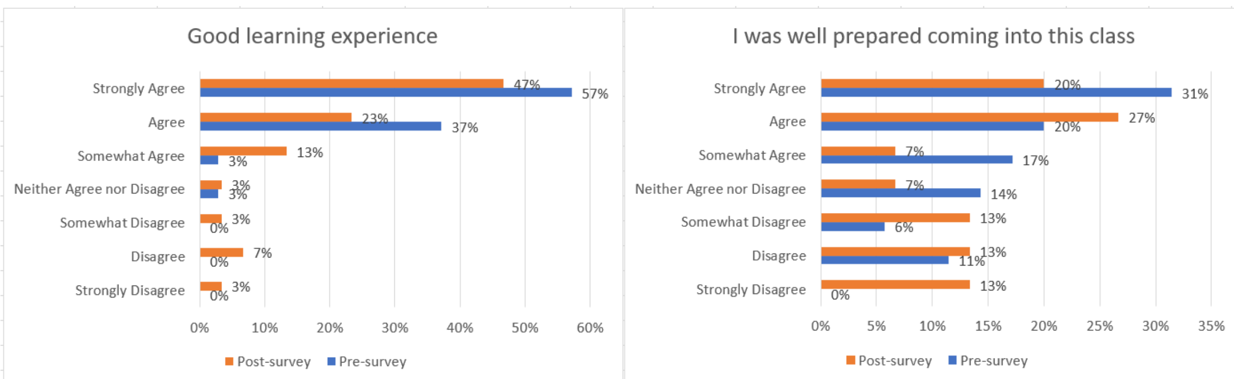
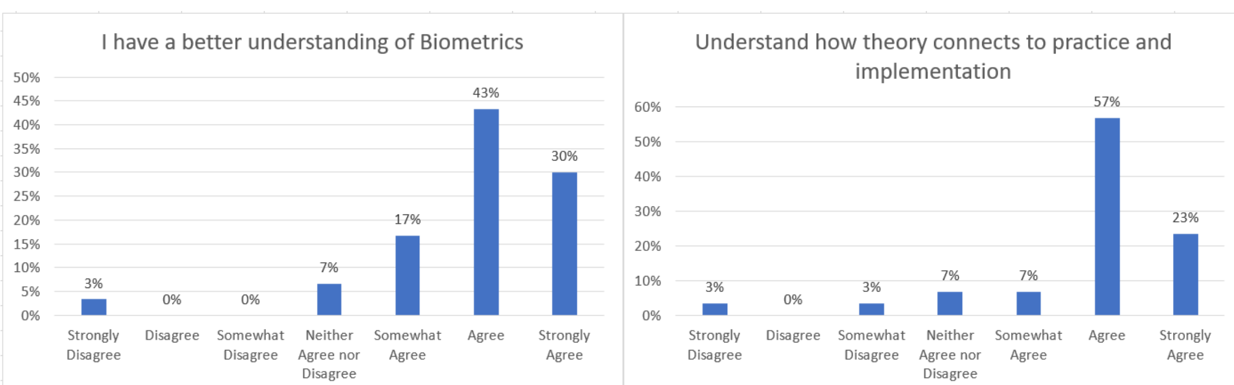


Figure 5 - Pre and post-survey Engagement and Learning Experience

Section 4.4 - Cybersecurity Concepts (Post-Survey Only)

Students were overwhelmingly positive in their responses associated with their understanding of biometrics and cybersecurity concepts after this project with 90% agreeing, 87% agreeing they understand how theory connects to practice and implementation, and approximately 90% agreeing that they understand key biometric concepts of enrollment, verification, identification, false acceptance rate, false rejection rate, and hamming distance. These responses support this type of project-based experiential learning.



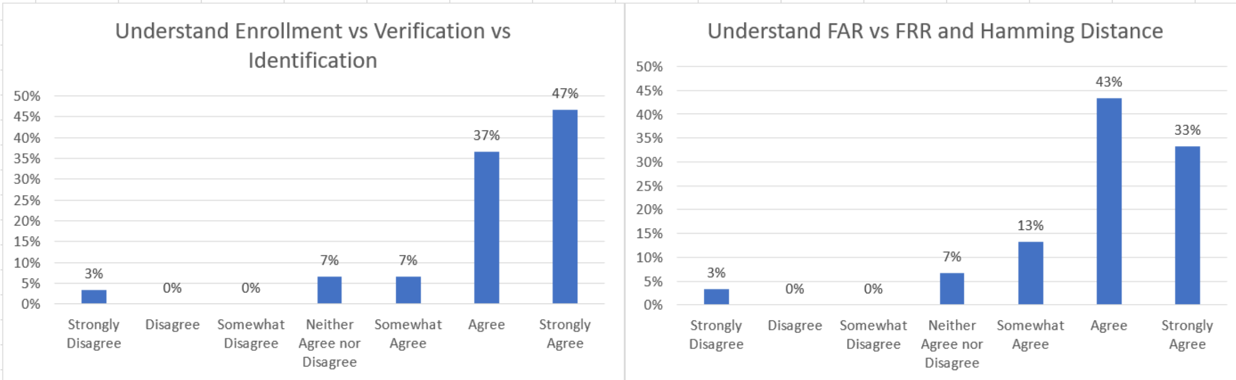


Figure 6 - Pre and post-survey Cybersecurity Concepts

Section 4.5 - Course Online Experience (Post-Survey Only)

Engaging students in online classes has been a challenge throughout the COVID-19 pandemic and 67% of respondents agree that online lectures through Zoom helped them stay connected with classmates, the instructor, and the course content while 77% agree that the project provided an opportunity to be an active participant in the online learning process. This online project-based experiential learning approach motivated 77% of the students to learn and research new cybersecurity topics and is in line with the reported 84% who felt motivate to learn about biometrics in section 4.3. When asked if they preferred this class be taught in a face-to-face modality, a surprising 40% neither agree or disagree while 47% agree. It could be argued that this was a good approach and delivery but further inquiries will help to clarify.

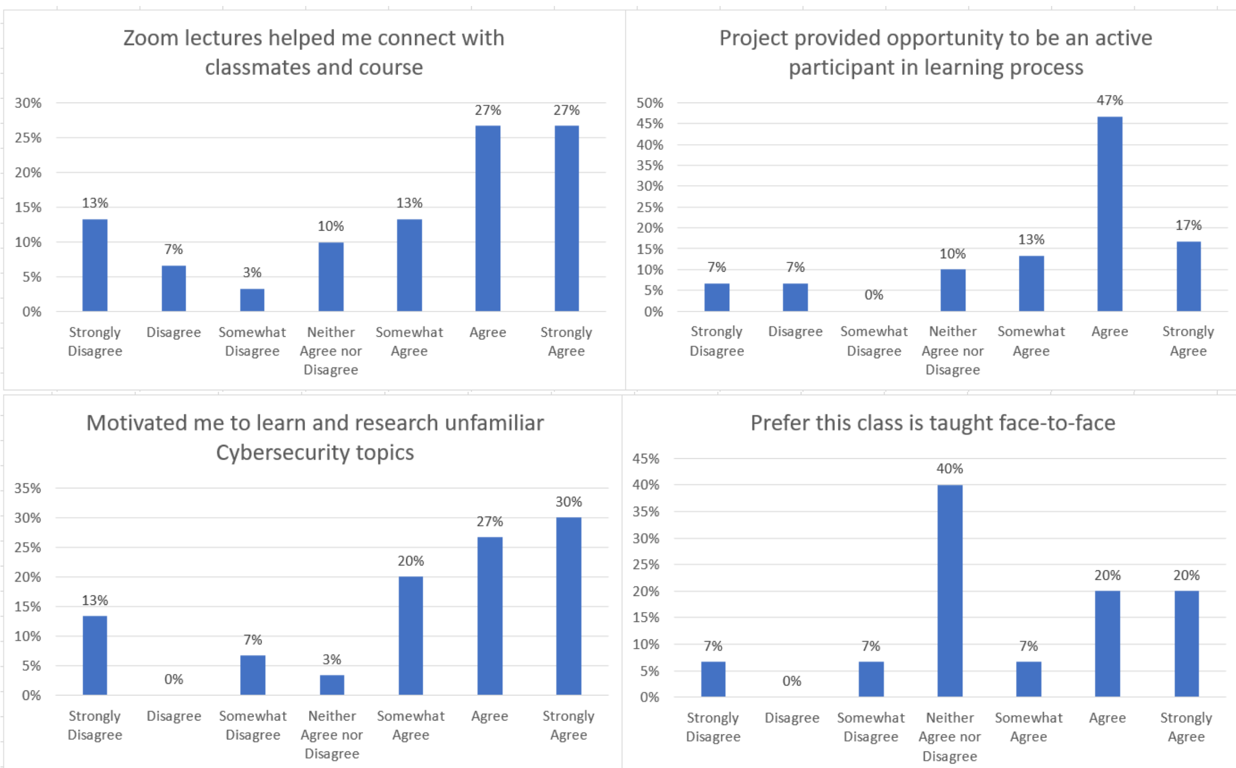


Figure 7 - Pre and post-survey Course Online Experience

Section 4.6 - Makerspace Experience (Post-Survey Only)

After the project, 87% of the responding students felt they understood the tools of the makerspace. Their makerspace experience caused 87% to conclude that they were well-prepared to bring creative ideas to a project, while 89% felt they were able to use resources effectively and efficiently. Seventy-seven percent of students felt that they effectively managed their time and that they were adequately prepared to deal with failure. Students were largely positive about their ability to share what they learned with others (80% agreed).

Over the course of the semester, it is clear from the survey that the students' perception of their understanding of the makerspace tools increased substantially. Most came into the course not having been exposed to a makerspace. Requiring them to spend time in the space, working with the equipment, paid off in increased self-efficacy. Several students indicated that they would actively seek opportunities to use the makerspace again in the future.

Interestingly, students' confidence in their ability to manage time, to be prepared for failure, and to share their learning and offer assistance to others all fell off when they were confronted with the reality of actually using the makerspace. It is likely that these students were not prepared coming into the course for the numerous failed experiments and resulting pivots this kind of work entails. Given their own struggles, it is possible that reaching out to others became a luxury they came to feel they could not afford. These are all useful lessons that engaging in experimentation in a makerspace can teach. It is probable that a second makerspace experience would change this result, as expectations would be adjusted.

Students' perceptions about being prepared to be creative and to use resources to create a project improved somewhat. Because of the challenges presented by working in a makerspace, these students appear to have learned that they are, in fact, creative and resourceful. These are empowering life lessons that extend well beyond the walls of the makerspace.

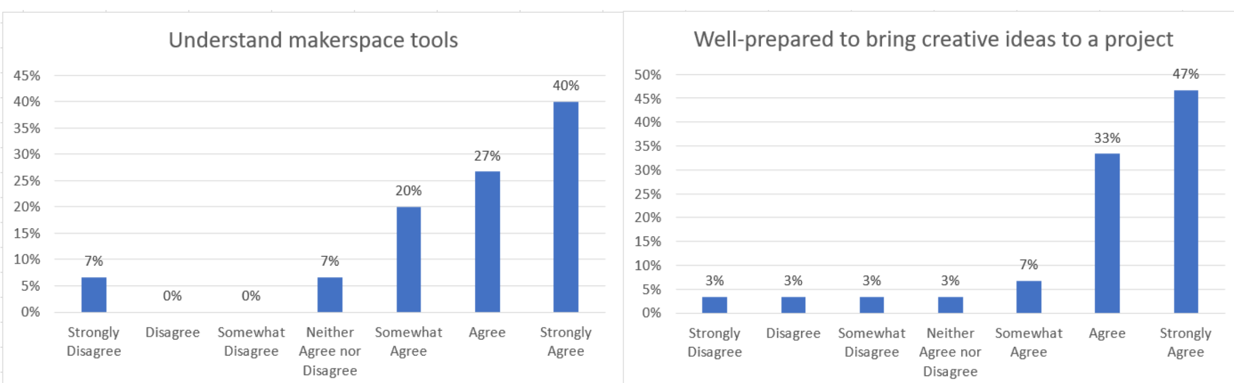


Figure 8 - Pre and post-survey Makerspace Experience

Section 4.7 - Open-ended Questions (Post-Survey Only)

Several open-ended questions were given in the post-survey to give students a chance to freely express their opinions and collect additional qualitative data. When asked on their impressions of this project and its ability to teach Cybersecurity and Biometric concepts, most responses were extremely positive and indicated that the project provided an excellent learning experience, helped them learn the material, and challenge their skills.

The responses were mixed when asked for suggestions to help improve the project. Several focused on more instructions, more deadlines, making it an individual project, and implementing more accountability. These reflect the survey results described in sections 4.2 and 4.3. Others responded that nothing was needed to improve on the project.

Students were also asked if they envision using the makerspace lab again and 90% responded yes. The majority planned on using it for personal projects while some for both personal and class related projects. Those who responded no indicated that they had their own 3D printer. The main tool and skill students learned from using the makerspace for this project was 3D modeling and printing.

Section 5 - Discussion / Conclusion

Our case study showed that despite the limited exposure to a makerspace prior to this project, students found it to be a useful learning tool and believe that this project provided them with a good experience and increased their confidence and understanding of cybersecurity and biometrics concepts. Students came into the project with some skepticism about teamwork, but the majority were positive about it post-project.

We conclude that our research and use of the 5E Instructional Model and makerspace project-based experiential learning approach has shown benefits, and it is effective at bridging the gap and increasing students' understanding of theoretical cybersecurity concepts and practical implementation. It is our intention to continue this study through several iterations of this course to build a dynamic database and allow for cross-course analysis.

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Investigating Online Instructional Strategies: Perspectives from Instructional Designers

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Abstract: Teaching and learning have changed dramatically since the 2020 spring semester. Designing online courses and moving face-to-face courses online have been drawing attention in every educational institution. This article analyzes the challenges that we encountered when designing online courses at Purdue University followed by the introduction of solutions that we investigated. The final section of the article provides suggestions for future course design and studies.
Keywords: Instructional design, online courses, instructional strategy.

Background

Teaching and learning have changed dramatically all over the world since the 2020 spring semester. The pandemic created both challenges and opportunities in online teaching (Adedoyin & Soykan, 2020). Courses that were taught in classrooms had to be moved online or delivered through a hybrid method (a combination of online class and in-person class). This notable change created tension for both faculty and instructional designers. It has also produced opportunities to explore methods to make online instructions more effective, efficient, and engaging. This article will review the challenges that we faced from an instructional designer's perspective and will discuss the methods, especially online teaching strategies, that have been investigated by the instructional designers in the course production team at Purdue University.

Challenges and Opportunities

In the past two years, the main challenges that faculty and instructional designers have encountered in our university can be concluded in three aspects. First, many faculty members did not have experience in teaching virtually, particularly fully online courses. There has been confusion on the concept of online teaching, and some faculty members were apprehensive about converting their traditional in-person classes to online class. Second, a wide range of instructors were not familiar with using learning management system (LMS). This situation became extremely complicated and increased tensions as our university started to move to a new LMS in January 2020. Finally, faculty members have expressed concerns about assessing online learning. One of the biggest concerns was how to maintain academic integrity in ways that are comparable to an in-person class assessment.

While working with faculty, instructional designers realized the second and the third challenges can be solved by providing workshops, consultations, and related technical support. However, it takes longer time and more efforts to overcome the first challenge, which is the lack of online teaching experience for many faculty members. Additionally, researchers pointed out most university faculty lack formal trainings compared to teachers and have been using more unofficial methods that they have been taught, such as in many STEM courses (Yang, 2017). They have been caught in more difficult situations while attempting to design online courses. Given this situation, designers worked together with faculty by analyzing online teaching phases. Similar to the methods of teaching traditional in person courses, online teaching includes three phases, which are planning instruction, delivery of instruction, and evaluation of student learning. Greater emphasis should be placed on the initial planning phase (Simonson, Smaldino, Albright, & Zvacek, 2012) due to the teaching strategies and evaluation plans needed to complete this phase. Instructional strategies refer to the methods instructors use to help students achieve learning goals (Smith & Ragan, 2005), and they are considered as critical factors that impact online teaching and learning (Fresen, 2005). Therefore, investigating online teaching strategies became one of the first steps in our course design process.

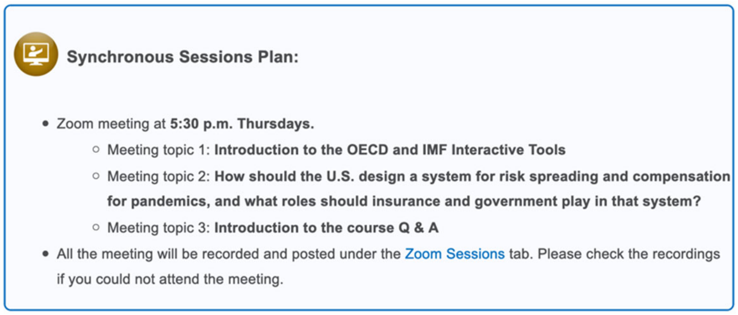
Investigating Online Instructional Strategies

Educators have discussed online instructional strategies and provided suggestions, such as encouraging student interactions (Miller, 2007), using student-led discussions (Simonson, Smaldino, Albright, & Zvacek, 2012), providing prompt feedback (Sorensen & Baylen, 2004), and adapting some methods that were proven to be successful in a traditional classroom setting (Simonson, et al, 2012). These discussions and suggestions inspired our investigation. While working with faculty, our designers adopted the backward design method (Richard, 2013) and followed three principles to choose/create instructional strategies, which are connecting the course activities, mapping the course content, and engaging class online. Each of these principles includes multiple strategies.

Connecting Course Activities:

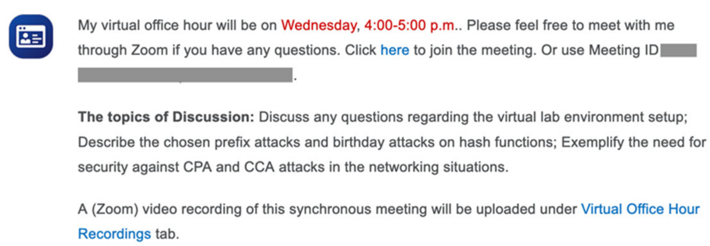
The most popular strategies that we have been using to deliver the content in fully online courses include using online discussion boards for class discussion, creating course Q & A (online discussion board) to encourage students asking question, recording lecture videos to guide learning, and providing synchronous session/virtual office hours. We noticed that these activities are usually designed independently to each other and often lack in connections between each other. For example, some faculty members complained that some students were working on the homework without watching lecture videos. One way we have solved this problem was to add in-video quizzes or after-video quizzes. Another way we tried was by connecting the lecture videos with online discussions. In other words, instructors could ask questions at the end of the video and students would be required to post their response on discussion board. The faculty noticed that the number of views on lecture videos have increased significantly after adopting this strategy and concluded this was a better way to assess learning progress.

In fully online courses, office hours also need to be held virtually. However, faculty members have reported that this is not as efficient as regular face-to-face office hours. Students seemed to be unwilling to ask questions using a video conference tool. The solution that we found was to connect the Course Q & A online discussion forum directly to virtual office hours. Students can choose to post their questions on the forum before office hours. Faculty review the questions and answer the ones that are easy to explain in the course Q & A forum and lead a deeper discussion on the more complex questions in the video conference. This method has reported to be extremely successful and resulted in a higher efficiency of virtual office hour usage. Therefore we kept working in this direction and added small element to the live (synchronous) classes. We encouraged instructors to post the topics and detailed plans of the live sessions on the course site to help online students better prepare for the live class and discussions. The following images show a synchronous session plan and a virtual office hour plan that have been posted on two different course sites.


Synchronous Sessions Plan:

- Zoom meeting at **5:30 p.m. Thursdays.**
  - Meeting topic 1: **Introduction to the OECD and IMF Interactive Tools**
  - Meeting topic 2: **How should the U.S. design a system for risk spreading and compensation for pandemics, and what roles should insurance and government play in that system?**
  - Meeting topic 3: **Introduction to the course Q & A**
- All the meeting will be recorded and posted under the Zoom Sessions tab. Please check the recordings if you could not attend the meeting.

Figure 1: Synchronous Session Plan.


My virtual office hour will be on Wednesday, 4:00-5:00 p.m.. Please feel free to meet with me through Zoom if you have any questions. Click here to join the meeting. Or use Meeting ID [redacted].

The topics of Discussion: Discuss any questions regarding the virtual lab environment setup; Describe the chosen prefix attacks and birthday attacks on hash functions; Exemplify the need for security against CPA and CCA attacks in the networking situations.

A (Zoom) video recording of this synchronous meeting will be uploaded under Virtual Office Hour Recordings tab.

Figure 2: Virtual Office Hour Plan.

Connecting course activities can also engage students in hybrid course settings. The instructors of a hybrid MBA course designed a group assignment for students to draft discussion questions based on the readings and learning resources in the first week of class. This assignment was required to be submitted before the end of the week. In the following week, students met in classrooms and each small group led the class discussion using the questions that they drafted in the assignment. This was reported as a very effective way to engage hybrid students and we are planning to adapt this strategy for future fully online courses.

Mapping Learning Objectives

Instructional design should follow a well-organized procedure that provides guidance to instructors and students (Simonson, Smaldino, Albright, & Zvacek, 2012). For instructors, one way to organize the course materials is to create clear course outcomes and unit/module level learning objectives. Learning objectives are described as statements that explain what students should be able to do after they have completed a segment of instruction (Smith & Ragan, 2005). Well-written learning objectives are specific, measurable, and can provide a clear road map of the course content and assessment.

Learning objectives not only help faculty organize course content but also helps to improve learning. In traditional in-person class, stating learning objectives in class is considered to be an effective teaching strategy (Englert, 1984). Research shows explicitly linking learning objectives and class activities helps motivate and engage students (Reed, 2021). In addition, sharing learning objectives with students in each lecture and aligning objectives with assessments helps increase student academic performance (Englert, 1984). Research studies shows that students consider the list of learning objectives as the most helpful component of a lecture (Armbruster, Patel, Johnson, & Weiss, 2009).

In both online and in-person course design, we tried to map course content starting with helping faculty create two levels of learning objectives: the course level learning outcomes and the weekly module level learning objectives. For example, in a computer science course, course level objectives are listed under course introduction page and the module level objectives are listed under each lecture video and assignment. The following image shows the connections between module level learning objectives and lecture videos.

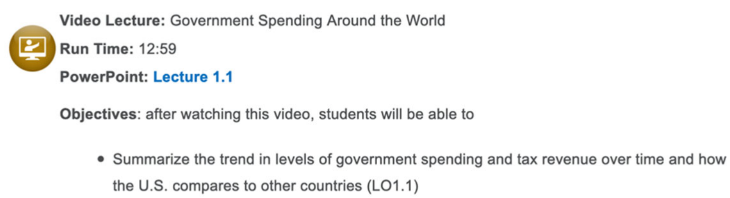


Figure 3: Learning Objectives

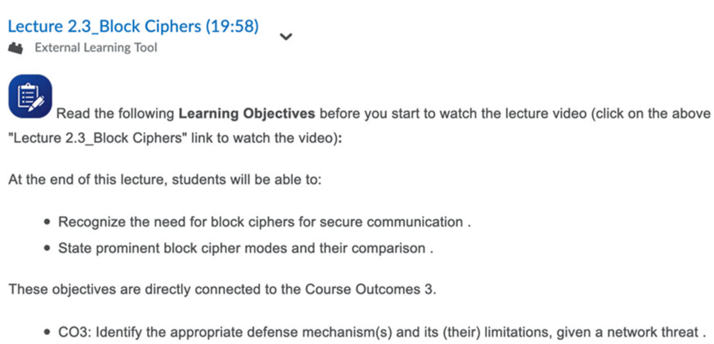


Figure 4: Learning Objectives and Course Outcomes

Adapting In-person Class Activities for Online Courses.

As mentioned earlier, many strategies that have been successfully used for traditional in-person classes can be adapted for online courses (Simonson, Smaldino, Albright, & Zvacek, 2012). Research shows that many methods can help improve learning efficiency in traditional in person classes such as group work (Chad, 2012), case-based class discussion (Mackavey, & Cron, 2019), project-based learning (Langer-Osuna, 2015), and flipped classroom (Zheng, Bhagat, Zhen, & Zhang, 2020), etc. In addition, the Seven Principles (Chickering & Gamson, 1987) of good practice in undergraduate education have been proven to be successful in traditional in-person classes. These principles are:

- 1. Encourage contact between students and faculty
- 2. Develop reciprocity and cooperation among students
- 3. Use active learning techniques
- 4. Give prompt feedback
- 5. Emphasize time on task
- 6. Communicate high expectations
- 7. Respect diverse talents and ways of learning (Chickering & Gamson, 1987, pp.3)

In the past 20 years, these principles have been adjusted to fit online education (Sorensen & Baylen, 2004). The strategies that focus on student center learning and incorporate communication and interactions are considered the most successful methods (Miller, 2007; Simonson, Smaldino, Albright, & Zvacek, 2012). While designing online course instructional strategies, we adapted the seven principles for online courses and focused on encouraging communication. The following table shows the specific strategies that we have been using in online course design.

Table 1
Online Course Instructional Strategies

Seven Principles	**Adapted Instructional Strategies for Online Courses**
Student -faculty contact	• Set up Course Q & A forums under discussion boards. In many courses, the faculty only chose to set up Q & A forum for each module. • Provide weekly virtual office hours using video conference tools • Provide synchronous class sessions using video conference tools
Collaboration among students	• Set up self-introduction forum and random topics forums under the discussion board • Assign online group discussion questions and encourage online communication • Set up group projects and homework • Use peer evaluations to encourage participation
Active learning	It refers to giving students opportunities to think about a topic and respond to learning content (Sorensen & Bylen, 2004), such as case study analysis and structured discussions (Simonson, Smaldino, Albright, Zvacek, 2012). • Create virtual presentation homework • Utilize peer evaluation and critique • Create simulations or case study projects • Connect online discussions with live classes to improve deeper understanding
Prompt feedback	• List feedback turnaround time on syllabus and course site • Host virtual office hours to answer questions

Time on task	• Clearly list due dates on course site • Use checklists to help students manage their time • Use weekly task lists to remind current learning tasks
High expectations	• List extra reading and learning materials for students who would like to explore more relating to specific topics. • Encourage students to explore more if they are interested in any topics that are covered by the learning materials.
Respect for diverse talents and ways of learning	• Create self-check quizzes and review documents/resources to help students review the content that have been previously covered. (These activities won't count for the course final grades). • Provide options on the assignment topics for students to choose, especially on the final project (For example, the final presentation can be pre-recorded, present in a synchronous session, or other options such as a term paper) • Record virtual office hour meetings and live sessions and upload them to the course site for students who did not attend • Provide a wide variety of instructional strategies to meet students' needs.

Conclusion

Working together to solve the challenges that we encountered in online course design helps faculty realize that the key concepts to successful online teaching and learning are in the design, development, and delivery of instruction (Dempsey, & Van Eck, 2007; Kidd, 2005; & Simons, Smaldino, Albrigh, Zvacek, 2012). In addition, with a high-quality instructional design, online learning can be just as or more effective compared to traditional learning (Colvin, Champaign, Liu, Zhou, Feredricks, & Pritchard, 2014). The three principles and the related strategies that are discussed in this article focus on engaging online student and encouraging communication, which is considered as one of the most important principles for online teaching (Sorensen & Baylen, 2004). However, the effectiveness of these strategies is greatly impacted by many other factors, such as the course content, the way faculty diver the course, and student motivation. We would like to see more studies on the effectiveness of these specific strategies in the future.

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Big Data Visualizations Through MongoDB For Precision Medicine In Medical Education

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Abstract

The importance of precision medicine is increasingly being recognized in healthcare. Precision medicine is driven by patient data and physicians' diagnoses in a comprehensive manner that considers the uniqueness of individual patient where each patient is a partner in the whole process. Big data analytics can provide a means to analyze and interpret healthcare data in a manner that can be quickly implemented in patient care because the available data is not structured in the way traditional databases are. There is growing interest by physicians to take advantage of big data analytics. However, limitations in deciphering and interpreting this data by healthcare professionals has impeded implementation of this technology. Most off-the-shelf software do not provide step-by-step instructions needed for a physician to understand big data analytics. In this paper, we provide a way to create big data visualizations through MongoDB with upload & download capability on web repositories. Keywords from PubMed were integrated to provide data visualization using the MongoDB programming thereby providing a unique solution for the issues that healthcare providers face in their understanding of the big data. The web repositories with big data visualizations for precision medicine will provide healthcare professionals and specialists a readily accessible platform for efficient diagnosis and care. Recommendations are provided about patient documents and visualizations, which will provide a thorough understanding of the data, knowledge sharing, collaboration, help in medical education and efficiency to healthcare providers.

Keywords: big data visualization, mongodb, precision medicine, web repositories

Introduction

The history of precision medicine dates back to 1960 (Jane, 2002). However, the term "personalized medicine" first appeared in published works in 1999 (Managed Care, 2011). This term was revived through the Personalized Medicine Initiative (PMI) by President Obama in 2015 during his State of the Union address. The traditional one-size-fits-all approach with patients' diagnoses needs to be improved, as it lacks the inclusion of the latest technologies and collaboration. Precision medicine provides a newer approach to patients' diagnoses that is affordable and provides an opportunity to consider other important factors, such as genes, environment, and ethnicity which could provide useful information for the treatment (Dhawan, 2016). One reason why precision medicine is uncommon in routine practice is because analyzing big data is complex and beyond the scope of most physicians. In a 2020 Health Trends Report done at Stanford University with 523 physicians, 44% of them said their medical education was "not very helpful" or "not helpful at all as it applies to the emerging data related technologies (Stanford Medicine, 2020). This response came in the context of the latest data driven technologies for healthcare. The same report pointed out the fact that the majority of the physicians were open to the latest technologies dealing with data and thought it was essential for their decisions on healthcare. However, the challenge is in the understanding and use of the latest technologies that could be used in healthcare

There is enough evidence about the need and the importance of precision medicine and big data analytics (Jain, 2002 & Stanford Medicine, 2020). The problem lies when the physicians do not have sufficient skill sets to understand big data and its analysis as it is beyond the reach of most physicians. While a good percentage of physicians are going back to school for further training on the latest technologies, it might not be possible for every physician to do the same. Big data analysis through an easy-to-understand software might be a solution for those who do not have time to go back to school. This paper presents the methodology for the design of such a software through big data analysis using MongoDB visualizations. It is critical that the physicians who would utilize such a software-are able to understand the patients' data and create visualizations without learning all the technicalities of MongoDB. A concept of web repositories is also presented in this paper, demonstrating that visualizations could be stored for collaboration among other physicians, healthcare professionals, and big data experts – we call them a "team" of precision medicine in this paper. Such a "team" can benefit enormously through an easy-to-understand software which is designed for an average layman person and not for IT experts.

Methodology

The main topics of this paper include patients' documents processing, extraction of the data from patients' documents into JavaScript Object Notation (JSON) format, the storage of JSON into big data using MongoDB, the creation of visualizations using Python programming language, and the upload and download capabilities of the proposed software to an intranet web repository using Python. While JSON, MongoDB, Visualization, and Python are done by an IT expert – it does not have to be learnt by a physician. The physician is an end user of the software that used these technologies. These technologies are currently used by big data on daily basis (Agrahari1 & Rao, 2017). There are so many technologies which are out there to process medical data, however, it needs a bridge building between the IT experts and the medical community.

Only then, the potential of these emerging technologies could be utilized benefitting the humanity. A software approach proposed in this research is the solution.

The process of the proposed software presented in this paper starts by finding patients who would be interested in participating in a collaboration program similar to *All-of-Us* (NIH Homepage, 2020). The patients sign a consent form and provide the relevant information needed by physicians on the team. It is suggested that a big data analyst/s, such as a MongoDB expert is hired by a healthcare organization's team depending on its size. In May 2018, the *All-of-Us* Research Program was declared and funds were allocated to collect the whole-genome sequencing of 200,000 people per year (NIH Homepage, 2020) . After the patients sign consent form to become a partner in a program like *All-of Us*, the patient data is collected by his or her healthcare provider and stored in documents of history and physical exams, operative notes, discharge summaries and outpatient clinic visit notes (NIH Homepage, 2015). This document is then provided to a MongoDB expert. The MongoDB expert extracts the pertinent big data in consultation with the physicians who are on the team of precision medicine. MongoDB uses a JSON type description, which is based on key-value pairs. A sample big data obtained from a patient's document could be like figure 1 (NIH Homepage, 2015). A similar approach in storing big data as JSON format into MongoDB has been proposed previously by other authors as well (Messaoudi, Fissoune, & Badir, 2018). JSON is widely used in the IT industry for many text related data. In the past, XML was a choice for small to medium size data but JSON has more usage in the modern IT software.

```
{
    Id : 123456789
    Age: 59
    Gender: M
    Ethnicity: Black
    Marital_Status: Married
    Location: Denver
    Physical Activity: Yes
    Pain_Scale: 5
}
```

Fig. 1. A sample JSON format for the data extracted from patients' documents and stored in MongoDB

JSON is a popular format used in web and database related software technologies. MongoDB is a NoSQL (Not-only SQL) database management system used for documents. Traditional database management systems lack the capabilities to handle documents' attributes (Messaoudi, Fissoune, & Badir, 2018). Traditional databases involve relationships between entities (tables). Traditional databases had been with the IT people for quite some time. While it will stay in many disciplines, the production of big data on daily basis demand for a new technology like big data. The above information was chosen as if a physician wanted to pick data related to Pain_Scale based on demographics. The Pain_Scale was fictitiously entered from a scale of 1 through 10 which was multiplied by 10 to create better visualization. Visualization is achieved here through python modules. Python is another popular language used in the development of software which has built in modules to help/display visualization as shown in figure 2. Visualizations are easy to understand by everyone including physicians. They do not require the technicalities involved behind the scenes. Visualizations are available in various forms of graphs, such as, line, bar, histograms, etc. Many visualizations were used in the current COVID-19 data using python modules (Ganesh, 2021). These visualizations provided the healthcare experts to see the trends of the pandemic. Similar visualizations can be used in the proposed software to understand the patients' data under examination. These visualizations are then shared by the 'team' to get the best expertise in the area. Many case studies can be looked at by various physicians for knowledge sharing and best diagnosis. It is a game changer concept in the healthcare industry. Right now, most of the case studies are done by mutual acquaintances among the physicians. However, with the software proposed by the author these visualizations can be shared through hundreds and thousands of physicians across the globe using the concept behind web repositories. With the technologies mentioned in this paper, all of this is possible and feasible.

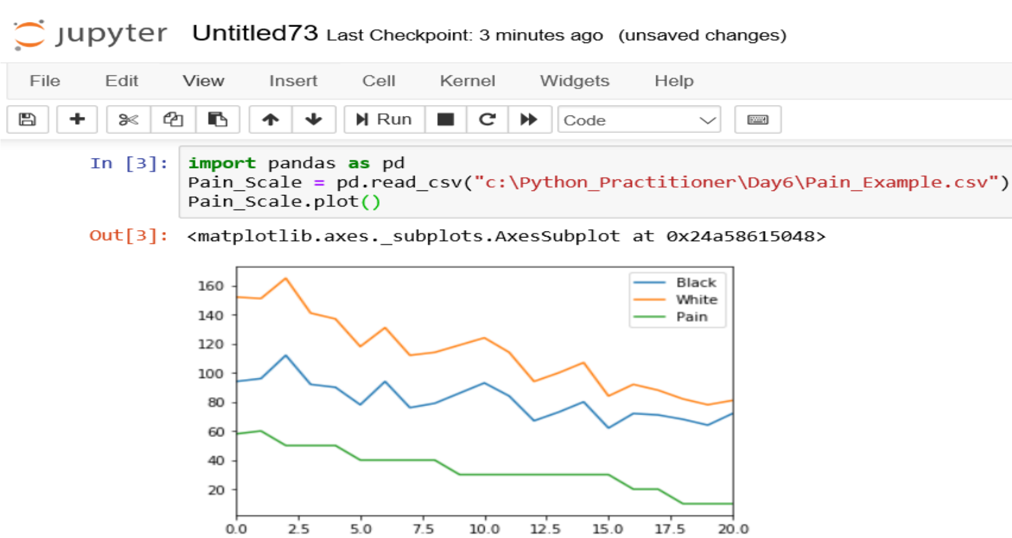

Fig. 2. A plot showing visualization of patient data. The MongoDB key-value pairs are converted into csv format and then python programming is used to draw the visualization using Jupyter.

In the above sample data, 8 key-value pairs were used. However, this data could be structured involving more key-value pairs as needed. The JSON file that stored the key-value pairs of data was then converted to a comma separated value(csv) file by using Python programming language. The Python programming code used is shown in figure 2 to create the visualization from the data originally stored in MongoDB.

The pain_scale is between 9 through 58 which were rounded to 10 and 60 respectively. The different frequency for Black and White were entered for a certain pain_scale. All of these numbers were fictitious to demonstrate that a visualization is possible for big data (MongoDB) using Python. The Python code in Figure 2 imports "pandas" which is open source, meaning it is free of charge to its users. Jupyter is used as an Integrated Development Environment(IDE) to run the Python code. Python has rich libraries and modules like pandas, which have built-in methods to help plot the visualization as well. A physician, after consultation and training on big data should be able to create a similar visualization about "Pain_Scale" as it relates to the demographic data. MongoDB charts and many third-party software tools also allow MongoDB data to be used for visualizations. The visualizations illustrate the level of Pain_Scale among two key-value pairs based on their ethnicity. These two pairs of data are a sample for demonstration purposes and can be changed to other key-value pairs on a as needed basis. The whole process from the collection of patients' data to the creation of visualization is shown in Figure 3.

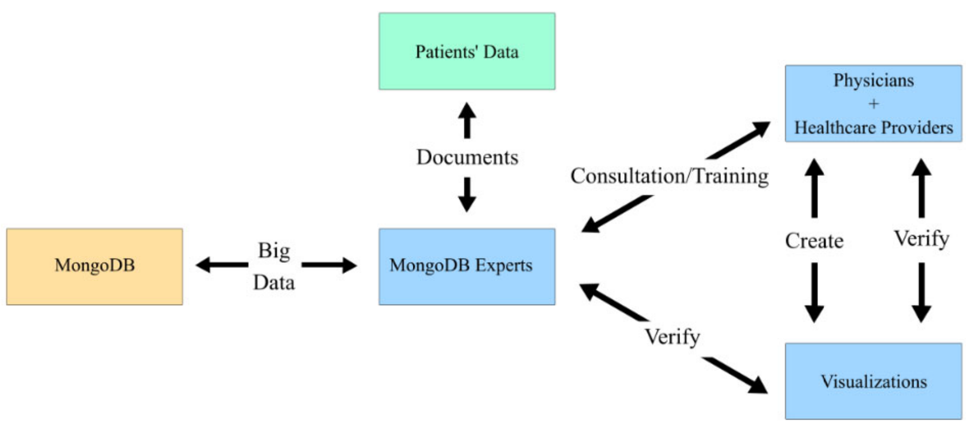

Fig. 3. Schematic outlining the whole process from the collection of big data from patients' documents until the creation of visualization is shown.

In Figure 3, the MongoDB experts receive the patients' documents in electronic format and convert into JSON format. The JSON format is ready to be stored as big data into MongoDB. During this process, the MongoDB expert is in constant consultation with the physicians, providing consultation and training on what data is being stored that is relevant and important. Once trained, the physicians can create visualizations themselves that are ready to be uploaded. During this process, the physicians verify the accuracy of visualizations among their peers and MongoDB experts.

The process of collaboration among physicians begins when a physician starts uploading and downloading such visualizations and shares with other physicians and healthcare professionals. In the proposed software, a physician would have to provide a password for authentication before he or she can upload or download a visualization on a web repository. Web repositories provide a great way for sharing knowledge and collaboration in many areas (Siddiqui, 2015). The visualizations will be stored on an intranet web repository based on its classification. Classification plays an important role in searching and saves time (NIH Homepage, 2015). The web repository is a central location like a Microsoft SharePoint intranet site (Williams, 2011). The classification could correspond to folders. A sample web repository would look like figure 4 where a physician will click on the visualization of his/her choice after logging in.

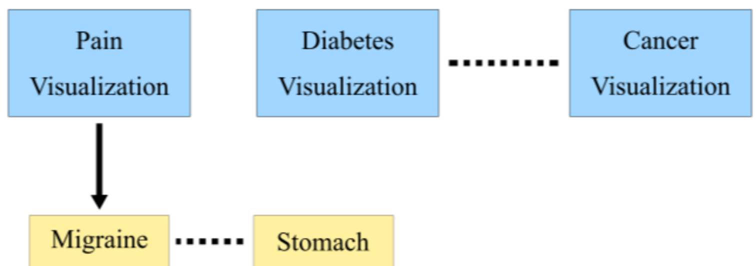

Fig. 4. The web repository classified into different categories of diseases.

Once a visualization is completed by a physician, they can authenticate their identity though a username and password for the intranet that they are part of. This is essential for the security of the data of their patients. The visualizations are classified based on the type of a disease. The classification is critical for an efficient use of information. With the overwhelming amount of data that is available, it is difficult to filter the data that is relevant. Therefore, the diseases are put into their corresponding folder shown in Figure 4. This also gives an opportunity for the physicians to click on the folder of their specialty. This classification is done by the MongoDB experts after consultation with the team. It is possible to have further classification within a disease category as well.

The whole process after the creation of a visualization to uploading/downloading on a web repository is shown in Figure 5. The visualizations will help physicians to understand the disease with more data and help in the diagnosis of a patient in a personalized manner.

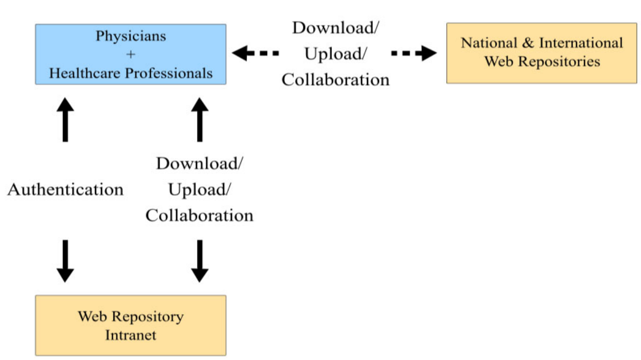

Fig. 5. After the visualization is created, a physician is authenticated through username/password and then given the option to upload or download on an intranet for collaboration with other physicians. This concept could be extended to the national and international level web repositories.

As shown in Figure 5, once a visualization is uploaded, it can be shared with other physicians and healthcare providers. The power of collaboration through web repositories should be limited to the local doctors' offices and healthcare providers. It should be expanded to the national and international level web repositories in situations where the cure is not easily found as in the case of the COVID-19 outbreak.

Results and Discussion

While all of the data related technologies discussed above already exist, and many works have been published on each of the above topics, it lacks the comprehensive approach that is needed to benefit from each of the above technologies at smaller doctors' offices and healthcare organizations. Moreover, the element of collaboration is also lacking at smaller medical offices in the whole diagnostic process of a patient. The objective of this paper is to synthesize all the emerging technologies into one easy-to-use software that will benefit the physicians who would otherwise not pursue a data emerging degree program and would be excluded from the power of collaboration and modern technologies. The key thing is to develop a sophisticated software using the emerging technologies.

Precision medicine is becoming the future of treatment for the patients in developed countries where the latest data related technologies have progressed tremendously in the past decade. Many physicians are realizing the power of big data and its application in the field of precision medicine. While a good percentage of the physicians are going back to school for data technologies related degrees, not all of them have this flexibility. A user-friendly software with little training for physicians is proposed in this paper to better equip physicians who are unable to pursue another big data technology degree. The software proposed could be written with the help of IT experts, physicians, and healthcare professionals who are part of the same team. The technologies involved in the writing of the software include, python programming with visualizations and big data using MongoDB. These technologies are proven in the industry and are widely used for the software that deal with big data.

Patients should be notified requesting their consent to be included into a research study about a certain disease before their documents are accessed for the proposed software. The key-value pairs in the MongoDB are selected from the patients' documents, which are those fields that are useful to physicians' diagnoses process. This paper picked one variable of pain-scale randomly, and fictitious responses from two ethnicities were stored in a csv format. Python was used to visualize the csv file. Python scripts can be used to create a button in a software's user interface for upload/download capabilities that could be merged with the proposed software (More complex APIs, 2020). The physicians are authenticated with a username/password before they can access the web repository in an intranet. The participating physicians could collaborate in a similar fashion through web repositories on the internet at national and international level for a particular disease. Collaboration is an important factor to learn about a disease and diagnoses (NIH homepage, 2020). The collaboration will help physicians to understand the disease with evidence from more data, help gain expertise from their colleagues, and allow faster and more accurate diagnoses of their patients' illnesses. All of the technologies discussed in this paper are available and tested by the industry. The thing which is missing is the connection of these technologies with the physicians. There is no better way to communicate and collaborate than web repositories in the modern age when we are all connected through today's cutting-edge internet technology.

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Learning Analytics Feedforward: Designing Dashboards According to Learner Expectations and Lecturer Perspectives.

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Abstract

Learning analytics provide valuable information for learners and instructors by combining and analyzing learners' historical data during the learning experience. The most common way of employing this information is in the form of learning analytics dashboards (LADs). This study primarily aims to propose LADs design based on the perspectives of various stakeholders. The secondary aim of the study is to propose the concept of 'learning analytics feedforward'. After an iterative and formative design process, the LADs were developed in two different interfaces: a course-related dashboard and a topic-related dashboard. Each dashboard element is classified according to whether it contains feedback or feedforward. The development of LADs based on learner expectations and lecturer perspectives is described in detail.

Keywords: *learning analytics, feedback, feedforward.*

1. INTRODUCTION

With the spread of technology, the interest in online learning environments is increasing. The desire to obtain meaningful results from the digital data left by learners in online environments and the efforts to improve learning environments reveal the need for learning analytics. Learning analytics is based on data resulting from the user's interaction with information and communication technologies. For example, recorded log data is potential data for event learning analytics with timestamps about viewing certain resources, completing essays and quizzes, or discussion messages viewed or sent (Gašević et al., 2016). Learning analytics is considered an interdisciplinary field within the fields of educational technology, pedagogy, machine learning, business intelligence, artificial intelligence, and statistics as a new field of study (Guenaga & Garaizar, 2016; Siemens, 2013, Chatti et al., 2012). The aim of learning analytics is to improve learning, teaching, and learning environment by using educational data (Clow, 2013). Moreover, learning analytics is expressed as measuring, collecting, analyzing, and reporting data about students and their contexts to optimize learning and learning environments (Siemens, 2013).

The use of learning analytics has been increasing in recent years and is frequently preferred especially for the creation of individualized learning environments. In this process, learning analytics indicators are important in terms of monitoring students' success-failure situations and monitoring their behaviors in the process. In addition, recommendation and guidance feedback based on learning analytics (also known as learning analytics feedback) by instructors in this process will provide various benefits to students. The most foreseen benefit of the learning environment is the improvement of the communication between the instructor and the student. In addition, the instructor can give more effective feedback based on the knowledge gained in the process. The log data consists of the students' own behaviors, and feedback can be provided on the behavior of the students, such as which lesson and when they watch, where they hang out, where they do it right. Siemens (2013) states that learning analytics will affect existing education models and provide new insights on learning and teaching. He further indicated that in order to accomplish this goal, firstly it is necessary to make a deep sense of the existing potential in education, and secondly to deal with the difficulties encountered in educational applications of learning analytics.

Instructors can obtain information about students' behavior, performance, learning processes and learning outcomes in the online learning environment which can be obtained by learning indicators. In addition, these reports can provide instructors with an insight into students' learning needs and learning deficiencies. Also, instructors can have a foresight about whether to intervene with the student based on the learning analytics results in the process. Furthermore, how and when this intervention will take place is decided based on these results. To do so, creating personalized learning environments with learning analytics can be utilized as useful tools to provide personalized feedback. In this context, learning analytics can also be administered as an evaluation tool regarding the instructional design process, and it can provide input for the next cyclical processes of the instructional design process.

Recent research results yielded that providing tips, advice, and guidance about learning behaviors by using learning analytics in the process of creating personalized learning environments and improving instructional design processes is recommended (Jivet, Scheffel, Specht, & Drachsler, 2018). Thanks to the learning analytics based recommendation and guidance feedback, students will be able to recognize their own learning deficiencies and will try to tackle them by knowing where they have shortcomings and mistakes. The recommendation and guidance feedback utilized are based on learning analytics. These feedbacks given in the process are suggestions based on learning analytics.

Feedback is considered the key element in formative assessment (Carrillo-de-le-Pena et al., 2009). However, feedback alone is not sufficient for formative assessment. Similar to instruction, formative assessment is often sequential (Hattie & Timperley, 2007). Each new sequence exponentially increases the possibilities for the next. Therefore, a feedforward approach is needed in addition to feedback.

1.1. Learning analytics feedforward

The concept of feedforward is as old as feedback. Björkman (1972) defined feedback and feedforward as different operators serving the same purpose. In both operators, task-related information is provided by evaluating current performance against a specific target. Both can have supporting functions in providing information and policy making in the teaching process. (Sengupta & Abdel-Hamid., 1993). It is a controversial issue to completely separate the concepts of feedback and feedforward. While some views on the meaning of feedforward consider this concept as responses to feedback or as a feature of effective feedback (Dulama & Ilovan, 2016; Faulconer, Griffith, & Frank, 2019; Hattie & Timperley, 2007), some view a computational strategy used to offer suggestions before a task or performance (Björkman, 1972; Hendry, White, & Herbert, 2016).

Feedforward was not investigated as commonly as feedback in educational research (Dulama & Ilovan, 2016). The lack of necessary environments for providing feedforward was one of the reasons why it was not widely used in the past. However, in recent years, feedforward has gained attention by the use of educational data mining algorithms based on machine learning in learning environments (Knight, 2020; Meredith, 2020; Sedrakyan, Malmberg, Verbert, Jarvela, & Kirschner, 2020).

When it comes to operational definitions of feedback, the focus is always on current performance or target performance. However, there is a need for proactive approaches in the context of formative assessment. It is necessary not only to focus on current or target performance, but also to take into account possible performance. If possible performance is predicted accurately, prevention of learners from drop-out will be more easier and intervention to learning experience will be more meaningful.

The study primarily aims to propose a learning analytics dashboard design based on the perspectives of various stakeholders. The secondary aim of the study is to propose the concept of learning analytics feedforward (LA feedforward) to the educational researchers. As mentioned before, although it is not frequently used in educational research, the concept of feedforward has different functional definitions. For this reason, we recommend the use of the concept of learning analytics feedforward, just like the concept of learning analytics feedback (LA feedback). Thus, a common view will be formed when LA based feedforward is said.

2. METHOD

Within the scope of this study, a systematic data collection process was carried out for the dashboard design. This process was carried out on the basis of design-based research. Design-based research; new theory with iterative processes that do not have a fixed prescription (Barab, 2014, pp. 151), requires high cohesion and cooperation with the participants (Amiel & Reeves, 2008), is aimed at improving educational practices (Wang & Hannafin, 2005), and can be adapted to other teaching contexts. It is a research method/framework that aims to develop applications (Barab, 2014, pp. 151). In this study, analysis, design and development phases were carried out. Although it is an iterative and formative design process, this study can be defined as quasi design-based research since there is no implementation phase.

2.1. Participants

The study was carried out in three phases with different participants. Figure 1 shows the distribution of participants at each phase by gender and education level.

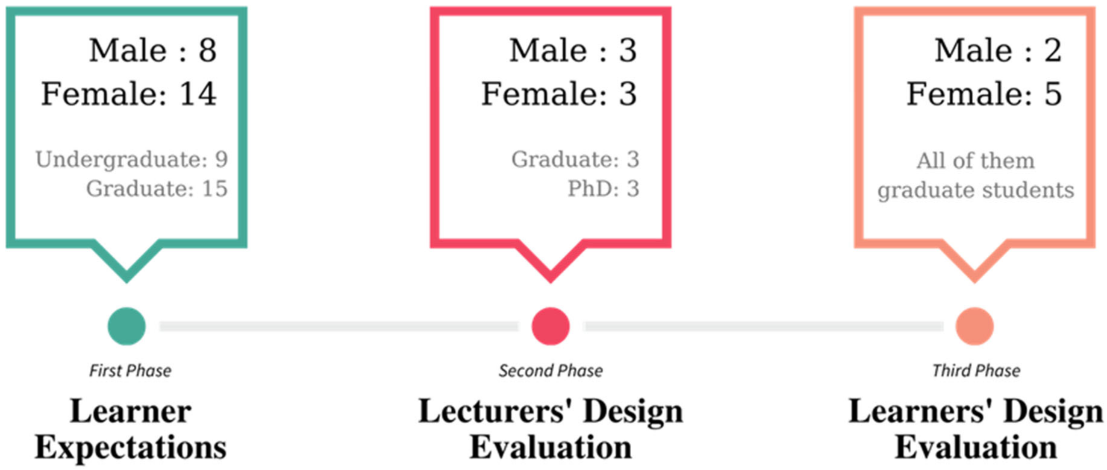


Fig 1. Phases of the study and participants

2.2. Data collection

In the first phase of study, an inclusive question was used to determine learner expectations from learning analytics. The expectations of 22 undergraduate and graduate students were obtained via a web-based form. This form includes only the below question:

"We need you to use your imagination. Suppose there is a Genie in the system, like Alaadin's Genie. If you had a maximum of 3 wishes (information you want to see based on your system interaction data), what would you wish from this Genie?"

A draft design for dashboard elements was created based on these expectations. The lecturers' perspectives on the draft design were gathered in the second phase of the study. Draft design form was sent via e-mail and six of eight lecturers participated. Draft design form includes this information:

1. Purpose and scope of feedback/feedforward to be presented,
2. Metrics/variables needed to present feedback/feedforward,
3. Details of the metrics/variables calculations or visualization components,
4. Appropriate data visualization graphs/charts to present feedback/feedforward,
5. Area for the lecturer comments,
6. Lecturers rating area for evaluating the information chunk from 1 to 5.

Lecturers gave their opinions for each dashboard element containing the above information, which was created according to learner expectations. Additionally, the lecturers can suggest a new dashboard element in the above format. This form was revised as a result of the opinions of the lecturers.

The revised draft design form was presented to the students in the third phase of the study. The dashboard elements in the draft design were rated by seven graduate students who also took part in the first phase. The students on the other hand were not provided with metrics, detailed explanations and a comment area. Students only rated it from 1 to 5. Elements rated as 4 or 5 by all students were the elements to be included in the dashboard to be developed.

2.3. Environment

The aim of this study is to design a dashboard to be integrated into an existing MOOC system. However, in order to better understand some of the metrics and system components in the dashboard, Smart MOOC Integrated with Intelligent Tutoring (SMIT) is briefly introduced in this section.

SMIT was developed using HTML, JS, CSS, PHP, MySQL script and software languages. On the SMIT platform, the topics are presented as modules. Learners must take a mastery test to complete each module and the system decides that the relevant learner is master for that topic. Bayesian network method is utilized to determine the level of mastery. SPRT (Sequential Probability Ratio Test) was utilized in the estimation of mastery. When SMIT makes an authorized decision about the user, this is indicated to the user. When the system decides that the learner is not the master, the learner is directed to the relevant content and recommended to study the content. The user who is directed to the content decides that he/she is ready by browsing the learning materials, he/she can take the proficiency test until he/she is the master. When learners are not the master, they can also be directed to the intelligent tutoring system.

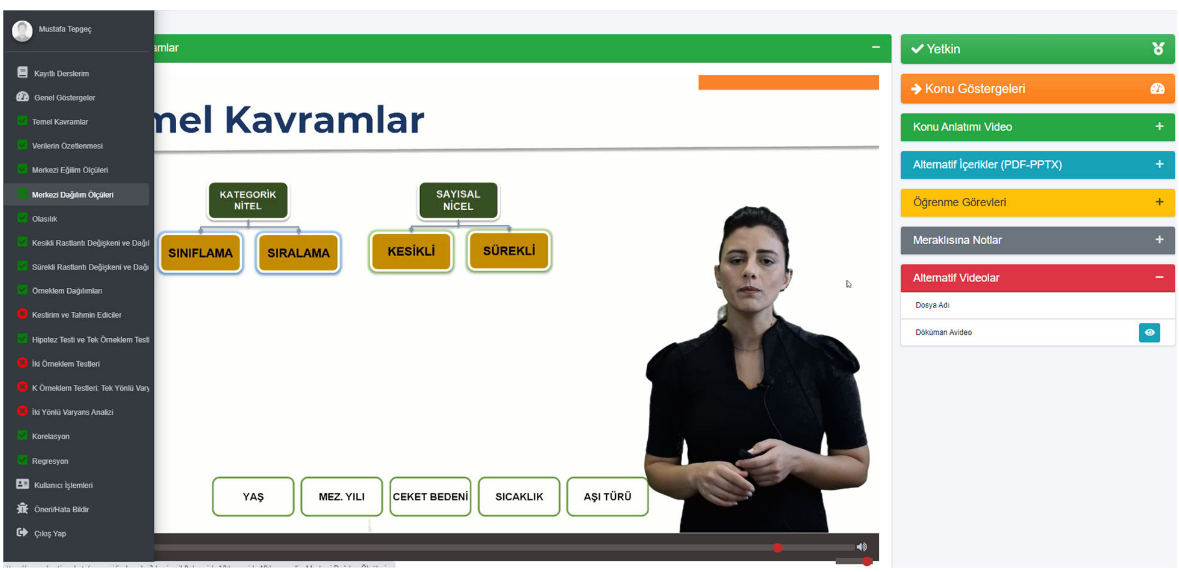


Fig 2. Screenshot of the learning environment

On the SMIT platform, the contents are presented in a highly enriched way. In addition to the topic video, presented in Figure 2, learners can reach alternative videos, written materials, presentations, and infographics from the section on the right. In addition, they can perform learning tasks and learn the topic in depth by going to the "notes to the curious" section. Moreover, learners can take notes while working on the content and view the indicators related to the topic from the right column. Learners can view all the topics in the course and the course-related dashboard from the left column.

RESULTS

In this study, learning analytics dashboards (LADs) were designed gradually according to different stakeholders' opinions. In this section, the development of dashboard elements as well as the findings of the three-phase data collection process are presented.

3.1. Findings on learner expectations

In order to determine learner expectations from the learning analytics, a web-based form consisting of an inclusive open-ended question is presented. Students stated a maximum 3 expectations via this form. Consequently, the learners stated 36 information in total. However, not all of these expectations were considered during the design phase. Some of these are:

P2: "I couldn't understand the learning task, can you explain in detail?"

P22: "What should I do to be the best of the month??"

P1: "Can you provide material to maintain the permanence of what I have learned?"

Since every expectation recommended by the learners is not suitable for the features of the current system, nearly half of them were not used in the design phase. While the first comment above is about the feature of providing a more detailed explanation for the presented learning task, the second comment is about gamification elements and the third comment is about adaptively providing alternative content that already exists in the system to the learner. Within the scope of this study, since it is aimed to design LADs for an existing system, these comments were not evaluated during the design phase, since features that do not exist in the existing system cannot be added. Excluding these kinds of expectations, the remaining 19 information was analyzed in two categories as LA feedback and LA feedforward.

LA feedback provides information about the gap between learners' current state and targeted state by utilizing learning analytics. LA feedforward provides a prediction based on learners' past learning experiences and/or the learning experiences of others. 9 of learner expectations were evaluated as LA feedback and 10 of them were evaluated as LA feedforward.

3.2. Findings on design evaluation

A draft design form was developed corresponding with students' expectations from learning analytics. This design form was first presented to the lecturers. Lecturers rated dashboard elements that might be useful for learners, and also defined new dashboard elements that might be meaningful for learners to encounter in the current system. The 24 dashboard elements that the lecturers agreed upon were presented to the learners for final evaluation. Of these 24 dashboard elements, 15 contained LA feedback and 9 contained LA feedforward information. In addition, out of these 24 dashboard items, 15 were created based on learner expectations and 9 based on lecturer recommendations. Examples of presented information in the dashboard element, depending on whether they are from lecturer recommendations or learner expectations and whether they include LA feedback or LA feedforward, are shown in Table 1.

Table 1 Examples of LA feedback and LA feedforward

	LA feedback	LA feedforward

Based on learner expectations	Trending material information Performance trend information relative to others	Prediction of success in the topic according to system interactions Information on when to complete the course
Based on lecturer recommendations	Mastery test performance information Log-in numbers information	Drop-out prediction information Next topic estimation

The learner views mentioned in the previous sections reflected the learners' expectations from learning analytics. Some of these learners (n=7) also participated in the design evaluation phase (third phase). The design evaluation form, which was developed according to the expectations of the learners at the first phase, was revised as a result of the lecturers' opinions. The revised design form was presented to these learners upon their design evaluation.

Unlike the form evaluated by the lecturers, the learners only rated scope and sample visualization of the dashboard element from 1 to 5. While the primary purpose of this phase is to provide the learner's views on the more concrete design, the secondary purpose is to identify the best among out of this information, since presenting 24 elements in the dashboard may result in negative learning outcomes. Hence, the elements that all 7 learners who participated in the research indicated 4 or 5 degrees out of 5 were included in the dashboard final design. Learners marked as 4 or 5 out of 5 for 12 elements out of 24 elements. Of these 12 dashboard elements, 8 were treated as LA feedback (later 3 of them revised as a single dashboard element), and 4 as LA feedforward.

3.3. Dashboard elements

In this section, the dashboard elements created as a result different stakeholder opinion will be introduced gradually. Since 3 of the agreed 12 dashboard elements (LA feedback) are composed of related metrics, they are graphed as a single dashboard element. Therefore, of the 10 dashboard elements, 6 were LA feedback and 4 were LA feedforward. As a result, these 10 dashboard elements obtained by the researchers were integrated into the system on two separate pages as topic-related and course-related.

LADs are designed for MOOCs, which was developed from a project. There are many courses in MOOC platforms and each course has a syllabus in general. Each element of the syllabuses is treated as a topic. Therefore, the dashboard design in this study is configured separately as both course-related and topic-related.

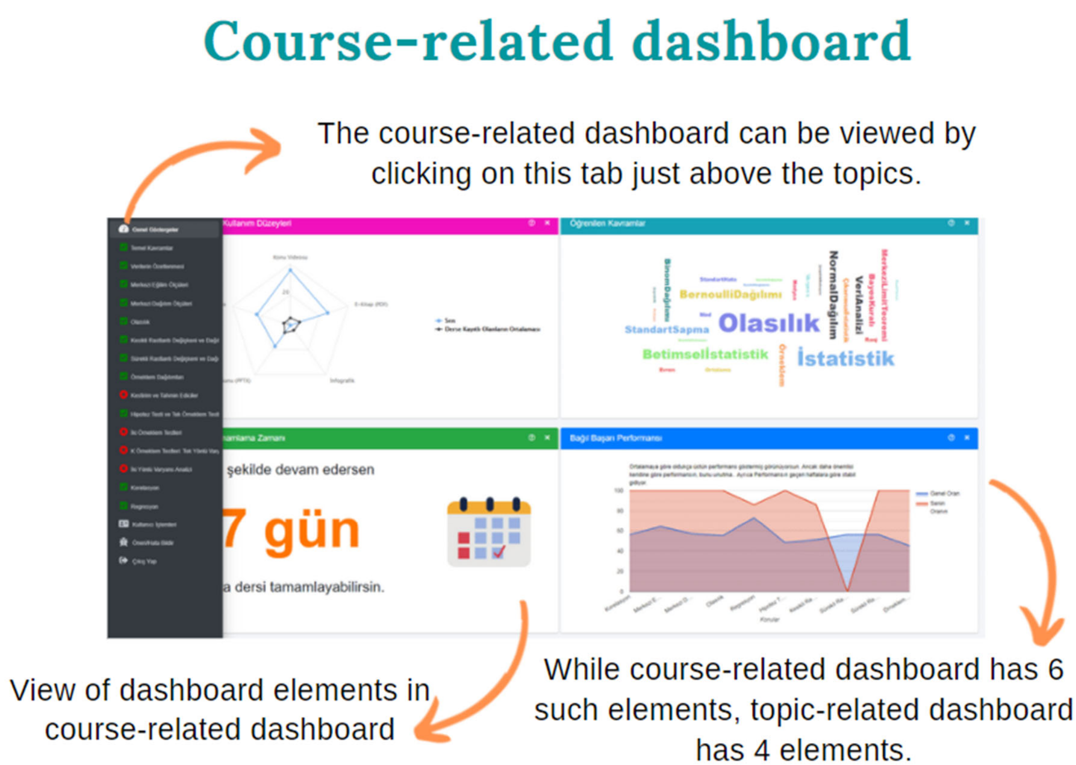


Fig 3. Screenshot of the course-related dashboard

Figure 3 shows a screenshot from the course-related dashboard. Topic-related dashboard is designed similarly, and dashboard elements on both pages are discussed separately in this section.

3.3.1. Course-related dashboard elements

As a result of the study, 6 (4 LA feedback, 2 LA feedforward) dashboard elements are determined and located under the course-related dashboard. In this section, each element to be included in the course-related dashboard, stakeholder opinions referring to this element, the metrics required for the information to be included in the element, the calculation methods, and visualization of these metrics will be presented.

Course-related element 1: Performance displays based on mastery test indicators

This dashboard element covers 3 different information and presents mastery testing performances to learners descriptively. Therefore, the information presented here is considered as LA feedback. The illustration and explanations of this element are given in Figure 4.

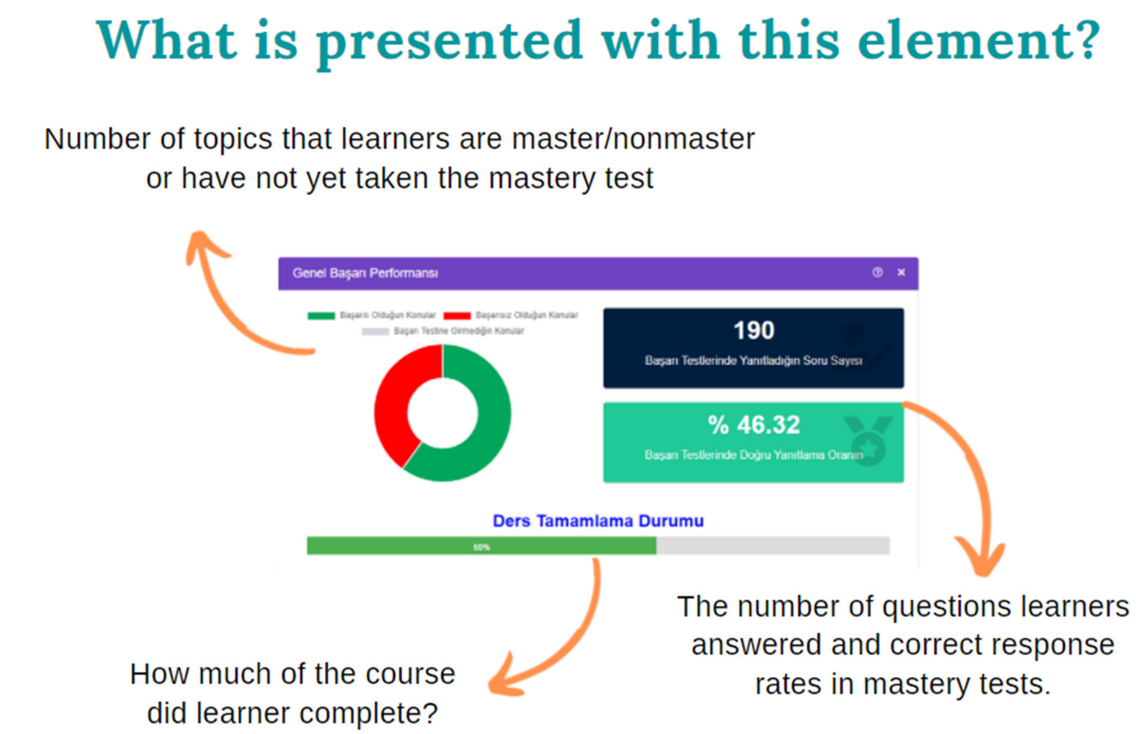


Fig 4. Course-related dashboard element-1

The dashboard element was created by consolidating 3 different information. While 2 information were recommended by the lecturers, 1 information was added based on the comment below.

P15: "How much progress have I made in this course according to interactions on the system?"

This dashboard element does not require any complex calculations. From this descriptive information, master/non-master/not taken metrics are presented as they are. Similarly, the number of questions encountered was obtained by adding the questions encountered in the mastery test in all topics, while the correct answer rate obtained by dividing the questions answered correctly by the number of questions encountered. The information in the progress bar under the element is obtained by dividing the topics of competence into the total topics.

Course-related element 2: Norm-referenced feedback and self-referenced feedback according to recent performance

Through this dashboard, the recent mastery testing performance of the learners is presented in comparison to the group and personal performance. The illustration and explanations for this element are shown in Figure 5.

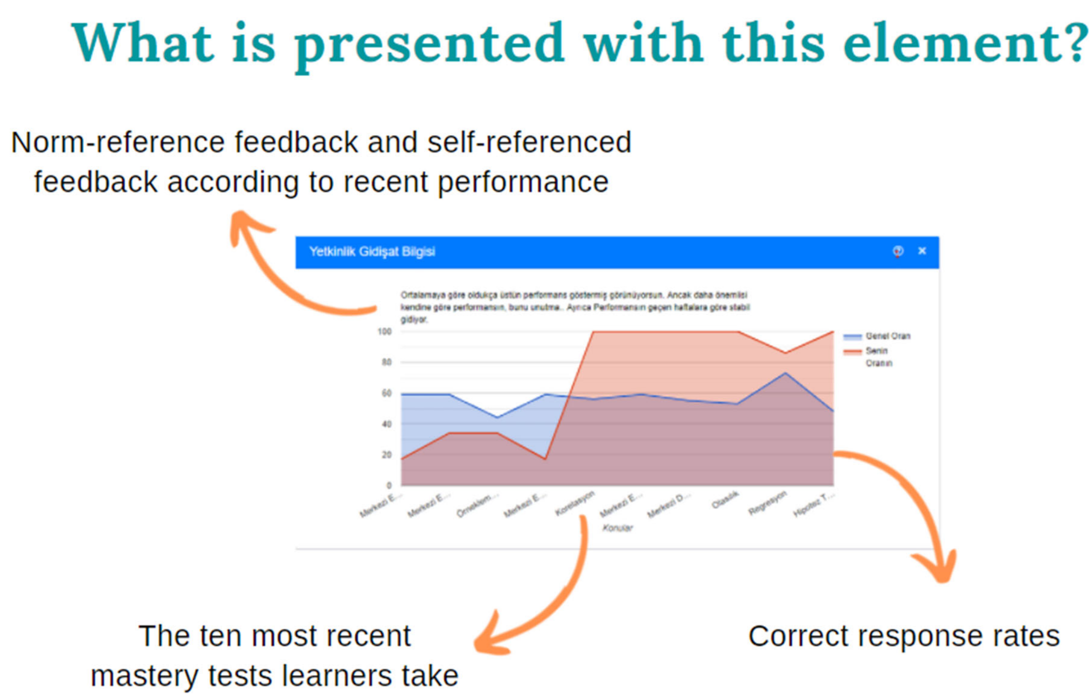


Fig 5. Course-related dashboard element-2

While the expectations of the learners were in the direction of norm-referenced feedback, self-reference feedback information was included in the design by the researchers. The comments of the learners for the related dashboard element are presented below.

P3: *"I am working but am I right? How is my performance compared to others?"*

P12: "*Hey genie, how am I compared to other users?"*

As it was deduced from the comments, the learners wanted to see the performance compared to the others. This performance information was created according to mastery testing. The last 10 mastery tests that the learner took and the correct answer rates are presented. Norm-referenced feedback is provided depending on three conditions. For these conditions, the standard deviation of the student's performance is defined. If it is greater than 1, determined as above the average, it is above the -1 determined as below the average and other conditions determined as at the average level.

Self-referenced feedback compares the student's performance on the last two tests to the prior three tests. If 2 of the last 2 test performances are lower than the average of the previous 3 test performances, it is reported that the trend is negative, and if it is higher, the progress is positive. Otherwise, the message that the status is stable.

Course-related element 3: Success predictions for all topics

Through this element, it is aimed to provide a success prediction for all the topics. As it turns out, this element is covered under LA feedforward. The illustration and explanations of this element are shown in Figure 6.

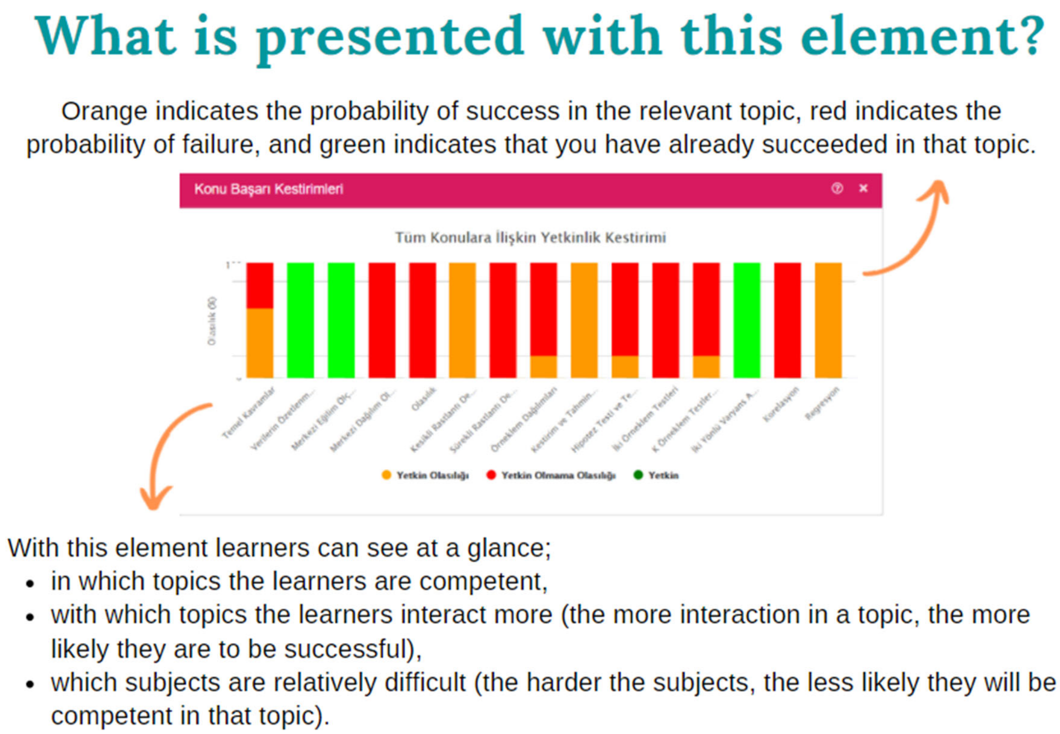


Fig 6. Course-related dashboard element-3

This dashboard element was created based on the expectations of 2 learners. In essence, learner expectations indirectly reflect this information. The comments of the learners for the related dashboard element are presented below.

P3: *"I have done so much right in this topic; will I be successful in the other topic or should I leave it here?"*

P13: *"Genie can tell my shortcomings and tell me the topics I need to focus on."*

As it mentioned in the comments, learners will have information about difficulty levels of the topics and the probability of being successful in topics according to their performance in a particular topic. In order to make this estimation, the correct response rate on all topics, the number of learning task views, and the number of course-related dashboard views were used. In addition, the duration of each topic-specific content, the number of video interactions (rewind, replay, note-taking) and the number of views on alternative content (pdf, pptx, infographic) were evaluated. Naive Bayes algorithm was used for predictions.

Course-related element 4: Course completion time prediction

In this dashboard element, the estimation on when the learner will complete the topic was presented based on their current performance. Thus, this element was evaluated under LA feedforward. The illustrations and the explanations related to this element are presented in Figure 7.

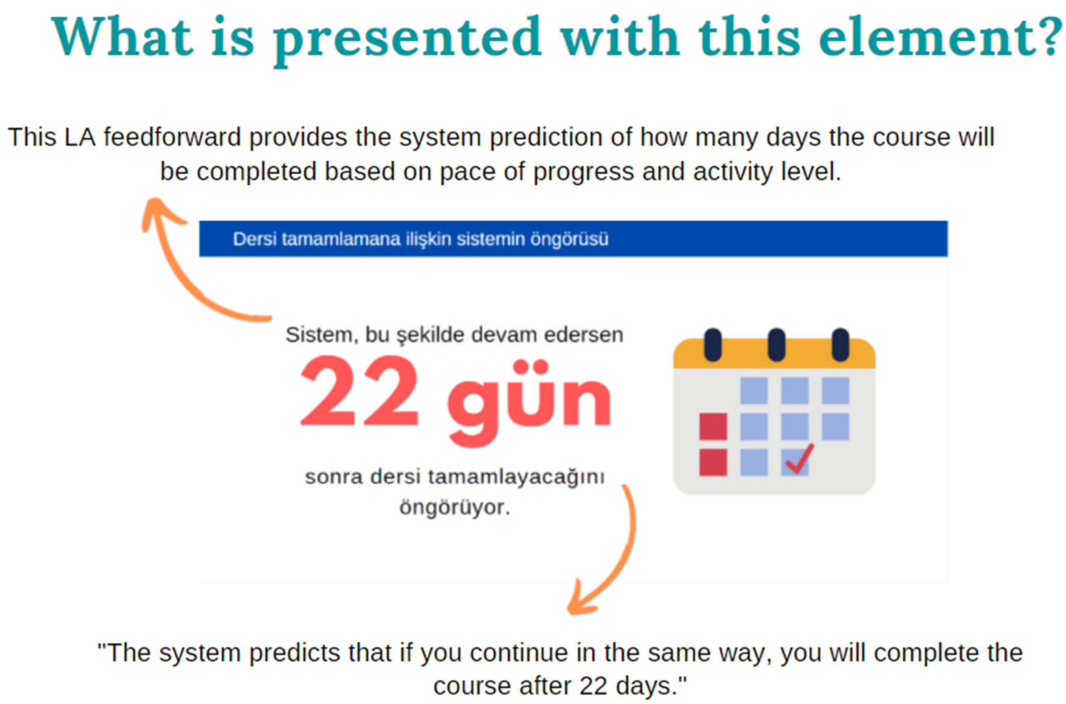


Fig 7. Course-related dashboard element-4

The learner expectations related to this element is given below.

P14: "*According to the information I have before the course, Genie can predict how long it will take to complete the course.*"

For this dashboard element learner expectations were revised based on current performance although previously learner expectations were based on prior learnings. The estimation regarding completion time was estimated utilizing metrics that are obtained by the time spent on mastery topic in the system, the time elapsed from the two component topics to the previous component topic, and the number of completed topics. k nearest neighbor algorithm was utilized in order to gather this estimation.

Course-related element 5: Concepts learned

In this dashboard element, learners are presented with the concepts they have learned according to the content of the topics they are competent in. This dashboard element is considered as LA feedback since it provides information regarding previous performance. The illustrations and the explanations related to this element are presented in Figure 8.

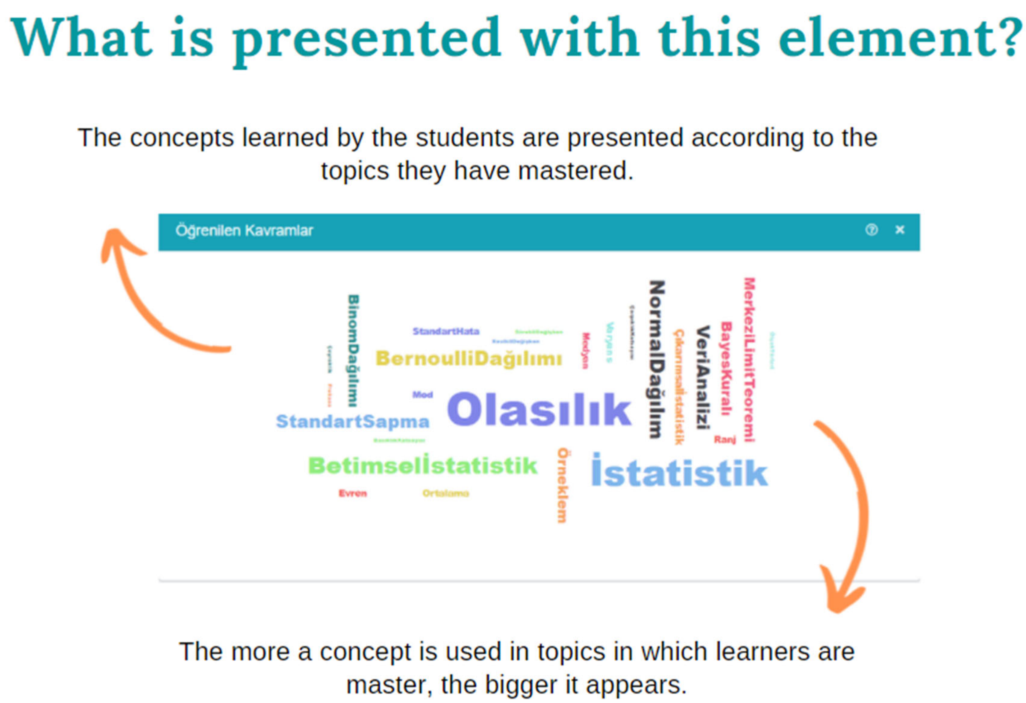


Fig 8. Course-related dashboard element-5

The learner expectations related to this dashboard element is given below.

P22: "*So, what I do know?*"

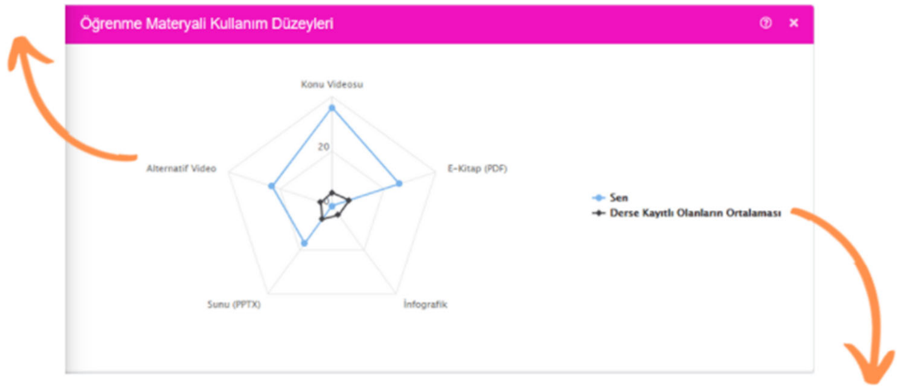
In order to create the word cloud, each topic and related concepts were paired based on instructor opinions. When the learner is competent in a particular topic, those concepts are added to the word with their weights.

Course-related element 6: Trending material types

The materials that learners are interested in the system are presented through this element. This dashboard element is considered as LA feedback. The illustrations and the explanations related to this element are presented in Figure 9.

What is presented with this element?

Types of materials that learners can choose while studying on the topic



The blue lines represent the number of times the learner viewed the materials, while the black lines represent the average number of times the students enrolled viewed the materials.

Fig 9. Course-related dashboard element-6

The learner expectations related to this element is given below.

P22: “*What type of content did I tend to most?*”

The material information that learners as well as others are interested is presented. The number of existing videos, alternative videos, presentations, pdfs, and infographic elements are given.

3.3.2. Topic-related dashboard elements

4 of the dashboard elements developed as a result of the study (2 LA feedback, 2 LA feedforward) can differ according to the topics. Therefore, this dashboard is not in the main menus of the system, but in the content of a topic and is customized according to the current topic.

Topic-related element 1: Roadmap of successful learners

Through this element, learners can view how successful people follow their topic content. With this element, the message "you can be successful if you follow a path like this" is presented secretly. Therefore, this dashboard element is also evaluated under the LA feedforward. The notation and explanations of this element are shown in Figure 10.

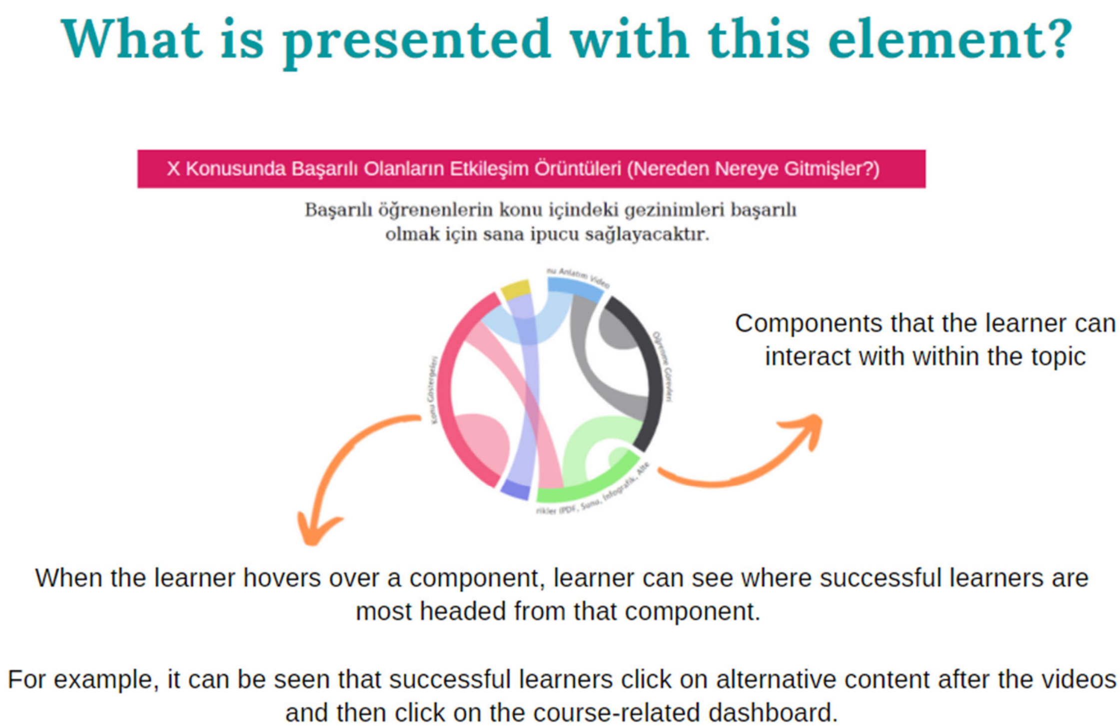


Fig 10. Topic-related dashboard element-1

The learner expectation associated with this dashboard element is presented below.

P1: "*What material will be most effective for me in my next learning?*"

Transition matrices have been created for this element. For example, information such as how many times successful learners have passed from the topic videos to the learning task on the relevant topic was displayed when hovering over the relevant component.

Topic-related element 2: Time spent on the topic

Through this element, the time spent by the learners is presented descriptively. Similarly, information about the average time spent by successful learners in the topic is presented. This dashboard element has been evaluated as LA feedback. The notation and explanations of this element are presented in Figure 11.

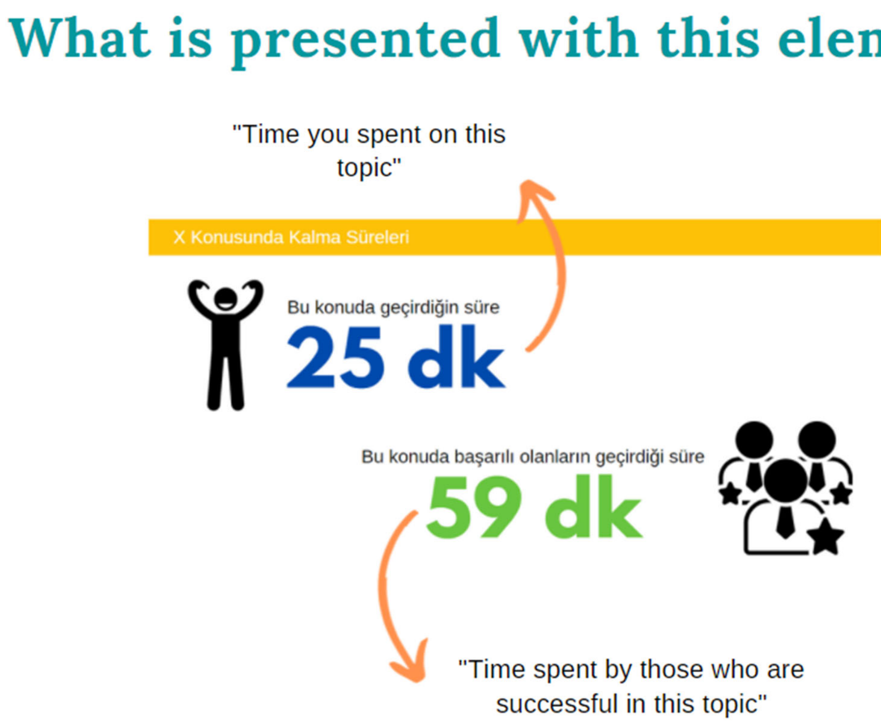


Fig 11. Topic-related dashboard element-2

The learner expectations associated with this dashboard element are presented below.

P1: "*How much time do I need to learn the next topic effectively?*"

P12: "*What is the average time I have to spend for each topic?*"

For this dashboard element, the time spent by the learners on the relevant topic and the average time spent by the successful ones are directly presented.

Topic-related element 3: Success prediction for the relevant topic

Through this element, the topic estimation in course-related 3 is presented under each topic-related dashboard. This display format is indicated in Figure 12.

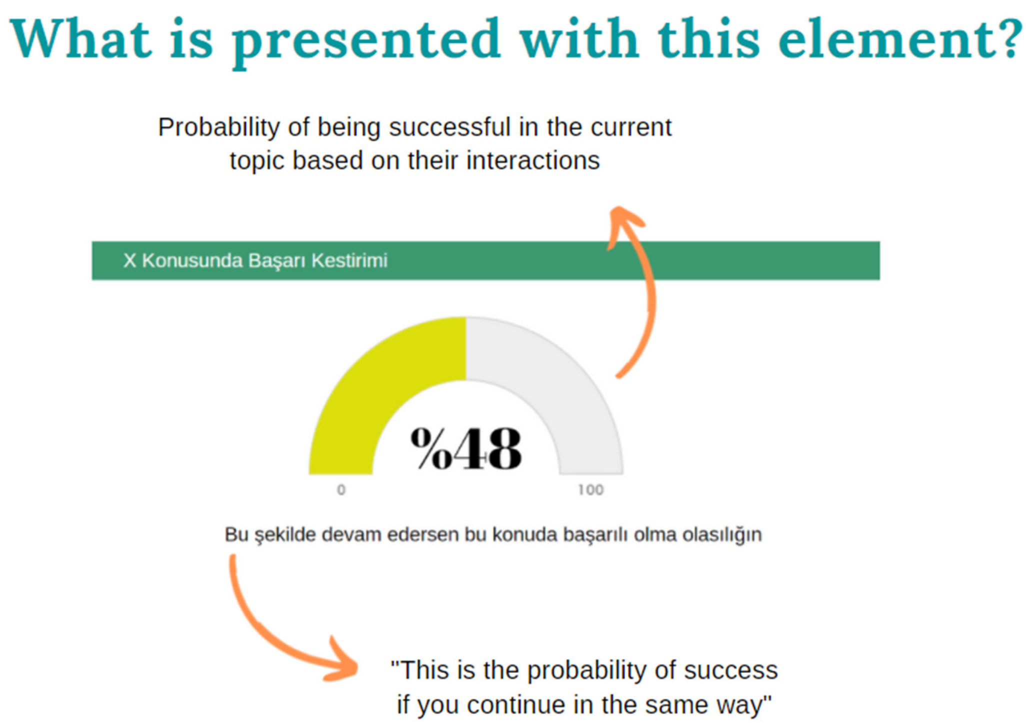


Fig 12. Topic-related dashboard element-3

The learner expectations associated with this dashboard element are presented below.

P2: "*Can I be successful if I don't watch the video and only study the topic via pdf?*"

P17: *"Hey Genie, I only worked with infographics and presentations. Will I be able to succeed in this topic?"*

With the LA feedforward in Course-related 3, the calculations and the algorithm used are the same, and the representation of this information is different.

Topic-related element 4: Interactions for the relevant topic

In this section material interaction levels of the learners after taking the proficiency test on a topic are demonstrated. This information was considered as LA feedback. The illustrations and the explanations regarding this element are shown in Figure 13.

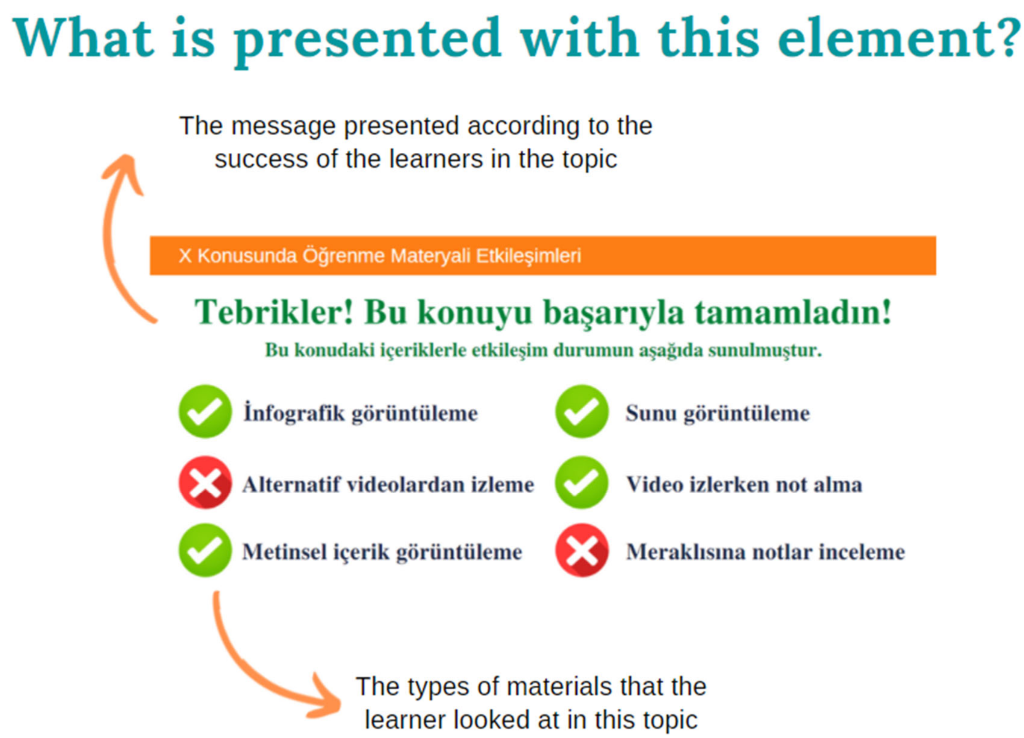


Fig 13. Topic-related dashboard element-4

The learner expectations related to this element is given below.

P17: *"I interacted with content on many topics. What content do you think I am more successful?"*

Learners can follow their level of mastery/non-mastery and their interaction with the related material. Hence, material interaction after taking the proficiency test can be followed by the learners.

In sum, 10 dashboard elements were generated as a result of a systematic design process. These elements were developed under course-related and topic-related sections. Four elements on the course-related dashboard were LA feedback and two of them were LA feedforward. While on the topic-related dashboard three elements were LA feedback and one element was LA feedforward. The design process can be revised based on application and evaluation. However, the ultimate aim of this study is to reveal a systematic design process as well as the dashboard design based on this process. Future studies will contribute for development and optimization of this design.

4. DISCUSSION and CONCLUSION

As a result of the systematic design process, it was determined that the expectations of students and lecturers from the learning dashboard were gathered under two main themes. First of all, it was agreed that the learning dashboard should be presented to visualize the current status of the students using the system. LA feedbacks, in which students' current situations are revealed depending on the system usage, are included in the learning dashboard. On the other hand, the future behavior and performance of the students has been tried to predict based on their current system usage behaviors and performances. These learning analytics indicators are also included in the learning dashboard as a LA feedforward.

The dashboard elements to be presented at the end of a systematic data collection and design process are structured on two separate pages as course-related dashboard and topic-related dashboard. MOOCs platforms are generally competency-based and have a modular structure. Therefore, the topic-related dashboard presented here is an example for other MOOC platforms.

As a result of the study, 10 dashboard elements were created, some of which consist of a single metric and some of which consist of many metrics. 6 of them were evaluated as LA feedback. The following information is presented with the dashboard elements evaluated as LA based feedback:

- Performance displays based on mastery test indicators
- Norm-referenced feedback and self-referenced feedback according to recent performance
- Concepts learned
- Trending material types
- Time spent on the topic
- Interactions for the relevant topic

Dashboard elements evaluated as LA feedforward are as follows:

- Success predictions for all topics
- Course completion time prediction
- Roadmap of successful learners
- Success prediction for the relevant topic

When researches on learning analytics are examined, most of the existing research until recent years included learning analytics reports based on descriptive statistics, aiming to determine the current behavior of students in the learning management system (Clow, 2013; Bakharia et al., 2016). Researchers emphasize that the benefit of reporting student data on LADs of learning management systems will be limited. The importance of interpreting these reports in a way that students can understand, making predictions about the future behavior and performance of the students, and making recommendations for students is emphasized (Jivet, Scheffel, Drachsler, & Specht, 2017; Jivet, Scheffel, Specht, & Drachsler, 2018). The importance of learning analytics indicators to be used for feedforward purposes, which will be included in LADs, becomes evident. In the study carried out by Leavy and Rheinschmidt (2010), a metric was developed to predict the success of the students in the online course. It was observed that there was a significant increase in the success of the students who took the course as a result of the lecturers following the student based on this metric and making interventions when necessary. Similarly, it has been demonstrated that learning analytics has the ability to accurately predict risky behaviors and improve students' learning performance and learning outcomes (Du, Yang, Shelton, Hung, & Zhang, (2021); Herodotou, Rienties, Hlosta, Boroowa, Mangafa, & Zdrahal, 2020; Mubarak, Cao, & Ahmed, 2021; Namoun & Alshanqiti, 2021).

It is stated that in the studies carried out on learning analytics indicators, the opinions of students and instructors are mostly not consulted on which metrics should be used. Researchers especially emphasize the importance of student-centered learning analytics, which also includes student and instructor opinions (Muljana & Luo, 2021; Ochoa & Wise, 2021). With this research, learning analytics indicators that were decided to be utilized as feedback and feedforward in the learning analytics dashboard were determined based on student and lecturer opinions. For future research, obtaining data on the performance of this learning panel, determining the improvement process of the learning panel, and the effect of panel usage on the learning process and results of the students.

5. ACKNOWLEDGMENT

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Teaching Nature of Science Through the High School Production of the Theatre Play *Life of Galileo*, by Bertolt Brecht

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Descriptors: Action Research, Instructional Design

Abstract

Many scholars, educational institutions, and governmental bodies, including the National Research Council, consider science literacy and the Nature of Science understanding fundamental goals of K–12 STEM education. However, there is little research exploring the enhancement of Nature of Science understanding through theatre productions related to the history of science. This action research design proposal suggests that the adaptation and production of *Life of Galileo* by Bertolt Brecht could improve high school students' online research skills, enhance students' understanding of research, the scientific method, and the criteria that differentiate scientific from non-scientific theories. All the above improvements of skills could lead to the enhancement of students' Nature of Science understanding.

Introduction

The Research Question

Could the high school production of the theatre play *Life of Galileo* by Bertolt Brecht enhance the students' Nature of Science understanding?

Nature of Science in K-12 STEM Education

The arguments for incorporating History and Philosophy of Science (HPS) (Klopfer & Cooley, 1963) in STEM (Science, Technology, Engineering, & Mathematics) education, the calls for science literacy (Rutherford & Ahlgren, 1989), and proposals for ways of implementing the teaching of Nature of Science (NOS) understanding (Lederman & Lederman, 2004) in educational institutions are not new. NOS is the general term defining the scientific enterprise that incorporates both HPS and science literacy. NOS is a fertile hybrid arena that combines elements of various social science studies. NOS incorporates history, sociology, and philosophy of science, coupled with cognitive science research, such as psychology, into a rich explanation of what science is, how it operates, how scientists function as a social community, and how society itself both guides and reacts to the scientific goal (McComas, 1998, p. 4).

Rutherford (2001), Teixeira, Greca, & Freire (2009), Garik & Benétreau-Dupin (2014), Matthews (2014, 2017, 2018), Michel & Neumann (2016), and other scholars argue that HPS can contribute to contemporary U.S. Science teaching for K-16 education and advocate the inclusion of HPS in their science syllabi (Matthews, 2014). Garik & Benétreau-Dupin (2014) argue that it is of high importance that students recognize that argumentation, criticism, and analysis are fundamental to science and that students should be educated to value science as part of our culture. Additionally, many scholars claim that the inclusion of NOS in STEM curricula would improve the content learning of students (McComas, 1998; Rutherford, 2001; Dass, 2005; Teixeira et al., 2009; Abd-El-Khalick, 2012; Garik & Benétreau-Dupin, 2014; Matthews, 2014; Michel & Neumann, 2016; Pellegrino, 2016; Gandolfi, 2019).

According to Matthews (2014), many governmental and educational bodies in the past few decades have proposed the inclusion of HPS or NOS to their science syllabi, among which is the U.S. National Research Council (NRC), with its Next Generation Science Standards (NGSS) (National Research Council, 2013). Matthews (2014) argues that incorporating HPS into STEM curricula "has a significant contribution to make to improving science teaching and learning and, consequently, personal and social flourishing." (p. 14).

The justification of the NRC (2013) for integrating NOS into STEM education is that people need to know and understand the world around them. Moreover, humans need to modify their world by using technology to match what they understand or want. In certain situations, the need to know emerges from fulfilling essential needs in the face of possible risk. It is often a natural curiosity, and in other instances, it promises a better, more comfortable existence. Science is the pursuit of natural world explanations, while technology and engineering are the means to fulfill human needs, intellectual interests, and ambitions. Another consistent characteristic of scientific knowledge across disciplines is that scientific knowledge itself is subject to revision in the light of new evidence (p. 96). A scientifically literate person who can appreciate scientific knowledge's essence is a fundamental aim of K–12 science education.

Garik and Benétreau-Dupin (2014) drew the critical conclusion that science education must be integrated into a liberal arts education to prepare students to be equal participants in a participatory democracy. "Science teachers alone should not be expected to prepare students to be scientifically literate, and a modern curriculum that is organized through the humanities would be needed to educate students for scientific literacy." (p. 1853).

This action research design's suggested learning process considers and integrates all the NOS factors of McComas' (1998) description and follows the NGSS on NOS (NGSS, NRC, 2013). The resources and tools suggested for this project to improve NOS understanding are debating and argumentation, online research, interdisciplinarity, and using art in STEM education, in this case, the performing arts, and more specifically, theatre.

Using Theatre to Enhance Students' Nature of Science Understanding

The Drama-based pedagogy (DBP) is well researched and applied (Lee et al., 2015). It is a collection of drama-based teaching and learning strategies to facilitate learning in non-drama and drama-specific content through an embodied process-oriented approach to learning. Nevertheless, in DBP, the non-drama content focuses mainly on reading comprehension, social and emotional skills, or other non-scientific areas. Also, DBP interventions are usually limited in their scope and duration.

There are cases where theatre is implemented for teaching the philosophy of science (Toonders, Verhoeff, & Zwart, 2016)), popularizing the theory of evolution in a science museum setting (Peleg & Baram-Tsabari, 2016), or even dramatize original research and present it to elementary school students (Burgin, Alonzo, & Hill, 2016). Nevertheless, researchers have highlighted the limited use of drama in education. And while according to Toonders, Verhoeff, & Zwart (2016), "Drama is a relatively unexplored tool in academic science education," Braund (2015) goes so far as to ask the question of whether drama and learning science is "an empty space."

Theatre has indeed been used to support science teaching (Giliberti et al., 2019; Abed, 2016; Kerby et al., 2010; Peleg & Baram-Tsabari, 2011; Yoon, 2006) or history of science (Jansson & Aksela, 2013), but to a minimal degree. Some researchers have recently employed theatre to expand student understanding of NOS (Burke, Wessels, & McAvella, 2018; Burke, McAvella, & Wessels, 2020) or even train new science teachers on the NOS (Melo & Bächtold, 2018). However, they were limited both in time and their scope.

Adapting and Producing the Play *Life of Galileo*, by Bertolt Brecht

This action research design is about the adaptation and production of the play *Life of Galileo* by Bertolt Brecht in the context of an elective course (e.g., Theatre I to Theatre IV Honors) offered to all high school students of a school in the Miami-Dade area in Florida. The book used for the production will be *Life of Galileo (Student Edition)* by Bertolt Brecht (Brecht, 2020). The play is about the Italian natural philosopher's career whom the Roman Catholic Church tried for the proclamation of his scientific discoveries. The play's primary theme is the conflict between science and dogmatism. The students' understanding of the experiment, the scientific method, and the criteria that differentiate scientific from non-scientific theories could be expanded through different stages of the play's production. It is essential that students acknowledge that debating through valid arguments, criticism, and analysis, are fundamental operations in science and learn to value science as part of our shared human culture. The students will be evaluated through the readings, online research, rehearsals for the play's production, and their replies to an open-ended questionnaire and interview administered three times during the school year.

Lastly, this design will invite teachers from other disciplines to get involved and facilitate the students learning of the NOS, e.g., educators that teach language, literature, history, philosophy, social sciences, and STEM subjects, e.g., physics, mathematics, and biology.

The Use of Online Research

This research proposal intends to ask students, throughout all the stages of the play's production, to conduct online research in small teams about the topic in question and decipher whether the sources they find are reliable scientific sources or not. Following the online research, each team could be asked to present and explain the topic to the rest of the class. In other instances, the whole class could be split into two parts and debate, using their argumentation skills, taking opposing views on the given topic. The topics could be assigned by the theatre teacher or emerge throughout the production processes of the play. The topics that emerge could be specific to the historical events described in the play, for example, Galileo's life, the telescope, the gravitational theories, e.t.c., or broader topics related to science. These broader topics could be, for example, the history and philosophy of science, the scientific method, and the history, the physics, or the mathematics of gravitational theories from Aristotle to Einstein.

The Interdisciplinarity of the Project

An essential aspect of the scientific endeavor is its interdisciplinary and collaborative nature. Understanding NOS includes the understanding that scientific inquiry is a process where a multitude of disciplines are contributing through the ages in the effort of the human species to understand nature and human's place in it. Although the play is concentrated on Galileo, it is clear that people from other crafts and disciplines, for example, people like Giordano Bruno, Copernicus, a lens grinder, the inventor of the telescope, mathematicians, astronomers, philosophers, and other scholars, appear or are mentioned in the play (Brecht, 2020). Through all the production processes of the play, students could realize how the various disciplines are included, each of them offering their perspective and knowledge, providing a more multifaceted understanding of the scientific inquiry.

Teachers from other disciplines will be invited as guest speakers to facilitate the conversation related to their field of expertise. The rationale for this is to highlight the interdisciplinarity of scientific inquiry and the collaboration of different scientific disciplines in scientific research.

A language teacher could be a valuable resource as she can explain unknown words or scientific terms and help with the play's language analysis, which will also accommodate diverse learners. The students analyzing the language used in the play and the words and expressions used in the 17th century (and are not used anymore) could significantly improve their understanding of the language of the play, the innuendos, and the nuances that would be missed without the language teacher's input. The engagement of the English teacher might be essential for the first stage of the readings of the play.

A literature teacher could work with the theatre teacher at the play's analysis stage and the conversation about playwright Bertolt Brecht and his ideas. Furthermore, a literature teacher could help the theatre teacher explain the characteristics of Brecht's Epic Theatre, a theatrical movement of the early 20th century based on theories and practices responding to the era's political climate, leading to the creation of new political dramas.

A history teacher will be needed for both the history of the Copernican revolution and the scientific revolution, together with their socio-cultural aspects. The theatre teacher has a master's degree in history and philosophy of science and technology, and together with the history teacher, could navigate the students through the historical events that lead to Galileo's discoveries and to the conflict with the Catholic Church, as well as the events that followed Galileo's era. Students' understanding of the history of science could enhance their NOS understanding.

A philosophy teacher, in collaboration with the theatre teacher, will define what philosophy of science is and shed light on the philosophical aspects not only of the scientific revolution and the scientific method but also of the theological positions in opposition to the scientific conclusions of Galileo about the revolution of the Earth around the Sun.

A physics teacher could offer more detailed explanations and insights into Galileo's theory from a scientific perspective. The physics teacher could construct two experiments. The first could be about measuring the acceleration of gravity using only a measuring tape to measure the altitude from which a ball is let fall and a stopwatch to measure the time it takes the ball to reach the floor. For the second experiment, the students could also calculate the acceleration of gravity using, this time, a swinging pendulum. The students could be informed that in all measurements, there are errors introduced. So, after repeating the experiments several times, the students will be taught how to use linear regression to find an approximation of the acceleration of gravity. A conversation could come after the experiments where the team will discuss the processes of physicists, the unavoidable errors introduced in measurement, and the reasons for recreating and repeating experiments.

The mathematics teacher will work together with the theatre teacher (who also has a bachelor's degree in mathematics and teaches mathematics at the school) concerning the mathematics involved in Galileo's theory. Furthermore, a discussion could follow on the nature of mathematics as a model for physics and other sciences. To increase NOS understanding and accurately describe the scientific method, students need to understand the importance that the mathematical models of the natural phenomena in question play in creating a hypothesis or, eventually, a theory in physics.

The biology teacher could also be proved essential because Galileo lived through two Plague outbreaks during his lifetime. A Plague outbreak takes place in one of the play's scenes that affects the characters' actions. In addition, given the COVID-19 pandemic and the requirement that students wear masks, an understanding of the biology aspect of pandemics is crucial not only for the analysis of the play and the understanding of the current situation but also for further deepening the NOS understanding of the students.

The presence and interaction of all the teachers from different disciplines working together to help students understand the multitude of ways available to explore the nature of the scientific endeavor could result in students' deepening of understanding of NOS.

Assessment Instruments for NOS Understanding

There are multiple assessment instruments for evaluating students' NOS understanding that have been proposed, administered, researched, and validated (Lederman et al., 2002; 2004; 2014; 2017, Lovelace & Brickman, 2013). Lederman et al. (2017) describe a plethora of NOS assessment instruments developed to assess students from 1954 to 2006 (Lederman et al., 2017, pp. 981-986). VNOS differs from typical paper and pencil instruments because of its open-ended nature. The results of their various studies and the follow-up interviews supported a high confidence level about the validity of the VNOS for assessing NOS understanding (p. 517). A historical review of the VNOS questionnaire and interview script can be found in the paper by Ayala-Villamil & García-Martínez (2021).

Lederman et al.'s paper (2017) is focused on evaluating the development of the open-ended instrument, *Views of NOS Questionnaire (VNOS)*. The authors find evidence regarding VNOS validity for the range of the NOS aspects it aims to assess. Lederman et al. claim that establishing an instrument's validity is always an ongoing process. The best the researchers can do is provide evidence of an instrument's efficacy in measuring what it is designed to measure. The results of their various studies and the follow-up interviews supported a high confidence level about the validity of the VNOS instrument for assessing NOS understanding.

For this action research project, we plan to use the *VNOS-Form C* instrument (Lederman et al., 2002, p. 509), adapting and improving it to assess students' understanding of NOS before the beginning of the classes, during the online research and rehearsals, and after the performances.

The Timeframe of the Design Proposal

First Grading Period

Part of the classes at the beginning of the school year is the administration of the *VNOS Form C Open-ended Questionnaire and Interview Script* (Lederman, 2002, p. 509). The plan for the improvisations, theatrical games, and team-building activities is the themes to be taken from historical debates within the scientific community and between scientists and philosophers, religion advocates, or proponents of other disciplines of inquiry. Usually, during the first grading period, the students read the play, analyze the plot and the characters, and improvise on specific characters for the casting process. The students will be asked to conduct online research in teams about topics related to their characters, the era, the themes introduced in the play, and unknown scientific terms. Then they could be asked to explain the researched topic to the rest of the team or engage in a debate. The language, the physics, and the biology teacher could come as guests during this first grading period. All the guests will present their topics and then, with the help and the interventions of the theatre teacher will lead a discussion with the students.

Second Grading Period

By the beginning of the second grading period, the casting will be finalized. At this point, the students usually present parts of their scenes and explore their characters by going more in-depth in understanding their intentions, the relations with the other characters, and the plot. The students will be asked to research online and discuss what natural philosophy, the experiment, and natural philosophy's methods were in Galileo's era. The literature teacher could come as a guest to discuss Brecht and *Epic Theatre* with the students. The theatre teacher could present and discuss with the students the history of science from Mesopotamia (3000 BCE) to Italy (1600 CE) and the history of optics in art and science, the camera obscura, and the telescope. The mathematics teacher could present the mathematics of Galileo's theory and the process of creating a mathematical model of a natural phenomenon. The history teacher could present to the students the history of the Catholic Church and the Inquisition. The *VNOS Form C Open-ended Questionnaire* and the interviews are planned to be administered again at the end of this second grading period.

Third Grading Period

During the third grading period, the students learn their lines, improvise their scenes staying in character, and have more detailed conversations about their characters. During this period, it is suggested to discuss how science and other inquiry disciplines affect and form different opinions, psychological traits, and characters and how society affects the object of scientific inquiry and its direction. How cognitive science research is conducted, and how science is different from art. The philosophy and the social studies teachers could be invited during this grading period. These two teachers and the theatre teacher could suggest topics for students' continuing online research, discussion, and debate.

Fourth Grading Period

The fourth grading period is devoted to rehearsing whole acts, the dress rehearsals, and the performances. More elaborate conversations on Galileo's scientific theory and the Catholic Church's beliefs and why they oppose each other are proposed to happen from a philosophical point of view. Themes that could be discussed are the differences between scientific knowledge, beliefs, and opinions and how the same scientific data can have different interpretations within the scientific community. The conversations for the last grading period are suggested to be about NOS, HPS, and Science literacy. This last grading period is the time for the students to self-reflect on what they have learned about what science is and its relationship with society. The *VNOS Form C Open-ended Questionnaire* and the interviews are proposed to be administered once more before the end of the fourth grading period.

Coda

The author understands the theatre team as a community that is building its knowledge collectively. The theatre teacher is a part of that community. Student questions about different themes, topics, or terms that could emerge at any point of the production process of the play could change the suggested timeframe of this proposal. Following a predetermined schedule independently of the flow, the process, and the level of student understanding defies the purpose and the iterative nature of action research. Action research, both as a philosophy and methodology of research, is a process that leads to transformative change through the iterative operation of taking action and doing research, linked and becoming a whole through critical reflection (Stringer, 2014).

Data Collection and Methodology

Throughout the school year, the qualitative data intended to be collected are observations and field notes, videos of all the lessons and the interviews, three answered *VNOS Form C Open-ended Questionnaires* from each participant student, and the interviews of the students. The assessment instrument for measuring the students' NOS understanding will be the *Views of Nature of Science - Form C Questionnaire and Interview Script*, which can be found in *Views of Nature of Science Questionnaire: Towards Valid and Meaningful Assessment of Learners' Conceptions of Nature of Science* (Lederman et al., 2002). At the end of the school year, all the observation and field notes, the videos, the three answered questionnaires per participating student, and the transcripts of their follow-up interviews will be put together for the qualitative data analysis that will follow. The answers to the questionnaires and the transcribed interview texts will be examined and interpreted to understand what they represent. This coding process of labeling and organizing the qualitative data will identify different themes and their relationships.

Views of Nature of Science - Form C Questionnaire and Interview Script

The *Views of Nature of Science - Form C Questionnaire and Interview Script* (Lederman et al., 2002, p. 509) comprises ten open-ended questions. Based on the questionnaire and the students' answers, the researcher will interview the students to ask clarification or follow-up questions using the ten questions and the students' replies as the interview script. The ten open-ended questions are seen below.

1. What in your view is science? What makes science (or a scientific discipline such as physics, biology, etc.) different from other disciplines of inquiry (e.g., religion, philosophy)?

2. What is an experiment?

3. Does the development of scientific knowledge require experiments?
• If yes, explain why. Give an example to defend your position.
• If no, explain why. Give an example to defend your position.

4. After scientists have developed a scientific theory (e.g., atomic theory, evolution theory), does the theory ever change?
• If you believe that scientific theories do not change, explain why. Defend your answer with examples.
• If you believe that scientific theories do change: (a) Explain why theories change? (b) Explained why we
bother to learn scientific theories? Defend your answer with examples.

5. Is there a difference between a scientific theory and a scientific law? Illustrate your answer with an example.

6. Science textbooks often represent the atom as a central nucleus composed of protons (positively charged particles) and neutrons (neutral particles) with electrons (negatively charged particles) orbiting that nucleus. How certain are scientists about the structure of the atom? What specific evidence do you think scientists used to determine what an atom looks like?

7. Science textbooks often define a species as a group of organisms that share similar characteristics and can interbreed with one another to produce fertile offspring. How certain are scientists about their characterization of what a species is? What specific evidence do you think scientists used to determine what the species is?

8. It is believed that about 65 million years ago the dinosaurs became extinct. Of the hypotheses formulated by scientists to explain the extinction, two enjoy wide support. The first, formulated by one group of scientists, subjects that a huge meteorite hit the Earth 65 million years ago and led to a series of events that caused the extinction. The second hypothesis, formulated by another group of scientists, suggests that massive and violent volcanic eruptions were responsible for the extinction. How are these different conclusions possible if scientists in both groups have access to and use the same set of data to derive their conclusions?

9. Some claim that science is infused with social and cultural values. That is, science reflects the social and political values, philosophical assumptions, and intellectual norms of the culture in which it is practiced. Others claim that science is universal. That is, science transcends national and cultural boundaries and is not affected by social, political, and philosophical values, and intellectual norms of the culture in which it is practiced.

• If you believe that science reflects social and cultural values, explain why. Defend your answer with
examples.
• If you believe that science is universal, explain why. Defend your answer with examples.

10. Scientists perform experiments/investigations when trying to find answers to the questions they put forth. Do scientists use their creativity and imagination during their investigations?
• If yes, then at which stages of the investigations you believe scientists use their imagination and creativity:
planning and design, data collection, after data collection? Please explain why scientists use imagination
and creativity. Provide examples if appropriate.
• If you believe that scientists do not use imagination and creativity, please explain why. Provide examples if
appropriate.

Expected Outcomes

A critical reflection could inform and adapt the elective Theatre course based on the implementation of this action research design and its conclusions. Through this process of analysis of learning needs and goals, the end product of this design is suggested to be developing a delivery system to meet the students' needs in successfully enhancing NOS understanding through the school production of theatrical plays relative to the history of science.

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Exploring Levels and Patterns of Social Presence in Asynchronous Online Discussion (AODs): A Longitudinal Study

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Abstract

The prevalence of shifting face-to-face classes to online learning under the pandemic suggests that social presence is crucial in overcoming inherently impersonal characteristics of online instruction. Observation techniques, social network mapping, and content analysis, using the Community of Inquiry framework (CoI), were conducted in a longitudinal study exploring patterns of social presence across two online courses over two semesters for a single cohort of graduate students. Patterns and suggestions for the instructional design are discussed.

Keywords: Asynchronous Online Discussions; Social Presence

Introduction

Education largely depends on social interaction and effective communication (Lowenthal & Dunlap, 2018). Interaction has been stated as one of the critical aspects of the online learning environment (Moore, 1989; Wagner, 1994) since it enables learners to gain other people's perspectives through interaction, and it is essential to create a learning community advocated by Garrison, and other learning theorists who emphasize the crucial role of community in learning (Garrison, Anderson & Archer, 2000). Social presence and interaction are closely related (Huang, Gan, Wen & Li, 2017), that the concept of presence has been used to understand interactions in online learning environments (Saadatmand et al., 2017). Arbaugh et al. (2008) suggest that the CoI is a powerful and relevant theoretical framework to examine and explain online learning effectiveness and provides opportunities for researchers to evaluate learners' interaction and experiences in online learning environments. In Community of Inquiry framework (CoI), social presence is a popular construct used to describe and understand how people socially interact in online learning environments (Whiteside, Dikkers, & Swan, 2017). Garrison (2009) defined social presence as "the ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop interpersonal relationships progressively by projecting their individual personalities."

An appropriate pedagogical design and proper exploitation of social technologies are crucial in fostering the processes of communication and interaction (Saadatmand et al., 2017). Asynchronous online discussions (AODs) are among the most widely used instructional techniques to support students' online learning (Koszalka, Pavlov & Wu, 2021; Gao, Zhang & Franklin, 2013). Participating in AODs through sharing thoughts, asking questions, and providing feedback, students are provided with ample possibilities that promote interaction and communication, thus building community in the online learning environment (Yang, Yeh & Wong, 2010).

Considerable effort has been devoted to studying social presence's establishment, notwithstanding, the nature and development of social presence in the online learning environment is still an ongoing issue (Lowenthal & Dunlap, 2018, 2020; Rourke & Kanuka, 2009; Swan & Shih, 2005). The majority of the social presence research sought to evaluate and measure students' perceptions of social presence by solely employing self-report surveys and interview instruments, which overlooked the importance of assessing and observing students' actual social presence behaviors with specific indicators. Empirical evidence also suggests that students' perceptions derived from self-reporting surveys do not accurately represent and truly match with their actual behaviors and participations in online courses (Picciano, 2002). Bernard et al. (2009) reported in their meta-analysis on interaction that research on interaction in distance education and online learning tends to focus more on interaction interventions (i.e., conditions or environments designed to elicit interaction) than on students' actual interactions (i.e., their behaviors). In addition, many of the previous social presence studies were conducted as short-term studies within the same context with different participants. Given the importance of social interaction in terms of developing social presence, it is necessary to further analyze how students interact online to establish social presence, thereby achieving an interactive and communicative online learning community that is meaningful to their learning experiences.

Beyond the self-report surveying generally used in this type of research, this longitudinal study explored the patterns and levels of the same cohort of graduate students' social presence in AODs across two online courses over two semesters. We sought to explore various patterns among students' social interactions and relationships in AODs. Observation techniques, document analysis, and social network mapping were employed to provide another point of analysis that faithfully characterizes the characteristics and the development of social interactions and social presence in the online environment.

Research Questions

Based on previous research limitations that justify the need for conducting the current study, the questions guiding this study focus on the nature and development of social presence. Typically, social presence is established and maintained in AODs through social interactions among the same cohort of students over the long term across two semesters. The specific research questions were:

1. What are the patterns of social presence within a single cohort of students in AODs across two online courses over two semesters?
2. What are the levels of social presence within a single cohort of students in AODs across two online courses over two semesters?

Method

Participants & Context

The study participants were the same cohort of twelve full-time graduate students who enrolled in two consecutive online courses over two semesters (Fall 2020 & Spring 2021) for an MS Instructional Design at a private northeastern university in the United States. The average age of the participants was 44 years old, and most of the participants were male (80%). The majority of the participants were active duty (80%), and the rest were veterans (20%). The average number of previous online courses have taken among participants was above four.

Data Collection & Analysis

Data collected from AOD scripts from two different consecutive online courses was under an IRB exempt status. The analysis comprises embedded case studies, 5 cases of AODs in Fall 2020 course, and 5 in Spring 2021. Transcripts of postings from two courses were retrieved from the Blackboard LMS, downloaded, cleaned, and saved in the qualitative data analysis software MAXQDA before coding. Transcript analysis was applied using the categorical indicators defined in the CoI framework, where social presence was analyzed in the transcripts by coding for affective responses, interactive responses, and cohesive responses (Swan, 2003; Hughes et al., 2007). The unit of analysis was sentence, whereby a single sentence could include multiple social presence indicators. Through an iterative coding practice process, two coders finalized the coding scheme with an inter-rater agreement of 0.75. Social network mapping analysis was conducted through Gephi 0.9.2 program to investigate and visualize the participation patterns and interaction levels manifested within and across the two courses over two semesters.

Results

Social Presence Category Pattern

The descriptive data for the Fall 2020 course revealed that cohesive responses were present the most and had the highest overall mean scores (M= 98.6), followed by interactive (M= 90.2) and affective responses (M= 37.6). Across all the AODs in the Fall term, there was a relatively minor mean score difference between interactive and cohesive responses ($M_{Interactive}$= 90.2; $M_{Cohesive}$= 98.6) than the mean score differences between these two categories and the affective responses category ($M_{Affective}$= 37.6) since it was the only category had a mean score below 50 across two courses. This suggested that throughout the AODs in the Fall term, students barely used words or sentences that indicate their self-projection and acceptations of others into and within the learning community (Rourke et al., 1999).

Though the frequency and the mean score orders of social presence categories in the Spring 2021 course remained as the same pattern as the Fall 2020 course, the sharp decrease in the overall interactive responses and the moderate increase in the affective responses resulted in a larger difference between interactive and cohesive responses ($M_{Interactive}$= 76.0; $M_{Cohesive}$= 101.2) comparing to the one that the Fall term had. The overall increase in affective responses from the Fall term (M= 37.6) to the Spring term (M= 51.4) within the same cohort of students suggested that providing opportunities for longer interaction time and collaboration experiences might help facilitate student degree of comfort in recognizing each other in an online learning community.

Social Presence Indicator Pattern

Filling the gap of the majority of previous social presence research studies in the literature that "did not report results at the indicator level" (Lowenthal et al., 2020), this study looked at and compared the occurrence and frequency of individual social presence indicators across two courses. As the findings suggested, vocatives (M_{Fall}= 46.8; M_{Spring}= 49.6) and group references (M_{Fall}= 42.8; M_{Spring}= 49) were two mostly used social presence indicators that had the highest mean scores across both courses, followed by complimenting, expressing appreciation (M_{Fall}= 34.8; M_{Spring}= 31), and acknowledgment (M_{Fall}= 25.8; M_{Spring}= 25.4). On the contrary, embracing the group (M_{Fall}= 3.6; M_{Spring}= 0) was the least frequently used indicator, followed by humor (M_{Fall}= 4; M_{Spring}= 4.2), and greetings and salutations (M_{Fall}= 5.4; M_{Spring}= 2.6).

Overall, across two courses, the increasing trend in the affective responses (e.g., self-disclosure, paralanguage & humor) and the decreasing trend in interactive responses (e.g., agreement/disagreement, invitation, complimenting, and expressing appreciation) suggested that students felt and became more comfortable in sharing personal experiences with their peers as they keep collaborating from the Fall term to the Spring term, but tended to less focusing on exchanging meaningful knowledge or ideas related to the course content.

Student Interaction and Relationship Patterns Across Two Courses

Social network analysis was conducted to map out the differences of the same cohort of students' interactive activities patterns and relationships between two courses as shown in **Figure 1**, where the Fall 2020 course is on the left, and the Spring 2021 course is on the right side. Each map includes 12 nodes representing a student and one node representing the instructor (INS). In the visualization, the node size indicates each student's level of activity in responding to others' posts in AODs. It was calculated by the total number of responses that the student sent out divided by the total number of participants. The node color indicates students' popularity and centrality within the AODs calculated by the total number of responses the student received divided by the total number of participants. The higher the number, the more popular the student is. The edge and its width connecting the nodes represent the frequencies of participant interactions, and the arrows point out the directions of interactions.

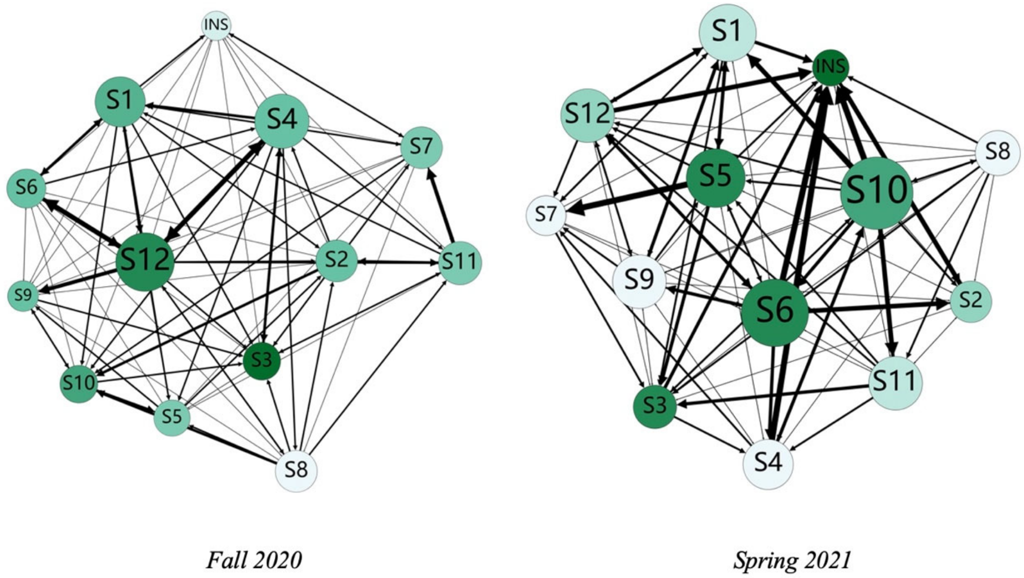

Figure 1. *Interaction Patterns and Relationships in Two Courses*

By comparing the social network maps between the two courses, there were more nodes in dark green in the Spring 2021 course than in the Fall 2020 course. This suggested that students replied as well as received more responses among each other in the Spring term than in the Fall term. Overall, the node sizes in the Spring 2021 course were relatively larger than those in the Fall 2020 course, which also demonstrated a higher student participation rate in replying to others' posts. There was an increasing number of thick edges among students in the Spring 2021 course than in the Fall 2020 course. Most of the thick edges among students in the Spring 2021 turned to be more stable and evenly distributed, which suggested that the Spring semester course had created a more trusting and sociable interactive learning community, where students had expanded their communications without a fixed social circle after experiencing previous AODs in the Fall semester. In addition, there was an increase in the number of students who had popular postings in the Spring course that aroused resonations and sympathies among peers. Though the sizes of instructor's nodes in both courses were almost the same, the Spring 2021's instructor had a much darker green node, which suggested the instructor's posts or comments had received more attentions among students as well as elicited more discussions with students.

Levels of Social Presence within Each AOD Across Two Courses

The percentage value for each of the social presence categories in each AOD case across two courses were calculated based on the number of coded sentences that contained one social presence category in one certain case divided by the sum of coded sentences that containing that particular category within all five cases in each course. The two courses shared the same highest level of affective responses and cohesive responses (28%) and the similar highest level of interactive responses (Fall = 25%; Spring = 26%). The majority of the thread sentences were coded as Cohesive Responses (44% in both Fall 2020 & Spring 2021), indicating a steady level of group cohesion within the same cohort of graduates over two courses.

Overall, both courses experienced similar observable fluctuation patterns of social presence level, which suggested that different time points throughout the course semester might influence students' level of participation and engagement in interacting with each other. Besides, different types of discussion topics and questions might also influence the level of social presence.

Discussion

Instruction Stages

Spending time in the Fall 2020 semester to interact and learn through participating AODs activity, the same cohort of students established and developed social presence continuously and intensely in the Spring 2021 semester. This study showed that different stages of AODs activity throughout the semester had an essential impact on student social presence level. The same repeated patterns of social presence level across two courses suggested that during the late half of the semester, students might experience course fatigue, which will lead to a lack of interest and motivations in participating and engaging in AODs. Specifically, the observable fluctuations were in the affective and cohesive responses. Therefore, this informed online instructional designers and educators to carefully plan and arrange AOD activity based on different stages to effectively sustain student efforts and volitions in interacting with each other as well as to avoid having a sense of loneliness and lack of interest in participating in AODs due to the inherently impersonal characteristics of the online learning environment.

Instructor Involvement

Social presence, however, may not be increased over time without appropriate instructional design (Akyol et al., 2011; Shea, 2006). Students may not perceive a higher social presence in a long-term course if the instructor does not provide more interaction opportunities and proper instructional approaches (Lee et al., 2018). Research has reported that the level of instructor involvement has an impact on student social presence. Lowenthal et al. (2020) found low instructor involvement helps build social presence, and findings in An et al.'s (2009) study showed students tended to express thoughts and opinions more freely with many social presence cues when the instructor's intervention was minimal. In this study, both courses had a limited level of instructor involvement, as shown in **Figure 1**. Nonetheless, there was still a higher level of social presence categories in the Spring 2021 course that could be attributed to the instructor's role in AODs. As thus, while keeping a minimal level of instructor involvement to help establish a higher level of social presence, online instructors should also be attentive to other instructor role-related aspects that might influence student social presence, such as the time for instructor entering and posting messages, the quality of the discussion feedback given, and the tones and styles of asking prompt questions that might arouse further and deeper discussions.

In this study, the decrease in interactive responses in the Spring 2021 course indicated that the same cohort of students related and shared more about personal experiences as they were getting used to interact and communicate with each other as a group, but less course content learning-related behaviors were noticed. Thus, this suggested instructor should make sure to keep students are interacting with each other in a meaningful learning way. Establishing social presence means creating a climate that supports critical inquiry to achieve educational outcomes (Garrison & Akyol, 2013). According to the CoI framework, the teacher plays an important role in building social presence. The instructor establishes relationships and a sense of belonging by designing, facilitating, and directing cognitive and social presences. The teacher's personality, teaching styles, approaches, and beliefs influence the development of presence (Casey & Kroth, 2013). There is a lack of research focusing on the instructional effect on helping students build social presence in the literature. Future research could examine whether there is a causal relationship between different instructional approaches and student social presence to investigate why students' interactive responses decreased over time, and which instructional strategies could effectively facilitate a higher level of social presence in online courses.

Previous relationships

Research has suggested that having a past relationship with class members is helpful when establishing social presence in online courses, where Lowenthal et al. (2018; 2020) found a positive group project experience helps increase students' perception of social presence and further helps maintain relationships with others. The results of this study confirmed their findings in a way that it is valuable that having "a cohort model enables students' multiple opportunities to build relationships with others across semesters" (Lowenthal, 2020) since the Spring 2021 social network map showed a more stable and expanded scope of student interactions with each other. Moreover, since all the participants in this study had a military background, even they did not have previous social relationship, their similar background set up a learning community that is easy for them to understand each other. Future studies could examine social presence within a cohort of students with different backgrounds, such as military versus on-campus students. In addition, it would also be helpful to study students individually based on their characteristics.

Conclusion

This longitudinal study investigated the social presence among the same cohort of students across two courses. Student discussion posts indicated that social presence, as analyzed through observation of behaviors, was an important part of AODs. Findings in this study help unpack the complexity and establishment of social relationships and provide insights into making AODs more productive. Thus, inform instructional designers and online educators on possible techniques to enhance and evoke student participation and engagement in AODs to gain a better and meaningful online learning experience. Hence, the analysis of these case studies provided further insights into the growth of social presence levels in AODs.

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Qualitative Research: Chinese language faculty's use of technological pedagogical content knowledge to engage students during emergency remote teaching

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Abstract

The purpose of the study was to investigate college language faculty's use of technologies to organize teaching and learning in language classrooms during emergency remote teaching necessitated by the pandemic in the spring semester of 2020. The study used Mishra and Koehler 's (2006) theoretical framework of the Technological Pedagogical Content Knowledge (TPACK) to analyze the five Chinese language instructors' strategies to virtually engage their students. The results indicate three themes in the participants' ERT relative to student engagement: Frequent communication, ERT-sustainable materials, and quick turnaround times for interaction. The study results offer theoretical and practical implications for both researchers and instructors.

Keywords: TPACK, emergency remote teaching (ERT)

Introduction

Language classrooms are typically interactive because the instructor and students are often engaged in a variety of activities to practice the language skills, such as drills, instant feedback, role-plays, and discussions. These exercises usually work well with the participants' physical presence. However, what would happen to language teaching and learning when a face-to-face spontaneity is absent from the instruction and when an exclusive reliance on technology as an instructional medium is necessary? The pandemic outbreak during the spring semester of 2020 abruptly migrated most college faculty and students in the United States from an in-person instructional setting to an emergency remote teaching (ERT) environment. ERT in this study refers to a temporary shift in the teaching modality that extemporaneously transforms what would have otherwise been face-to-face teaching components into a digital form.

One of the key differences that sets apart ERT from well-structured online instruction is its urgent, emergent nature. At many institutions, teaching online in a regular semester is a "bottom-up" affair (Lesht & Windes, 2011), in which faculty members elect to do so and have time for preparation. In addition, typically students are enrolled in web-based courses by choice. The willingness of faculty and students can be pivotal for successful technology integration into the instructional practice in non-emergency circumstances (Reid, 2012). Moreover, virtual teaching and learning involves instructors and learners in a process of role transformation (Cochran & Bemuto, 2016). Many online educators and students experience a shift in their roles from an in-classroom instructor and student with a visible center of attention to an invisible facilitator and users of online materials (Bair &Bair, 2011). Such a transition is often a movement on a continuum, and the faculty and students continue to adjust themselves in their new roles and learn to navigate how they can better engage with one another and with the subject content as online instruction proceeds. That is, in a non-crisis online educational setting, both faculty and students can pace themselves in their practical and psychological preparation as they transition to online instruction. However, that is not the case for ERT, when the situation indiscriminately demands a rapid transition from faculty and students, including those who did not have the skills or resources needed to thrive in the digital landscape. While less than ideal, this underprepared transition in the teaching modality presented both pedagogical challenges and growth opportunities.

The purpose of the study was to analyze college faculty's use of technologies to organize teaching and learning in language classrooms during ERT. Guided by Mishra and Koehler 's (2006) theoretical framework of the Technological Pedagogical Content Knowledge (TPACK), the study attempts to answer the following research question: How did Chinese language faculty apply their technological pedagogical content knowledge to engage students during ERT? The research findings are important because they evaluated the technological pedagogical content knowledge of instructors, who were not pedagogical technology specialists but completed their ERT successfully. The evaluation offers insights on the theoretical and curricular role that TPACK plays in faculty development. Moreover, this study discussed student-content engagement, one core emergent theme in the data, and raised questions regarding sustainability of virtual teaching materials.

Literature Review

Mishra and Koehler (2006) assert that when using technology to facilitate teaching, teacher knowledge of technology is context-dependent and integral to the knowledge system of subject matter and pedagogy. The technology knowledge has "a ripple effect" (p.1025) affecting faculty's instructional decisions because the use of technology, such as a Learning Management System (LMS), can change how instructors organize and then present the content information in a way that would have been different in the absence of technology. These technological pedagogical knowledge and skills need to be learned by faculty before effective application of educational technology can take place (Mohr & Shelton, 2017). However, in the reality, online instructors in a well-planned teaching context can still experience challenges. The faculty participants in Eichelberger and Leong's study (2019) reported that technical failures caused students' frustration and impatience with the instructors during their synchronous sessions. The participants in their study believed that these negative outcomes would have been mitigated had teachers and students had more specific knowledge to troubleshoot effectively. While some technical issues are evidently beyond faculty's control (e.g., an internet outage), they still affect instructional productivity. This leads to an inquiry regarding what faculty can do to plan and foster positive online student engagement and offer both instructional and social support in terms that enhances the teaching outcomes that technological efforts alone or the lack thereof cannot achieve in a virtual learning environment.

TPACK Framework

Teaching online is a complex cognitive activity that relies on teachers' flexible access to their many organized knowledge systems fundamental to teaching. To offer grounding that describes interplay among essential qualities of teacher knowledge necessary for successful use of educational technology in their teaching, Mishra and Koehler (2006) proposed Technological Pedagogical Content Knowledge (TPACK) framework based on Shulman's (1986) epistemological concept of pedagogical content knowledge with an integrative addition of technology. Shulman's model considers pedagogical content knowledge as a qualifier that defines the profession of teaching: teachers consider the process of teaching and learning and then accordingly interpret, organize, represent, and formulate the subject matter in comprehensible ways for their students. That is, content is transformed for teaching through teachers' application of pedagogical knowledge. Mishra and Koehler's TPACK is conceptualized in a similar way with an added domain of technology knowledge, and the integrated technological pedagogical content knowledge can change educators' consideration for not only instructional delivery but also the overall curriculum design (Voogt et al., 2011), such as offering online options in addition to in-person sessions.

TPACK is commonly represented using a Venn diagram with three overlapping circles representing the three core types of knowledge: content, pedagogy, and technology. The model proposes that the interplay among the three circles results in four additional types of knowledge with technological pedagogical content knowledge sitting in the center (see Figure 1).

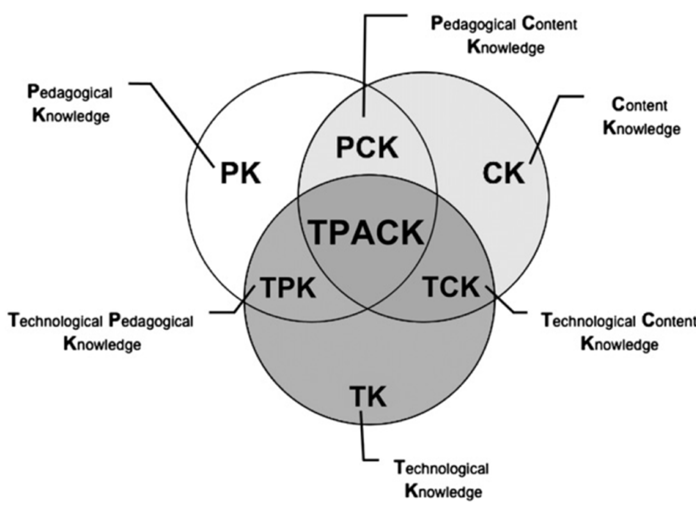

Figure 1 The TPACK framework (Archambault & Barnett, 2010, p. 1954)

The framework addresses three core interdependent constructs, three pairs of connected knowledge domains, and the centrally overlapped area. Pedagogical content knowledge is the integration of subject matter expertise and mastery of teaching skills. Technological content knowledge concerns the ways that application of technology changes the nature of content representation and learning processes. Technological pedagogical knowledge points to a teacher's knowledge regarding the available technological tools and teachers' capacity to strategically choose technologies to enhance learning outcomes. Coming together, technological pedagogical content knowledge is the basis of meaningful teaching with technology and requires faculty's understanding of

> the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones (Mishra & Koehler, 2006, p.1029).

The TPACK theoretical model is often used for analyzing teacher's integrated knowledge of technology, pedagogy, and content and examining how teachers apply technologies to represent, formulate, and transform the subject so it is comprehensible to learners. However, teachers' knowledge is complex, and an interconnectedness of multiple elements can make isolation and measurement of these individual types of knowledge challenging. Hence, while TPACK offers multiple categories of teachers' knowledge relative to content, pedagogy, and technology, researchers have been challenged by the fuzzy boundaries between adjacent constructs that are uneasy to separate out (Graham, 2011). Moreover, TPACK does not fully examine contextual factors known to impact instruction, such as faculty beliefs about their online teaching using TPACK (Eichelberger & Leong, 2019). Nevertheless, TPACK is helpful in organizing teachers' relevant knowledge domains (Archambault & Barnett, 2010).

Student engagement

Student engagement is crucial to improve student satisfaction, motivation to learn, sense of learning community, and academic performance (Martin & Bolliger, 2019). In understanding the importance of student engagement, Laurillard (2000) articulated that the purpose of higher education moves far above information access and aims to enable individuals to develop their capabilities to the fullest through "engagement with others in the gradual development of their personal understanding" (p.133). Such engagement, according to Anderson (2003), is developed through interaction among faculty, students, and subject content. In other words, both human and nonhuman engagement activities are essential and complementary elements of quality teaching and learning experiences. The research findings of Handelsman et al. (2005) suggested that an individual's interactivities with their peers, instructor, and content leads to an engaged learner, and that engagement is a significant predictor for the student academic achievement. The study of Abdous and Yen (2010) also supported the significant role of learner-to-teacher interaction in learning outcomes and student satisfaction in an online environment. Moreover, the study of Lear et al. (2010) showed that social engagement fostered among peers and faculty through class interactivity develops a sense of community, and this sense of belonging contributes to student learning and places faculty at the center of community development. Quality teaching and learning is reciprocal, responsive, and social, not competitive or isolated, and engagement among faculty, students, and content affords the participants opportunities to exchange ideas and sharpen thinking (Chickering & Gamson, 1987). Hence, educational engagement involves both social and cognitive aspects in an online learning community. The construct of student engagement in this study is situated within the ERT parameters and therefore refers to the instructor's use of technologies to organize their teaching activities and purposefully create virtual learning opportunities through students' interaction with the instructor, their peers, and the subject content.

Methodology

Participants

With the approval from the institutional review board at the researcher's university, a non-probability purposive sampling procedure was adopted to identify five faculty participants to represent the most diversity within the constraints (Teddlie & Tashakkori, 2008). A snowball recruitment technique was used to compile an initial list of twenty college Chinese language instructors who taught during ERT in the United States. Subsequently, the twenty instructors were cross-categorized by their genders, years of experience, position titles, and institutional types. One or two participants from each category were then selected to form the purposive sample. The five participants taught in four different classifications of institutions in the United States: state research-oriented, state teaching-focused, private research-emphasized, and private liberal arts. The participants were all native speakers of Chinese originated from either China or Taiwan between the ages of twenty-eight and sixty-five. The participants included both male and female, and their position titles ranked from Instructor I to Full Professor.

Interview questionnaire instrument

Voogt et al. (2013) pointed out that ultimately online instructors need to be competent in teaching their specific subject areas with technology and thus suggested that teacher's use of technology be assessed using TPACK that addresses domain-specific knowledge. As such, the instrument specified the interconnectedness among technology, language pedagogy, and Chinese language. Guided by the theoretical TPACK framework and the research question, an open-ended, semi-structured interview instrument was used for data collection during the videoconferencing interviews. To increase the instrument content validity and questioning techniques, three college professors who taught Chinese language during ERT but were not participants in the study were recruited for the field test. The instrument was subsequently revised according to the three professors' feedback. The five interviews ranged from sixty to eighty minutes, and they were centered on the following four core inquiries with varying follow-up questions based on the participants' narratives.

1. Can you share an overview of the differences in how you engaged your students before and during ERT?
2. Technological knowledge: Please describe your experience in using educational technologies before and during ERT.
3. Content knowledge: Please describe your specialized areas in Chinese language teaching and the materials you used before and during ERT.
4. Pedagogical knowledge: Please describe your teaching rationale and how you purposefully presented the subject content and create an effective learning experience before and during ERT?

Data analysis

The data included the video recordings, field notes, and analytic memos. They were member checked and coded using Saldana's (2009) the first and second coding procedure for recursive themes and explanations. The initial round of coding sought to list major topics relative to TPACK within individual interviews. The second coding focused on the shared topics across the five interviews. The third round of coding analyzed the interconnectedness among sub-datasets within and across the interviews. The final coding synthesized the thematic sub-datasets and prepared for listing findings. To verify the validity of the findings, two colleagues, who participated in the field test, checked the final codebook for data consistency and repeatability (Trochim, 2006) and verified that the listed findings were supported by the data (Guion, 2002).

Findings

This study sought to answer the question: How did Chinese language faculty apply their technological pedagogical content knowledge to engage students during ERT? The participants shared that while they were neither specialized in educational technologies nor a regular user of technologies beyond emailing and creating presentation slides before ERT, they became able to proficiently apply new technologies to engage students in a variety of learning activities during ERT. Three types of engagement that were described across the participants during ERT are as follows.

- Instructor-students interaction, such as intentional and frequent communication with students via voice messages for pronunciation assistance, routine check-in emails with Graphic Interchange Formats (GIFs) and emoji inserted, and one-on-one synchronous meetings to support both students' academic and personal needs
- Student-content interaction, such as the use of thought-provoking materials recorded by the students to invite sustainable virtual discussions
- Student-student interaction, such as adoptions of discussion-board topics that allowed quick responses and short turnaround times

One common theme in the discussions regarding the participants' approaches to create an effective ERT experience was their use of the course suspension days to transition their classes into ERT. During the course suspension periods, which ranged from three to fourteen days depending on the institution, while the faculty were not allowed to assign students any academic work, the participants strategized the time to collect information about their students' academic and personal needs. The participants used online free survey tools or connected with their students individually through email or videoconferencing to inquire about the students' expectations of their learning during ERT. Based on the information, the faculty participants revised the syllabi accordingly. Participant One reported, "My students indicated in the survey that they wanted to finish the semester strong and were concerned that the learning outcomes would be compromised. As such, my goal during ERT was not only to survive but also to thrive." The participants also communicated with their students using online discussion boards during the suspension periods to share questions and answers among the students. In this endeavor, the participants intended their information exchanges to be frequent, quick, and brief. The twofold intentions of frequent communication through varying modalities were reported to provide timely academic and psychological support during the learning interruption. Moreover, in creating an effective ERT experience, the participants needed to reorganize teaching materials in effective ways, such as digitalizing the materials and centralizing the location of the files on the LMS. Furthermore, considering the challenges associated with students' personal lives (e.g., home environments not suitable for synchronous learning), the participants offered their students frequent individualized assistance through supplementary text-based, recorded, and synchronized instruction so the students could achieve the learning outcomes as they would have had they remained on campus.

The participants reported that the development of students' spoken skills and grammar knowledge continued to be key instructional objectives during ERT. In explaining the implementation of different pedagogies during ERT, Participant Two shared that "Technological constraints affected my instructional clarity. Hence, I sent pronunciation corrections through voice messages alongside text explanations. I also recorded a series of grammar lectures that my students could watch outside the class hours and have more time and space to reflect on them." Examples of technological constraints in this case are as follows. Pronunciation drills on videoconferencing were less effective due to the lack of eye contact and rhythm. Moreover, the instructor could not instantly pick up markers of different colors to enhance key points or handwrite Chinese characters on the screen easily. According to the student evaluation of teaching, the students found voice messages and videos helpful because they were engaged with the content through a familiar voice and pedagogy.

In addition to increasing more time and space for students' independent learning during ERT, the participants discussed the need for shortening turnaround times in a videoconferencing setting. Videoconferencing technology did not allow the instructor to attend to multiple breakout rooms simultaneously. Moreover, the transition between big and small groups often interrupted the class momentum. Upon realizing the technological limits, all participants chose not to continue virtual small group practice. As a result, when the entire class was present, only one student or one group could practice conversations at a time, and the rest had to just wait on the screen. This arrangement then created a new challenge, for large group provided less practice opportunities for each individual than small groups work. In responding to the technological challenges, keeping the class momentum, avoiding unmoderated breakout room activities, and involving more students to practice speaking during group learning, the participants compensated for the absence of small group work for smaller tasks. Specifically, Participant Three created a pool of varying smaller tasks for frequent teacher-student and student-student interactions by "downsizing" the regular speaking exercises, which would have otherwise been more extensive in a traditional classroom when physical contextual cues (e.g., body movements and acting) were available. Smaller-size language tasks using visual and audio prompts to elicit student output allowed quick turnaround times and enabled everyone in class to have new questions instead of repeating what had already been answered by their peers. Alongside the concept of quick turnaround times, the participants emphasized that the exchanges on the discussion boards featured frequent "short and sweet" responses to invite participation and move discussions along.

In elaborating on ERT pedagogies, the participants further discussed the importance of meaningful student-content interaction. To engage students with the subject content in a comfortable pace during ERT, Participant Four designed the speaking exercises in an online collaborative space where students regularly recorded their verbal comments based on multimedia prompts, such as videos, images, and voice recordings. The instructor then offered timely feedback on the same collaborative space. According to Participant Four, these exercises could make up for small group discussions, which were reported to be ineffective in their beginning-level language instructional context through videoconferencing. Moreover, to sharpen students' critical thinking skills, sustain their interest in the discussion, and build students' vocabulary, Participant Five purposefully asked students to videotape masking and COVID-19 situations in their towns or countries to stimulate discussion on first-hand information. According to the participant, the students were enthusiastic, and the discussions were engaging, which pushed the students to use more expressive vocabulary words. Participant Two added that when the materials could cause reactions from students, they were "idle-time-free" materials that were especially valuable in an online classroom.

Discussions

Overall, the findings reported that the participants did not consider themselves as specialists in digital literacy over pedagogical technologies before ERT. Regardless, the participants did not encounter or perceive any technical difficulties that stopped them from engaging their students during ERT. The participants concluded that they achieved their teaching goals and finished ERT successfully. This finding supports Lee's (2009) study that foreign language instructors who teach remotely are encouraged to "have good general computer literacy and skills, but they do not necessarily have to be familiar with each technology" (p. 250) in order to succeed in their teaching. Their digital literacy enabled the participants to implement an array of ERT instructional activities, and the three reoccurring pedagogical themes relative to student engagement during ERT were frequent communication, ERT-sustainable materials, and quick turnaround times for interaction. The data suggested that the participants purposefully selected a variety of technologies to help them to meet these pedagogical needs. Informed by the TPACK model, this section discusses how the participants presented effective instruction with technology and analyzed the teaching activities that would not have been accomplished without the integration of technology.

Frequent communication

Teacher-student engagement was reported to be more frequent. The high frequency occurred outside the instructional time, including both the suspension periods and throughout ERT, via online survey tools, email, and one-on-one videoconferencing. The increased frequency in communication was intentional and strategized by the participants to gather students' input on how to best organize teaching, provide academic assistance, and offer student wellness support during the unprecedented interruptions. These purposeful, frequent communication activities with individual students (e.g. polling students' learning preferences during ERT and promptly answering pronunciation questions via voice messages in addition to a written explanation) wouldn't have been accomplished without the integration of technology. That is, to create varying representations of the subject content and achieve their teaching objectives, the faculty participants needed to deploy different types of technologies. These technological tools assisted the participants to include various communication genres and purposes, such as written and oral, visual, audio, and text, formal and informal, concise and elaborate, social-affective and educational, and individual and community-based. The participants' use of technology showed their "ability to choose a tool based on its fitness, strategies for using the tool's affordances, and knowledge of pedagogical strategies and the ability to apply those strategies for use of technologies" (Mishra & Koehler, 2006, p. 1028). These implementations are evidence of the participants' technological content knowledge.

In addition to the increased occurrence of communication, the participants' use of symbols in written communication also changed. Many emotions were derived from interlocutors' physical presence (e.g., proximity, body movement, and posture), and because they could not be replicated during ERT, the participants inserted emojis, GIFs, and memes more frequently as a means of establishing animated engagement with their students. According to Resnick (1991) that instructor-student rapport can greatly affect the nature of student learning and educational outcomes. It is because when members in a learning community find the communication and interaction enjoyable and personally fulfilling, they are more likely to remain in the learning circle for the duration of the educational process and uphold the academic rigor (Garrison et al., 2000). As such, the frequent, positive connections with the students may have contributed to the participants' achievement in attaining their pedagogical objectives during ERT. In this study, the participants first identified characteristics of communication during ERT, "the nature of the target audience" (Mishra & Koehler, 2006, p. 1027), and their pedagogical options. Subsequently, based on their understanding of the emergent instructional context, the participants chose technological tools that could easily poll student information, complement other tools (e.g., voice messages along with text explanations), and compensated for the loss of in-person communication during ERT. These teaching activities and decisions, which involved integration of the three core constructs of technology, pedagogy, and content, reflected the participants' application of TPACK in their virtual instruction.

ERT-sustainable materials

Academic rigor remained crucial to both the participants and their students during ERT. As such, the theme of sustainability in material creation and reorganization was reoccurring in the data. The analyses showed two characteristics of the materials that qualified them to be sustainable in terms of enacting student-content engagement and providing academic support during ERT. First, thought-provoking was the feature that the participants were looking for when selecting videoconferencing-effective materials. This rationale is supported by the study results of Martin and Bolliger (2018) that online discussions on topics that encourage deep reflection to be the most valuable engagement strategy. Specifically, the "heated" discussions over the masking policies engaged Participant Five's students with the content, and such pedagogically crafted learner-content interaction could introduce "changes in the learner's understanding, the learner's perspective, or the cognitive structures of the learner's mind" (Moore, 1993, p.20). Participant Five's use of contentious videos, which were filmed by the students, about how COVID-19 masking was enforced in different areas was an example of the participant's application of technological pedagogical content knowledge. This thought-provoking learning opportunity with every student meeting via videoconferencing in real-time but bringing first-hand materials from different physical spaces could not have happened had the students been on campus together or had the necessary technologies been absent. The physical distance between students in this case was central to Participant Five introducing unique teaching materials that actively maintained student interest on a flat screen. The physical distance also contributed to the student learning through collecting and using authentic materials. In this example, the participant used the knowledge of technology productively and considered both content and pedagogy concurrently when designing this well-timed activity to stimulate and sustain the virtual language practice through dynamic discussions.

Instructional clarity was the second feature that the participants aimed to achieve when creating ERT-sustainable teaching materials that students could resort to outside the synchronous instructional hours. Participant Two made brief teaching videos and make them accessible through a free video sharing website to supplement student learning. The goals were to enhance students' comprehension of the subject matter and allow the students additional space and time to interact with the content asynchronously. The participant's pedagogies in this regard are supported by Meskill and Anthony's (2010) view that instructors of remote teaching should use text, sounds, and visuals to amplify instruction. Such instruction should also provide with diverse accessibilities and computer-mediated cues that can appeal to learners of varying learning styles and encourage them to engage with learning activities via student-computer interaction. The participant's strategies to complement synchronous human interaction with reflective student-content interaction created a quality teaching and learning experience (Anderson, 2003). With the creation of the video lessons that supported student learning, Participant Two facilitated learning discourse by engaging the students in "interacting about and building upon the information provided in the course instructional materials" (Garrison et al., 2007, p. 164). The coming together of Participant Two's knowledge in technology affordance, subject matter, alternative representations of concept brought an innovative, well-received outcome and shows an example of faculty application of TPACK to teaching.

Quick turnaround times for interaction

The data showed that inefficient implementation of concurrent multiple breakout rooms for group work through videoconferencing was a common concern. The participants redressed this limitation by creating a greater variety of quick-turnaround exercises for synchronous interactions, keeping asynchronous discussion board activities short and focused, and offering prompt responses to students' recorded speeches in an online collaborative space. One feature shared in these pedagogical techniques is their quick turnaround times. Brevity and promptness in these teaching activities were intended to motivate and enable more individuals to participate in the exercises within the allotted time and space. In addition, the participants created varied representations of the subject matters using images, audio recordings, and videos to engage the students with the content through different stimuli. The choice of technologies afforded the varying types of content ideas for the faculty participants to enrich their teaching. Being able to navigate the spaces flexibly defined by the three components of content, pedagogy, and technology and the interplay among them in their specific contexts shows the participants' integrated knowledge of TPACK.

The examples aforementioned in this section involved participants knowing not just the subject matter but also "the manner in which the subject matter can be changed by the application of technology" (Mishra & Koehler, 2006, p. 1028). In addition, the participants demonstrated their knowledge of the existence and utilities of various technological tools and accomplished the delivery of their teaching virtually. These ERT experiences in relation to instructor-student, student-content, and student-student engagement would not have been possible without the integration of technologies. The faculty participants' teaching techniques and technological choices were based on their pedagogical rationale and their understanding of the content. Together, it was the participants' discipline-specific TPACK knowledge that enabled them to enact "truly meaningful and deeply skilled teaching with technology (Koehler & Mishra, 2009, p.66).

Conclusion

The findings and implications must be interpreted within limitations. The study used a small, non-randomized sample. Hence, the results are not generalizable to a larger population. The interviews as the single data source also presents a limitation. Moreover, because the participants were asked to discuss their ERT experiences, potential recall errors and subjectivity are also limiting factors (Patton, 2001). Nevertheless, the qualitative study approach offers readers with a greater depth in analysis (Stake, 1995). The study results are significant in the following theoretical and practical implications. First, the participants of the study were competent in navigating the complex interactions among content, pedagogy, and technology as language teaching professionals who resorted to their general computer literacy and used varying technologies to organize their teaching rapidly during ERT. Their last-minute integration of technology into their pre-existing teaching practice was a success based on the participants' perceptions and the institutional student evaluation of teaching. This experience seems to suggest a different approach to TPACK than Koehler and Mishra's (2009) perspective that teachers and teacher educators should "move beyond oversimplified approaches that treat technology as an 'add-on'" (p. 67). In this study, technology was a component that joined the pre-existing teaching practice at a later stage during Spring 2020. The implication of this observation raises a question that if an "add-on" approach and general digital literacy suffice to lead to a positive result of faculty's use of the TPACK model, how does this inform the decision of teacher education programs and institutional professional development programs in relation to their curricular component of pedagogical technology? The issue with material sustainability and effectiveness in a virtual language learning environment reoccurred in the data. The participants had solutions to the challenges with varied degrees of success that need to be investigated. Moreover, practitioner research is necessary to evaluate the discipline-specific demands on online learning materials and subsequently to assess their effects on both teaching and learning.

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