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Table of Contents

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AECT 100 – Reflections and Transformations

Forty-Sixth Proceedings of the Annual Convention of the Association for Educational Communications and Technology

Joi L. Moore, Tutaleni I. Asino, Amy C. Bradshaw, Michael Simonson, Mohan Yang, & Royce Kimmons

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The 2023 convention marked 100 years of the Association for Educational Communications and Technology (AECT) as an organization. The convention theme was AECT 100 – Reflections and Transformations, which is reflected in the papers.

As we continue to address critical issues within our field and in our larger societies, AECT 100 also gave us opportunities to revisit and reflect on

- previous contributions that have shaped our current practices and perspectives
- fundamental theories and practices that contribute to today's research, policies, and practices
- whether our work includes, serves, and benefits from the diversity of learners and context

In these 46th Proceedings of the AECT Annual Convention, we share papers presented at the convention in Orlando, Florida, addressing the convention theme. This collection is published in an open-access journal, which allows for broader dissemination and access. By providing open access for scholars and practitioners beyond our current membership, we can increase awareness of the contributions and applicability of our work to other fields and disciplines that will benefit from our theoretically grounded research and expertise. We also increase our opportunities to attract scholars and practitioners with expertise in different domains with interests in understanding and applying learning and technology – and from whom we can learn.

Associations publish proceedings to provide an archive of new ideas, an explanation of scientific discoveries, and thoughtful reflections by scholars and practitioners. The first publication of the Proceedings of the Conferences of the Association for Educational Communications and Technology was started in 1979. Since then, there have been forty-five editions of the Proceedings. A total of 2,950 papers have been published, thirty co-editors have participated, and tens of thousands of hard and electronic copies have been distributed.

In 2023, we shifted the Proceedings from a printed and electronic book to digital papers available as a special issue of an open-access journal. Thus, these Proceedings are the first of a continuing series that will be available as a special issue of an academic journal. Papers were subjected to a double-phased review. First, a double-blind review of the convention submissions focused on the appropriateness and scholarly quality of the proposal. All references to authorship were removed from proposals before they were submitted to referees for review. Following the convention,

presenters were encouraged to submit their papers for a second review phase for possible inclusion in the Convention Proceedings. Papers were reviewed for adherence to guidelines, completeness, and quality. The Proceedings represent some of the most current thinking in educational communications and technology.

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A Scoping Review for Exploring Side Effects of Implementing Chatbots in EFL Classrooms

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This scoping review investigates the side effects of using chatbots in the EFL context. While using chatbots is known to be beneficial in most cases, little is known about its drawbacks. Our review will guide future researchers in terms of the optimal language learning experience. Based on the five foundations of a technology-enhanced learning environment, we found several factors that adversely influence learners' performance. For discussion, we provide four strategies to complement the learning experience with chatbots.

Background

Implementing chatbots in classrooms for learning English as a foreign language (EFL) has been advocated due to its known advantages for all-level students (Xu & Warschauer, 2020; Yang et al., 2022). It has been reported that interacting with chatbots is beneficial in terms of lowering anxiety, having more speaking opportunities, and thus developing communication skills (Chen et al., 2020; Hwang et al., 2022). Many studies, however, have identified some limitations of chatbots in terms of ultimately cultivating language proficiency (Dizon, 2020; Tai & Chen, 2022). In addition, some aspects of language learning with chatbots are still controversial. For example, there are still differences of opinion about how well chatbots can understand what learners say (Chen et al., 2020) and how designing multimodal chatbots affects the cognitive load of learners (Sweller, 2020).

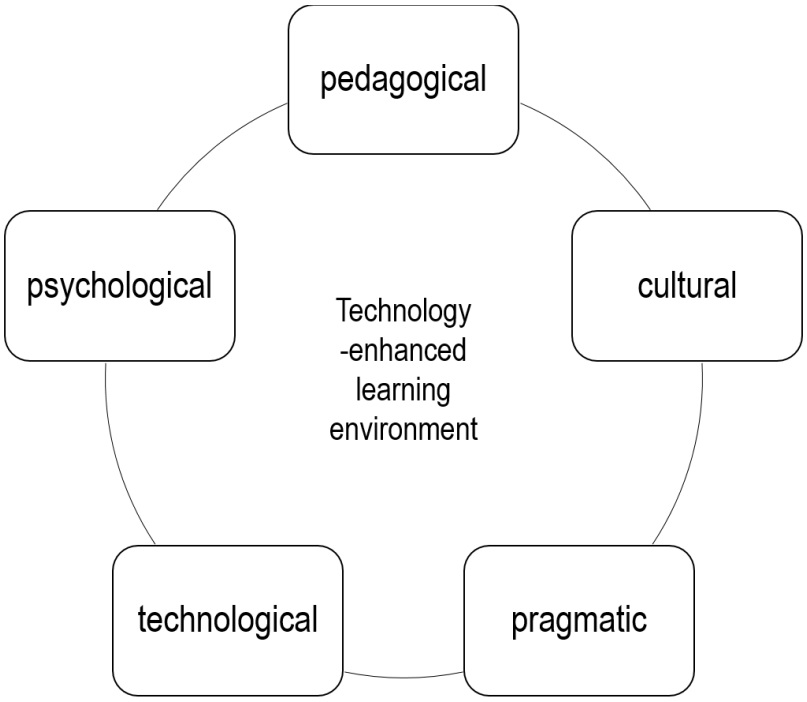
Multiple studies have pointed out the same flaws and problems with using chatbots, so it's time to take a closer look and figure out which parts of chatbots need to be improved for effective language learning. In this paper, we define chatbots as intellectual conversational agents with whom learners interact for language learning purposes, including Google Assistant and various other independently developed systems. This paper will provide directions for future researchers and teachers who intend to design better language learning experiences by focusing on relatively neglected aspects of chatbots in EFL classrooms.

Methods

We conducted a scoping review, analyzing existing literature on the topic, and extracting and charting information (Peters et al., 2022). To begin with, we searched relevant studies in databases including Web of Science, APA PsycINFO, Education Source, and ERIC, using search terms: 'EFL', 'English learning', 'chatbot', and 'intelligent personal assistant'. We included studies that (1) were published after 2010, (2) adopted an empirical approach, and (3) were written in English. A full-text review of 62 studies was done, and a summary was made using directed content analysis (Hsieh & Shannon, 2005) with the five conceptual foundations for the technology-enhanced learning environment as a guide. We synthesized the issues and limitations suggested in previous studies and provided potential breakthroughs for them, aggregating the ideas partially mentioned in studies scattered in the field. The original framework (Driscoll & Burner, 2021, p. 280) was adapted to reflect the interconnectivity of all foundations (Stenbom et al., 2016).

Figure 1

Five Conceptual Foundations for the Technology-enhanced Learning Environment



Discussion and Significance

In the presented framework, the psychological foundation is concerned with learning theories about how learners interact with technology to acquire and organize knowledge. The novelty effect and learners losing interest in chatbots over time have been constantly reported (Huang et al., 2022). This can also affect learners' perceptions of chatbots' human likeness. Girouard-Hallam et al. (2021) observed that learners tend to anthropomorphize chatbots as they gain more knowledge about them. This is undesirable in terms of motivation, as Jeon (2021) noted in some cases, students held a negative attitude toward learning English when they perceived chatbots as machines. If students don't feel like talking to a human partner, they tend to lose the willingness to communicate. Also, the jokes of chatbots lose appeal over time (Lopatovska, 2020), which calls for a need to build more human-like chatbots. Cultural foundations of the EFL environment play a role here, and Warschauer (2020) reported that ESL preschoolers in the United States perceived chatbots as a mixture between humans and machines. However, Lee and Jeon (2022), and Liu et al. (2022) said that EFL elementary students were more likely to give chatbots human traits. This can be due to the cultural differences between the ESL and EFL environments. Since the EFL environment does not allow much natural use of the target language, students tend to have high levels of anxiety, frustration, and aspiration toward communicating in English, making them more engaged in interacting with chatbots. However, this is not always the case, especially for low-proficiency learners. In terms of pedagogical foundation, many studies repeatedly reported the obstacles low-proficiency learners face when interacting with chatbots: not being able to take more initiative in dialogue (Wu et al., 2020) and adopt different communicative strategies (Chen et al., 2020), but abandon the conversation (Tai & Chen, 2022). It gets even worse when combined with issues from the technological foundations because when chatbots have difficulty understanding learners' pronunciations, low-proficiency learners usually repeat exactly the same utterance or give up (Chen et Al., 2020). Lastly, although the penetration rate of mobile devices in K-12 schools has largely increased after the pandemic (Goteka, 2022), pragmatic foundations, such as space and time, are still some of the remaining issues to tackle to support language learning through interacting with chatbots.

Four potential solutions emerged from the content analysis. First, chatbots need to provide translations for low-proficiency students. A chatbot being able to communicate in both L1 and L2 is time-saving (Tai, 2022) and decreases students' cognitive load (Divekar et al., 2018). It also complies with the communicative language teaching approach (Richards, 2005), which allows flexible use of the native language to improve understanding of the target language. Second, using predefined commands for communication can be an adaptive strategy for low-proficiency learners. It helps learners quickly familiarize how chatbots work (Pham et al., 2018) and makes the interface less confusing, which often causes frustration (Moussalli & Cardoso, 2021). Third, designing multimodal feedback is beneficial for low-proficiency learners. It facilitates learners' connection between aural and written forms of utterances (Lan & Liao, 2018) and lowers the level of anxiety when miscommunication happens (Tai & Chen, 2022). Lastly, various assistive strategies are currently explored in collaboration with chatbots, such as mind maps (Lin & Mubarok, 2021), supportive task design to assure learners' understanding of chatbots (Dizon, 2020), and integration with social media (Belda-Medina & Calvo-Ferrer, 2022).

Revisiting existing literature and suggesting directions for future studies is especially worthwhile at this point when AECT marks its 100th anniversary this year. In this study, we reflected on previous contributions that have established our fairly positive perspectives on using chatbots in language learning. This study will help future studies incorporate chatbots not repeating the same mistake and designing more holistic language learning experiences.

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A Systematic Review of Human Information Behavior: Implications for Research, Teaching, and Learning

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This systematic review provides an exploratory analysis of Human Information Behavior from the searchers' affective perspective within the domain of Higher Education. Additionally, results of the review will guide discussion for the design of information systems in higher education and related teaching practices. The review seeks to reveal research gaps in the existing literature and identify new directions for further study. Overall, this review will provide a valuable contribution to the field of HIB and its implications for research, teaching, and learning.

Introduction

We engage in information behavior throughout our lives. The actions taken, tools used, perspectives, needs, emotions, and barriers to information all play a role in our information behavior. Human Information Behavior (HIB) is an especially important concept for academia, students, and researchers. The prevalence of immense information systems that inform researchers are used to teach students research methods and expectations for information storage related to funding are all important outcomes or necessities influenced by HIB.

Information behavior has long been processed through the perspective of how to access information systems. Systems are created in hierarchical models informed by professional jargon, codes, languages, and syntaxes of expert knowledge in the field. However, some emerging HIB studies have investigated information systems through the lens of the users' needs. These studies are important for understanding barriers to accessing and using information systems and can explain some undesirable information behavior such as the inability to identify misinformation and the propensity to default to easy, yet not necessarily reliable, information systems such as Wikipedia and now generative, artificial intelligence systems such as ChatGPT. An examination of HIB from the users' perspective may contain answers to why students, researchers, and academics default to easily accessible systems and provide design guidance for future instructional interventions.

Human Information Behavior

Human Information Behavior is a complex phenomenon that encompasses the actions, tools, perspectives, needs, and barriers to information that people encounter throughout their lives and refers to a host of global behaviors, either passive or active, that are undertaken to satisfy an information requirement (Jansen & Rieh, 2010; Wilson, 1999). Early HIB scholarship (McNitch, 1949; Perry, 1963; Tagliacozzo & Kochen, 1970) explored models focused on information structures and system search features. Before Wilson's (1981) seminal work, there was little regard for the user's perspective in the phenomenon; in this work, Wilson examined a subset of HIB, Information Seeking Behavior (ISB). ISB refers to the physical, cognitive, and behavioral engagement experienced by the user during information seeking and systems searches. Subsequent to Wilson, scholars began to consider the impact of affect on HIB and ISB. Notably, Dervin's Sense-Making (1998), Ellis' Information Seeking (1993), and Kuhlthau's Information Search Process (1991) models considered the affective impact information systems have on information seekers. Generally, these user-focused models present multiple recursive stages of engagement with information and corresponding emotional states while seeking information to satisfy a need.

The study of HIB

In order to identify research gaps, identify new directions for research, and update researchers on the current state of scholarship, a systematic review was conducted to provide a comprehensive methodological, bibliometric, and thematic analysis of user perspective-focused HIB research with a particular focus on the affective domain and its implications for research, teaching, and learning. Furthermore the study focused on intrinsic (autonomous) motivation as opposed to extrinsic motivation (Dubnjacovik, 2018). Intrinsic motivation refers to a searchers' feelings of competence and satisfaction derived from satisfying a basic psychological need or need for information. In the second case, searchers may be extrinsically motivated to complete a search project because of an expected reward such as a grade or a publication.

The review was guided by the following research questions: RQ1) What concepts and constructs of HIB have been investigated?; RQ2) What applications of HIB have been investigated?; RQ3) What related models and frameworks have been developed to operationalize HIB?; RQ4) What situational factors influence HIB from a user perspective?; RQ5) Where is more research needed in HIB from the users' lens?

Methodology

This systematic review was conducted by three researchers and followed the protocols identified by Kitchenham and Charters (2007) adapted for use in the Social Sciences. To mitigate the possibility of bias, a predetermined review protocol was used to identify and select the research corpus. This protocol consisted of the above research questions; inclusion and exclusion criteria; a uniform, consistent search strategy; and a blinded literature selection process. This report shares preliminary results of the systematic review work in progress.

Inclusion and exclusion criteria can be found in Table 1.

Table 1

Inclusion/Exclusion Criteria

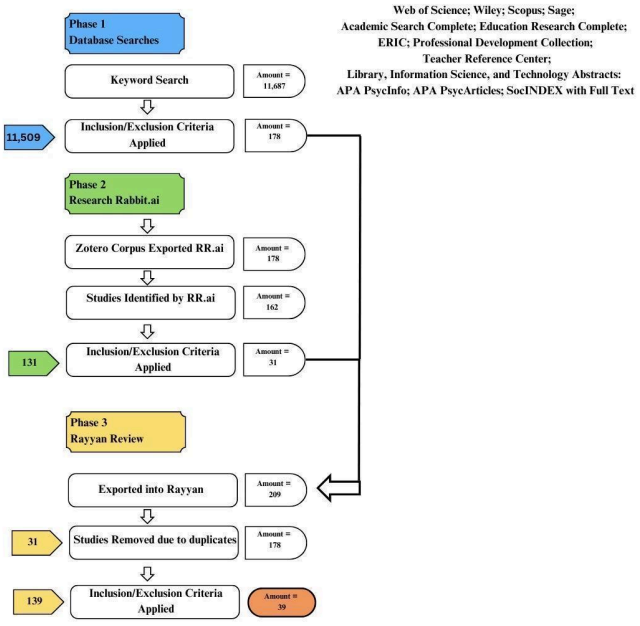
Inclusion	Exclusion
2016-July 2023	Posters
Conference ProceedingsArticlesPeer-ReviewedLatest version inclusive of dateFull-textEnglishInformation Science DisciplineHigher Education	Reviews (meta-analyses included)Non peer-reviewedEditorialsPrefacesEssaysRelevanceBusiness environmentsHospitalsHealth information-seeking

The predefined search strategy consisted of two phases. In the first phase, researchers searched thirteen databases using the following consistent search string: “information-seeking behavior” OR “information needs” OR “information seeking strategies” OR “information behavior” AND emotion OR feeling OR mood OR “emotional state” OR motivation OR motivation OR affect AND “higher education” or college or university. The individual databases' saved search features were used to collect and record these initial search results. These results were determined through an application of the identified inclusion and exclusion criteria to the studies’ titles and abstracts.

This initial corpus was exported to Zotero for deduplication and the second iteration of criteria application. When necessary, the full-text of articles was accessed and consulted to determine inclusion. The second iteration resulted in 178 studies collected. To ensure that no relevant scholarship was inadvertently missed (Wohin et. al, 2022), phase two consisted of citation-mining the references of the selected corpus from phase 1. Citation mining was conducted using Research Rabbit.ai. Zotero collections were uploaded in the tool and a review of relevant literature was conducted to two-levels of the corpus’ “Earlier” and “Later” articles. This phase resulted in an additional 31 studies. After completing both Phase 1 and 2, a total of 209 studies were exported into Rayyan for blind, inclusion review. Following a second deduplication (31 studies), all three researchers applied the above criteria to 178 studies. During this review, researchers were blinded to their fellow researchers' inclusion or exclusion of studies. Finally, disagreements regarding inclusion or exclusion were resolved through researcher discussion. Upon completion of the Rayyan review, 39 studies were selected for inclusion in the systematic review. The protocol for study selection can be found in Figure 1.

Figure 1

HIB Systematic Review Protocol



Results

RQ1. An exploration of publications on HIB indicates the prevalence of studies occurring in Information Science and Computer Science journals. Flourish Studio (https://flourish.studio/) was used to create a tree map of journals represented in the review; larger blocks indicate higher frequency of HIB topics published (See figure 2).

Figure 2

Treemap of Represented Journals in the HIB Systematic Review

RQ2. A preliminary visual examination of the review articles reveal methodologies that consist mostly of qualitative research designs using questionnaires and other instruments to gather self-perceptions of information seeking processes. In this study we distinguish questionnaire as a self-report instrument and a survey as an instrument measuring an identified HIB construct. Studies included self-report questionnaires (11), surveys (7), interviews (6), phenomenologies (4), correlations (4), observations (3), think alouds (2), case study (2), structural equation modeling (2). We found a single occurrence of each of the following studies: electroencephalogram (EEG), experimental with pre/posttest, grounded theory, group discussion, game play, focus group, artifact analysis, cognitive appraisal, eye-tracking/screen-recording, confirmatory factor analysis, essay, scenario based survey.

RQ3. This preliminary report found no new frameworks or models.

RQ4. A visual examination of abstracts identified a variety of themes including the following: avoidance behavior, misinformation use, information sharing, anxiety, group work, ease of access, and information beliefs.

RQ5. The field of HIB in general, and information seeking theories specifically, would benefit from empirical studies focusing on the role of both positive and negative emotions on performance through all search phases. This information would contribute to a suite of interventions to be deployed in information literacy and instruction sessions.

Discussion

The majority of the 39 articles in this preliminary analysis were published in Library and Information Science, Computer Science, and Information Science journals. There is a noted lack of educational technology and educational research focused journals represented in the tree map. We take this to be supporting evidence for a need to study HIB in the context of learning and teaching. Multiple studies collected data on individual seeking processes and the feelings associated with these processes, but only a single study applied an experimental design to empirically examine the effect of emotion on information searching and processing strategies (González-Ibáñez & Shah, 2016). The preliminary results of this study suggest that the fact that emotions do have an effect on HIB has been robustly established, but little research attention has been directed toward designing and testing interventions to mitigate these affective impacts. Current research trends indicate a focus on gathering data on researchers' self-reports of emotional states during searches. Preliminary results of this systematic review expose a gap in the scholarship in that it reveals a need for researchers to design experimental studies to test methods that could mitigate the effect of affect on HIB. The review indicates the use of currently identified frameworks and models; no emerging models or frameworks were identified. The final content analysis phase of articles may reveal themes for which models, frameworks, and later interventions can be designed.

Next Steps

The final stages of the systematic review include an evaluation of article quality (Nidhra et al., 2013) and an in-depth thematic content analysis (Kitchenham & Charters, 2007). Our recommendations call for experimental studies that confirm select interventions that address affective phases encountered during searches. This needed shift to empirical research could begin with studies designed to test the efficacy of interventions proposed by Kulthau (1994), specifically her proposed zones of intervention and process intervention strategies (collaborating, continuing, conversing, charting, and composing). Collaboration with Information Science and Library Science researchers to design and replicate improved strategies for intervention using HIB theories and ISP models could close

the research gap in this area. Research designs focusing on individual affective themes identified in RQ4 and using control and experimental groups to measure the efficacy of Kuhlthau's suggested intervention strategies could provide empirical support for the model upon which a robust theory of ISP could be constructed.

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An Augmented Classroom Teaching System based on AR and Facial Recognition

Jian Liao, Ying Xu, Yingxu Guan, & Geping Liu

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The goal of this study is to investigate the perception of the application of facial recognition and augmented reality in the classroom. HoloLens 2, an AR device, and Microsoft Azure cognitive services were utilized to enhance teachers' classroom perception by displaying learning analytics information on the AR device in real time. A focus group interview was conducted to collect initial feedback from teachers and students regarding the benefits, challenges, and design concerns related to the proposed system. A refined interface was designed based on the feedback from the participants.

Objectives

Augmented reality technology (AR) has been widely applied to education in recent years (e.g., Azuma, 1993; Bi et al., 2020). However, most studies on AR in education are limited to providing students with virtual learning resources. Few studies have been conducted to support teachers in enhancing their classroom teaching.

Classroom teaching is a complex activity. Students in the classroom have various backgrounds, behaviors, learning styles, and performances. It is challenging for teachers to manage the learning status of all students in a class and to adjust the teaching arrangement appropriately during the session.

Intelligent techniques, such as AR and facial recognition, can improve teachers' real-time perception of students' status. This study explores the application of AR and facial recognition in classroom teaching to enhance teachers' awareness of students' learning status during ongoing classroom activities. It aims to expand teachers' ability to monitor student progress or performance in real time during classroom activities.

Theoretical framework

Teaching Augmentation

Teaching augmentation (TA) systems apply various technologies to supplement and broaden teachers' capabilities in classroom activities (An et al., 2020; Holstein et al., 2018b). For instance, real-time learning analytics dashboards have been widely used in the teaching of multiple disciplines by providing real-time information about students' learning progress and performance (e.g., Molenaar & Knoop-van, 2018; Schewendimann, 2017). Wearable devices such as smartwatches and AR glasses have been employed to support various teaching tasks (Bakker et al., 2013; Berque & Newman, 2015). Additionally, distributed digital lamps have been used to display students' learning progress and help requests through signals with different colors and pulse rates (Alavi & Dillenbourg, 2012). Despite the development of numerous TA tools to assist classroom teaching, few studies have applied AR facial recognition to aid teachers in classroom monitoring and decision-making.

Learning Analytics

Learning analytics refers to the action of collecting, analyzing, and reporting learners' data for the purpose of understanding and improving learning (Ferguson, 2012; Lang et al., 2017; Romero & Ventura, 2020). While most learning analytics studies use PCs, mobile phones, or tablets to visualize the analytics data, a few studies (e.g., Holstein, 2018a) have employed AR devices as the interface for data visualization. The results show that real-time analytics have a positive impact on student learning.

Methodology

The proposed augmented teaching system utilizes Microsoft HoloLens 2 and Microsoft Azure Cognitive Services for face recognition, integrated with the Canvas learning management system. Figure 1 illustrates a scenario applying the proposed system in a classroom.

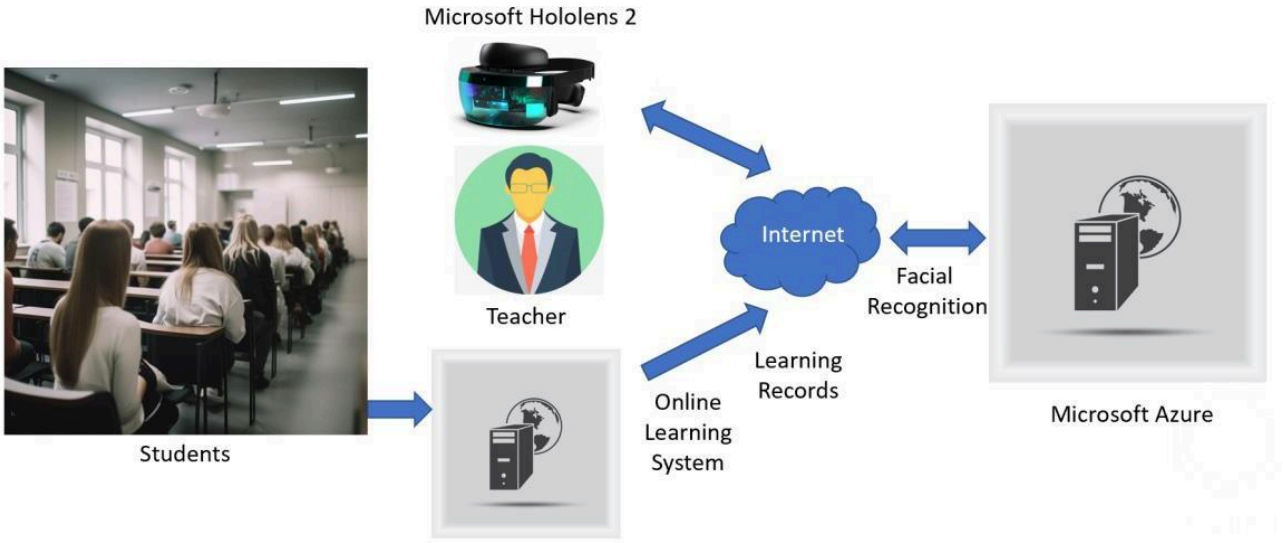
Figure 1

Scenario of Applying AR and Face Recognition Technology in a Classroom

Figure 2 further illustrates the architecture of the proposed system. A teacher wearing a Microsoft HoloLens 2 with the proposed system can gaze at a student and make a 'click' gesture to trigger the function, sending a screenshot to Microsoft Azure Cognitive Services for face recognition. Once a student is recognized, the system on the HoloLens 2 retrieves the student's learning records from a Learning Management System (LMS). Currently, we are using a testing LMS for the prototype development, but we plan to transition to Canvas LMS. Canvas can assist teachers with various tasks such as lesson planning, lecture support, online homework, online tutoring, process evaluation, and teaching management for a variety of teaching modes, including online learning, blended learning, collaborative learning, and flipped classrooms. Figure 3 illustrates the implemented function of the proposed system.

Figure 2

Architecture of the Proposed System



Three research questions were identified: (1) What are the perceived benefits of the proposed facial recognition and augmented reality system on HoloLens for classroom teaching? (2) What are the perceived shortcomings of the proposed systems? (3) What are the concerns to further refine the system?

Figure 3

Implemented Functions to Recognize a Student and Retrieve the Students' Information

This study used a focus group interview to collect the required information purposefully and systematically. Three university teachers and nine graduates from the Faculty of Education at a university in China participated in the interview. The research purpose and the design of the system were described first. The augmented teaching system was then demonstrated. Participants were encouraged to elaborate on their experiences and to propose suggestions relevant to the research questions. The content of the conversations was recorded during the interview and expanded upon as notes after the interview.

Results

Perceived benefits

Most teachers responded that the proposed system can help them check students' learning status and then

reflect on the teaching quality. The system has the potential to assist teachers in adjusting their teaching based on student status. Additionally, the system can help teachers become familiar with the students, especially at the beginning stage of a course in a large class. Specifically, the system can avoid awkward situations when a teacher wants to ask a student a question but forgets the name of the student.

Perceived shortcomings

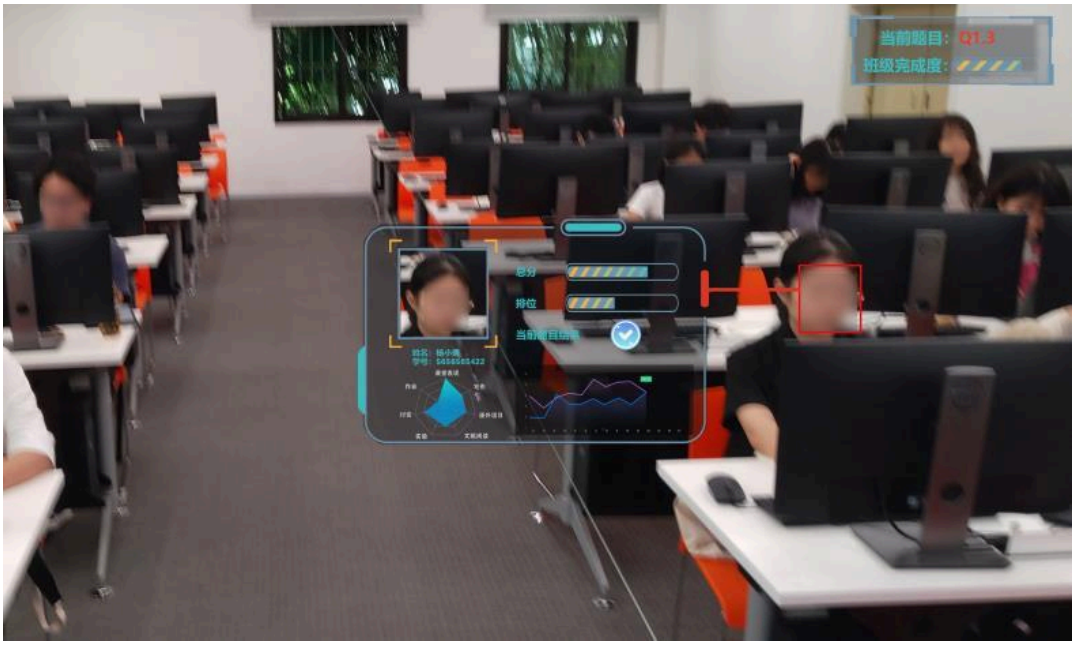
Although most participants had a positive attitude toward the system, some shortcomings were identified. First, the head-mounted AR device Hololens 2 (weighs 566 grams) could make teachers feel fatigued and uncomfortable when worn for a long time. Secondly, the power of the AR device lasted up to 2-3 hours and could not be used for too long at once, so the teacher had to recharge it after a couple of lessons. Thirdly, the appearance of the HoloLens 2 might be a distraction to students. In addition, HoloLens 2 had limited computing capacity (Qualcomm Snapdragon 850, 4GB RAM), making it difficult to use the AR device itself to recognize faces constantly. It took a couple of seconds to get the recognition result from Azure. Finally, it was important to obtain consent from all students in a class considering the system would capture students' facial information.

Design Concerns

The following ideas were proposed during the interview to improve the design of the system: (1) The currently displayed information (student name, grade level, and learning progress) is limited, and it would be better to provide more information that can support classroom teaching activities, such as randomly showing the name of the student on the AR devices for question answering; (2) Meanwhile, the design of the interface should be clean. Information redundancy could lead to cognitive overload for the teacher if too much information is displayed. We then refined the design of the interface based on the feedback from the participants, as shown in Figure 4.

Figure 4

Refined Design based on the Feedback from the Participants



Discussion

The results of the study align with the previous research on teaching augmentation, indicating that the TA system can help teachers identify students who need support from the teacher (Holstein, 2018a). AR and facial recognition provide a more flexible and intuitive way to identify students and display learning analytics information compared to traditional TA systems on PCs, mobile phones, or tablets. It is

feasible to refine the system for wider use in educational practice if the AR device can be improved in terms of weight, size, power, and computing capability.

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Are We Still Struggling with Accessibility? A Case Study Reflecting on Potential Transformations

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AECT
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This project aims to share reflections and potential transformations for instructional design practice around accessibility. Prompted by a situation involving an instructional design unit at a large state university as a case study, the two goals are to understand how accessibility concerns are treated when confronted with a lack of time and resources; as well as find appropriate actions to take to transform how accessibility and equity is achieved within our sphere of influence.

Purpose

This project aims to share reflections and potential transformations for instructional design and educational technology practice around accessibility, both for ourselves as individual designers and our organizations as a whole. Prompted by a unique personal situation involving a small instructional design unit within one college at a large state university, the goal is to understand how accessibility concerns are treated when instructional designers are confronted with a lack of time and resources, as well as find appropriate actions to take to transform how accessibility and equity is achieved within our own sphere of influence. This work in progress report explores the concrete work of achieving accessibility, reflecting on ethics, social justice, barriers, and potential solutions.

According to the Post Secondary National Policy Institute (2022), students with disabilities made up 19% of undergraduates and 12% of graduate students across the US. Both percentages are below the estimated prevalence of disabilities in the population at large, which the Center for Disease Control (2022) places at 26%. This means that not only are students with disabilities underrepresented in higher education, but those who do choose to pursue further education face additional barriers when attempting to complete their coursework. Equal educational provision for those with disabilities was codified into law with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act passed in 1990, yet many institutions have failed to meet these requirements, resulting in lawsuits and large payouts which can further diminish funds for accessibility training and personnel as well as the university at large (Carlson, n.d.). As instructional designers or higher education professionals, the condition of documented barriers to access persisting despite legal requirements to mitigate them creates for us a dilemma. In order to live up to our professional obligation to individual learners, and to professionally safeguard our institutions so that they function legally, we have an ethical imperative to ensure accessible content is being produced.

Context

Working as part of the instructional design team of an established college focusing on online education, a recent change in how the Accessibility and Disability Resource Center (ADRC) of our university handles accommodation requests has put us in a unique situation. As a relatively new team, responsible for a wide variety of legacy instructional content, the institutional changes necessitated making hundreds of preexisting courses accessible in a short amount of time, putting strain on an already full workload. This often meant compromising the quality or attention that was paid to making those courses fully accessible to all learners. Seeing this as an opportunity to reflect not only on how we got here, but on how accessibility is treated more broadly, the first author chose to explore this issue further as part of a course-related praxis project. If we truly wish to create equitable campuses that provide students the opportunity to participate fully, more attention and resources should be given to accessibility concerns; however, we may not always be in an administrative or leadership position to mandate changes for our organization. With much of the inquiry into improving accessibility focused on administrators and institutional policy and reform, what can we do as individual professionals, in less-than-ideal situations, to promote equity and belonging for all learners?

Guiding Frameworks

This exploration was also inspired by Bradshaw's (2014) call for the field to engage in questions of race, ethnicity, and social justice. The theoretical and practical foundations are critical pedagogy (Freire, 1990), the equity literacy framework (Gorski & Swalwell, 2015), a lens of critical humility (European-American Collaborative Challenging Whiteness, 2005), and a conception of instructional designers and educators as being transformative intellectuals instead of merely "technicians" (Giroux, 2013). Epistemologies of ignorance (e.g., Alcoff, 2007; Takacs, 2007) related to this context will also be explored. This involves looking into how we got here, and analyzing the forces that may prevent transformative change.

Taking guidance from the equity literacy framework (Gorski, 2015), the first author recognized that the instructional design team was perpetuating inequities in our work, and yet did not have the institutional support to find alternative solutions. Among a myriad of issues, these courses included PDFs that had not been — and in some cases could not be — tagged due to poor scans. Instructional videos lacked closed captions or, if they had them, they were incorrect. Additionally, entire programs were using a course template that was inaccessible in its design, on top of being generally broken. And yet, these courses had been running and needed to be ready to run again next term. With support from the curriculum team leadership, initiatives were begun to begin to address some of these issues, such as developing a new, accessible, template. Nevertheless, the lack of adequate time, personnel, or additional college or institutional level support, meant compromises were being made and barriers to learning persisted. Wanting to confront this inequity to the best of our abilities, we turned to exploring the issue and addressing what could be done.

As this problem cannot be solved in a vacuum, bringing in other viewpoints and experiences serves to highlight the issues and barriers faced in remediation of courses by other professionals involved in this work. Through engaging with the wider community and capturing interactions with decision makers and other stakeholders, the aim is to develop transformations that may be informative to other individuals and instructional design units.

Initial Approach

Qualitative data were collected via surveys and interviews with colleagues in the first author's work unit and the broader university community. Initial participants in this project were two instructional designers and an instructional technologist, all of whom were responsible for ensuring that online course offerings are accessible to all learners. The average experience level in addressing accessibility concerns in this initial group was four years. In the second iteration, ten participants from the Office of Digital Learning on campus were recruited, seven of whom completed the initial survey. All of this second group of participants were instructional designers engaged in making courses and materials accessible. The average experience level in this group was slightly lower, with four having 1-2 years' experience and three having 3-4 years of experience.

The initial Qualtrics survey gathered demographic information and asked participants about their familiarity, training, and attitudes regarding accessibility. Participants were also asked to share what accessibility meant to them as a concept, how much time they spent working on accessibility each week, and what kind of training they had been provided or sought out independently. Further, they were asked to rate how important accessibility was to them, their work unit, and the institution. Finally, participants were asked if they felt they were given adequate time and resources to make courses and materials accessible and what barriers they perceived limited their ability to do so. Most questions included open-ended response sections to allow participants to go more in depth about their experiences with accessibility work. Six of the ten participants so far have agreed to participate in follow-up interviews. These will be conducted via Zoom and will primarily consist of delving deeper into the personal experiences of participants and asking them to expand on responses they gave during the online survey.

Discussion

This study is grounded in a particular problem in a particular context. Results are expected to support future practice as well as inform future study design. Preliminary findings indicate a lack of time, resources (personnel/training), and institutional support related to making materials and courses accessible. This lack of time and personnel allotted to accessibility concerns highlights a view of accessibility as a secondary goal, instead of a requirement. Insufficient training on accessibility also appears to be an issue, as participants frequently cited either a lack of organizational training or an inadequate level of training being provided. Additionally, participants indicated lack of clarity regarding who is responsible to ensure accessibility is achieved, and that efforts and expertise among ADRC specialists, instructional designers and technologists, and course instructors are often siloed.

Two immediate implications are the need for increased training and collaboration. First, designers and instructors need structured, consistent training that moves beyond the basics to develop a comprehensive understanding of the principles of accessibility, as well as the technical knowledge to practically apply it. Second, intentional and institutionally supported collaboration is needed among ADRC, designers and technologists, and instructors. Findings will inform a larger research agenda focused on improving instructional design practices regarding accessibility. This study is on track to be completed by summer of 2024.

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Challenges and Needs of International Graduate Teaching Assistants

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In this mixed-methods study, we surveyed 23 international teaching assistants (ITAs) and interviewed eight at a public university. Preliminary findings suggest that ITAs find developing course materials, grading, and providing feedback most challenging. The language barriers, imbalance in work and study, uncertainty in professional identity, and feeling unacknowledged exacerbate the difficulty of performing their roles. Beyond mandatory institution-wide training, they voiced a need for more training to improve students' motivation, engagement, and time management.

Introduction

Graduate teaching assistants (GTAs) are important in enhancing the quality of higher education. However, their potential can be hampered by various challenges, often stemming from a lack of prior teaching experience (Chiu & Corrigan, 2019; Mills, 2011) or teacher training (Reeves et al., 2018). The situation is further complicated for international teaching assistants (ITAs) who, in addition to these challenges, grapple with cultural differences and language barriers (Avsar Erumit et al., 2021; Kim, 2009).

The professional development opportunities for ITAs encompass mandatory training provided by the universities and their self-directed professional development (PD) aimed at enhancing their instructional practices. Although training and PD opportunities were offered, most TA training courses and programs are static, prescriptive (Ke et al., 2021), and often instructor-led in a formal setting (Teasdale et al., 2019). The "one-size fits all" approach to training misaligns with the diverse needs of ITA.

Furthermore, the multifaceted challenges faced by ITAs can extend beyond the classroom, adversely affecting their mental health, work-life balance, and overall academic success and performance. In this study, we explore the challenges ITAs face, the professional development available to them, and their specific learning needs. By gaining a better understanding of their challenges and needs, we aim to provide practical implications that can improve the professional support and working conditions for ITAs. The guiding research questions are:

1. What responsibilities do ITAs perform?
2. What challenges and professional development needs do ITAs have?
3. Why do ITAs use or not use training or professional development opportunities?

Method

We used the mixed methods to examine the needs and challenges of ITAs at a large public US university. The data collection is ongoing, and we have received 23 valid survey responses and conducted eight interviews. Participants served as either solo instructors or a facilitative role (e.g., grader). Most came from Asian countries, including South Korea, China, and India. They have taught or assisted in both graduate (n=6) and undergraduate (n=13) courses, with some (n=4) involved in both levels.

The survey includes questions on demographics, prior teaching experience, and confidence levels in task performance, followed by items about ITAs' tasks, challenges, and PD they have engaged in or wish to have. We developed the survey items, referring to the responsibilities mentioned in previous research. Then, we revised the items and interview protocol based on feedback from the faculty and graduate students with TA experiences. The 30-minute semi-structured interviews via Zoom helped triangulate the survey data with deeper understanding of ITAs' challenges and needs. We performed descriptive statistics to analyze the survey data, reporting the frequencies of the responses. Interview transcripts were analyzed through thematic coding.

Results

Major responsibilities performed by ITAs

Most ITAs reported that their primary responsibilities were responding to students' questions (n=21, 91.3%) and grading (n=21, 91.3%) (see Table 1). Many ITAs also reported communication with students through email and announcements (n=20, 87.0%), providing feedback on assignments (n=19, 82.6%), and reviewing course materials (n=18, 78.3%) as their major responsibilities.

Table 1

ITAs' Responsibilities

ITAs' major responsibilities	N	%
Respond to students' questions	21	91.3
Grade assignments and report grades	21	91.3
Communicate with students via announcements and emails	20	87.0
Provide feedback on students' work	19	82.6
Review existing course materials	18	78.3
Monitor student progress (e.g., grades, assignment submissions)	17	73.9
Set up the course Canvas site	15	65.2
Communicate with instructors on assigned tasks	15	65.2
Host online or face-to-face office hours	15	65.2
Update course content, including syllabi, assignment due dates, and hyperlinks	13	56.5

Challenges and PD needs of ITAs

Responsibilities and challenges

ITAs reported grading as the most time-consuming task, followed by providing feedback, teaching, developing new course materials, and revising course materials.

In terms of the difficulty levels of their tasks, ITAs reported developing new course materials (n=11), grading (n=10), and providing feedback (n=9) were the most difficult. The easier tasks were reviewing existing course materials (n=15), communicating with instructors on assigned tasks (n=14), and communicating with students via announcements and emails (n=14).

We asked how frequently their performances were hindered by given factors. A total of 11 ITAs (47.8%) reported an imbalance between work, study, and life often or always inhibited their performance, followed by language barriers (n=10, 43.5%). The majority of ITAs (n=20, 87%) reported insufficient communication with the supervising faculty never or rarely inhibited their performance. Unfamiliarity of university policies and lack of support (e.g., training) similarly never or rarely influenced their job performance (both n=18, 78.3%).

Through interviews, we also identified several challenges and tensions that arise from language barriers, as well as assigned tasks, the expectations set for them (either clear or unclear), and their identities as TAs. Despite exhibiting fluent communication during interviews, a common challenge shared among ITAs was a lack of confidence in English when delivering courses, writing feedback on students' assignments, or engaging in discussion boards.

Two participants recounted that their contributions to the course went unmentioned in students' post-course feedback, which made them feel that their efforts were unseen and unacknowledged. The lack of feedback left them without any insights to improve their practices. This ambiguity in their identity also extended to doubts regarding their level of expertise when tasked with grading major assignments.

Needs

Most ITAs (n=22) completed the mandatory institutional training, and a few took additional training or courses offered by departments and colleges. When being asked about the areas they want to improve through the formal training programs, a total of 13 (56.5%) ITAs indicated a desire to develop public speaking skills a lot or a great deal, followed by motivating students to increase their interests in classes (n=12, 52.2%), engaging students in class activities (n=12, 52.2%), and managing classes (n=12, 52.2%). They also reported overcoming language conflicts (n=11, 47.8%) and time management (n=11, 47.8%) are areas they want to improve a lot or a great deal through formal training.

Reasons for training or PD opportunities

The survey results suggest that most participants (n=22) completed the institution-level training because it is mandatory. A few indicated receiving additional training from their program, while others had on-the-job training or mentoring. This mentoring was facilitated by supervising faculty, observation of other TAs, or participating in online courses and webinars to improve or adapt their teaching practices.

Some of them were motivated to pursue additional training to better engage students, adapt to pedagogy aligned to US culture, improve accessibility of the learning management systems, and enhance efficiency in grading. For example, one TA shared, “My style of teaching was very over-explanatory and interactive, as that's the kind of teaching I had in Asia. But here in the US, there's more structure to the course. So, to quickly adapt to that, I went to some professional development opportunities.”

The participants who chose not to pursue additional PD shared that they were unaware of available resources outside their academic programs. Time constraint was another reason, as they needed to juggle multiple commitments in their coursework, research, and life in general. While several ITAs expressed the desire to enhance their teaching skills, this was not prioritized among other commitments. Lastly, several ITAs believed that with clear job descriptions, the necessity for extra training would decrease.

Discussion and implications

ITAs perform various tasks and responsibilities in the courses they serve. Among these tasks, grading and providing comments on students’ work were commonly reported as challenging and time-consuming, regardless of class size. The reported language barrier can partially explain this challenge. Providing verbal and written comments requires them to know not only what should be said but also how it should be conveyed in their second language.

Related to a language barrier, ITAs wished to improve their public speaking skills. While navigating their professional identity formation, ITAs grappled with the manifesting notion and stereotyped views of their language use (Wang, 2020). In Wang’s study, both students and ITAs themselves perceived the importance of delivering instruction in non-monotone and non-accented English to ensure students’ comprehension of the content. Although ITAs may be proficient in pedagogical knowledge and skills,

they are placed in an inferior position because of their non-standardized English language use. Providing feedback on their English would support ITAs' development of professional identities.

Moreover, an imbalance between work, study, and life frequently inhibited their job performance, even discouraging their motivation for additional professional development. During the interviews, the majority of ITAs acknowledged that their TA experience was beneficial for future faculty positions after graduation. However, allocating more time for their TA roles seems challenging on top of managing various tasks as graduate students. Corrales and Komperda (2022) addressed the so-called "teaching-research trade-off," which implies a tendency of imbalance in multiple roles of graduate students in their article. Accordingly, participants hoped to improve their time management skills through formal training.

Lastly, several ITAs shared their struggles with engaging and motivating students, mostly domestic undergraduates. We speculate that cultural differences may play a role in this situation. Due to their diverse cultural backgrounds, ITAs may hold different pedagogical beliefs compared to their domestic counterparts (Kim, 2014). For example, in Kim's study, ITAs posed more close-ended questions and provided the answers to students faster than domestic TAs. Thus, the struggle with student engagement among ITAs might stem from cultural differences, even though ITAs in this study did not emphasize the cultural barriers as primary challenges. While ITAs might attribute student disengagement to their perceived lack of competence, cultural differences could be the real culprits. Hence, we suggest that incorporating topics on motivating and engaging domestic students in the training curriculum could help address this issue.

Conclusion

The study's findings highlight ITAs' diverse learning needs and implications for institutions in the design and development of professional development programs tailored to these needs. TAs tend to have a better perception of teaching and learning when they spend more time on their professional development (DeChenne et al., 2012). When TAs are well supported, this, in return, will benefit diverse learners that TAs work with and further promote a more inclusive and supportive environment conducive to learning.

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Cultural Factors Affecting Lifelong Learners' Motivation to Complete MOOCs

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Retention has been considered a major issue in MOOCs. Although many studies have examined factors affecting the learners' motivation to complete, there is still a need to examine these factors in different cultural and contextual circumstances. This study is intended to explore the factors affecting the learners' motivations to complete MOOCs on a country-specific platform, AKADEMA, and to compare these factors as well as the participants' characteristics with the literature. An online survey helped the researcher collect data. Instructor-learner interaction, instructor feedback, and course attendance were found to be the factors with the lowest mean scores, while perceived effectiveness had the highest mean score. Course content, technology, and instructor support were the factors that were most closely related to perceived effectiveness. Instructor-learner interaction and technology were the factors that were most closely related to course attendance.

Introduction

Studies have pointed out the low retention rate as a significant issue regarding MOOCs. A handful of studies (e.g., Bayeck & Choi, 2018) focused on cultural aspects of MOOCs, mainly comparing some characteristics (age, gender, education, engagement) of MOOC participants from different regions or countries or emphasizing MOOC design. But the literature does not really provide a study that directly examines the factors that affect MOOC participants' motivation. This study, therefore, is intended to examine these factors on a country-specific MOOC platform to contribute to the literature on motivational factors affecting MOOC completion. The AKADEMA platform of Anadolu University, Turkey, was chosen to conduct this study. AKADEMA was first launched in 2015 with seven courses, aimed at presenting a learning environment and materials to everyone of all ages and backgrounds and offering a structured learning experience that will support lifelong learning. In 2023, AKADEMA will continue to operate with 135 courses in 14 different categories. The courses are MOOC-type, but a number of them offer interaction opportunities with real instructors (guided study strategy); others require self-paced study. The courses are completely free of charge and open to everyone who wants to have a real course experience. They mainly consist of videos (introduction, mini-lecture, presentation, demonstration, etc.), readings, interactive multimedia learning materials embedded into learning activities (tasks) the learners should complete, as well as weekly assignments, discussions, and quizzes.

The main goal of this study was to explore the factors affecting the learners' motivations to complete MOOCs on a country-specific platform, targeting the Turkish people and those who have Turkish language skills all around the world, and to compare these factors as well as the participants' characteristics with the literature. Specifically, it was intended to see if there were any cultural or contextual differences. To do so, the answers to the following questions were sought in the study:

1. What are the general characteristics (age, gender, education, and previous MOOC experience) of MOOC participants?
2. What kind of interactions exist between the factors affecting motivation, perceived effectiveness, and course attendance?
3. What kind of interactions exist between the general characteristics of MOOC participants and the factors?

This study was a cross-sectional descriptive study in which an online survey was used to collect the learners' self-reported data. The survey consisted of questions about the learners' demographics and other related characteristics, such as previous MOOC experience, and a five-point Likert-type scale with 32 items. This scale was developed to identify the factors affecting the participants' perceptions of courses and, at the same time, provide insight about the factors affecting course completion. Items of the scale were adapted from two earlier studies about the effectiveness of online courses by Peltier et al. (2003) and Eom et al. (2016). After the scale was developed, three experts in open and distance learning and five lifelong learners who had similar characteristics as the possible participants of the study examined it in terms of content, construct, and face validity. The instrument was finalized, and a consent notice was included on the cover page. It was then posted on the AKADEMA platform and kept open for a total of three months. During this period, slightly over a thousand responses were collected, but a total of 719 were included in the analysis due to missing data and duplications. Of the participants who responded, 48.3% were female, mainly generation Y (47.2%); many of them had high school educations or less (39.2%); and inexperienced learners predominated both in enrolment (63.7%) and in completing AKADEMA courses (81.4%).

Findings and Conclusions

Overall, this study has revealed some supporting and some challenging results compared to the ones in the literature. First, more male participants were enrolled in the MOOCs than females. A similar supporting result was explored for age groups: A great deal of the participants in the study were from either the Y or Z generations. One of the areas where the results of this study did not support the literature was the educational level of the participants. Previous studies (e.g., Alcorn, Christensen, & Emanuel, 2014) have suggested that MOOCs are preferred by educated learners. However, AKADEMA participants were mostly at high school or lower educational levels. This was related to the country's educational system. Education is considered one of the major ways of getting a secure job, and so there is a high demand for education at all levels, but especially in those areas directly related to specific occupations, such as teacher education, engineering, medical schools, etc. However, this high demand makes access to higher education very competitive. Those who, for different reasons, including this competitive structure, cannot get into a higher education program, as well as those university graduates who could not get a job, look for short ways to improve their skills and get some sort of certificate to be able to get a job. Courses or programs that lead to a certificate are becoming popular among these groups. In light of this elaboration, one can easily interpret the interest of the Turkish high school or lesser educational level holders in the AKADEMA MOOCs and their preference to get a formal certificate at the end of the courses as meaningful.

Another interesting result was about the previous MOOC experiences. In the study, those who enrolled in none or only one MOOC prior to the time of the study were considered inexperienced MOOC participants, and this group outnumbered the experienced ones in course enrollment and completion. In other words, the inexperienced group took more courses in AKADEMA, and a greater number of these group members completed their courses compared to the experienced ones. This result wasn't also supporting the literature that pointed out the experienced participants likelihood to complete MOOCs more than inexperienced ones. The interest of the inexperienced learners might be related to the high unemployment rate among young adults in Turkey and the increasing importance of certificates for employment, as indicated before.

The factors with the highest mean scores were perceived effectiveness and course content. The correlation analysis determined that the factors of course content, technology, and instructor support had the strongest relationship with perceived effectiveness. The factors that had the strongest relationship with course attendance were instructor-learner interaction and technology. Studies in the relevant literature have also found that course content and perceived effectiveness significantly affect the attendance and completion of MOOCs (Hone & El Said, 2016). As reported by Watson et al. (2016), learners' opinions about course contents determine their satisfaction with and their intent to enroll in MOOCs. Designing appealing courses that meet learner needs and boost their motivation should be considered a requirement for quality MOOCs.

The results showed that the participants didn't find learner-learner interaction sufficient and that the courses did not provide adequate opportunities to interact with other learners. Studies in the relevant literature (Bezerra & Silva, 2017) have noted the interaction between learners as an important determinant of completing MOOCs and an unsatisfying peer interaction as one of the causes of dropouts in MOOCs. Communication tools such as video and audio conferences or text-based chat should be used to enhance interaction between learners in MOOCs and reduce their sense of isolation. On the other hand, the weak correlation between learner-to-learner interaction and course attendance in this study might be related to cultural differences. The education system at all levels is quite competitive and forces people to engage in individual learning in Turkey. This characteristic might be affected by the participants' preferences and perceptions.

The participants also expressed unsatisfactory feedback from the instructors. Alraimi et al. (2015) emphasized that instructor feedback is an important element that increases participants' motivation. None and El Said (2016), in their study, put forward the idea that interacting with the instructor is decisive for MOOC completion. The studies concluded that effective feedback positively affects learners' perceptions regarding course attendance, reinforces their learning, and contributes to the retention of learning. Discussion platforms, wikis, and other social media tools can be used to facilitate instructor-learner interaction. So, the AKADEMA instructors and designers should work on offering meaningful and timely feedback in the courses. Another consistent result in the literature was about gender and technology. Although males and females used the technology differently, the female learners found the course content interactive and facilitated their learning. Similar results were also observed in previous studies (e.g., Shao & Chen, 2020) that expressed how males and females behave differently in technology use.

Participation and completion rates in MOOCs are affected by learners' general characteristics and some factors related to the MOOC design and delivery. MOOCs should be designed in a holistic and systematic way that considers all points related to learners, instructors, content, and technology. It is critical to produce quality content that is interesting to learners by taking their needs into consideration. To do so, the interaction must be used to increase the quality of learning and provide learner satisfaction. In this study, instructor feedback was the major factor that affected the participants' attitudes positively. Using interactive e-course materials can sustain learners' motivation. Discussion forums can also enhance interaction between learners. They should be included in MOOC designs so that instructors can provide feedback, learners can address their ideas and questions to instructors, and learners can interact socially with each other. Few studies have discussed the reasons for participants' enrollment in and drop-out of MOOCs. These studies should be supported by qualitative studies. Further studies should also be conducted to investigate the cultural characteristics of participants and their effects on attitudes and achievement, as well as how to design courses that respect cultural differences.

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Design Considerations for Implicit Bias Training

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This paper identifies the issues with implicit bias training (IBT) and its ineffectiveness to reduce biased behavior. We seek to transform implicit bias training from introductory and reactive information sessions to training that supports students in obtaining fundamental skills that promote behavior change. We seek to design and develop a professional open educational resource (OER) instruction to support IBT for cross-disciplinary organizations that incorporate more behavior-focused implicit bias training within their diversity, equity, accessibility, and inclusion (DEAI) initiatives.

Design considerations for implicit bias training (IBT)

Implicit bias training (IBT) is increasingly presented as a solution to issues related to diversity, equity, and inclusion in organizations (see FitzGerald et al., 2019). In general, the goal of IBT is to inform participants what implicit bias is and how it operates to reduce individual bias. However, research on the effectiveness of IBT indicates that these trainings do little more than raise awareness; few have successfully changed participant behavior (Forscher et al., 2019; Gleicher et al., 2022). For IBT to move beyond awareness, it must be intentionally designed to support behavioral change. Currently, there is little guidance in the literature about how to design IBT for behavior-based outcomes.

Below, we propose a framework based on social cognitive theory and metacognition that addresses how to support behavioral change in IBT. Using this framework, we propose several design considerations for IBT. Ultimately, we plan to implement these design considerations in an open educational resource (OER) IBT. The purpose of this work is to meaningfully impact IBT designs to meet the critical needs of society.

Theoretical framework

Social cognitive theory (SCT) and behavior change

Bandura (2001) proposed that behavior is the result of interactions between an individual's self-efficacy, outcome expectations, sociostructural factors, and goals. Self-efficacy refers to an individual's belief in their ability to complete a

task. Behavioral change may be brought about through changes to an individual's perceived self-efficacy, provided appropriate skills and incentives are also present (Bandura, 1977; 2001). One way to support learner's perceived self-efficacy is through the development of metacognitive skills (Cera et al., 2013).

Metacognition, schema theory, and knowledge acquisition

Metacognition refers to how one monitors, controls, and evaluates their cognition. There are several components to metacognition including metamemory, metacomprehension, self-regulation, schema training, and transfer (Osman & Hannafin, 1992). Metacognitive processes both impact and are impacted by one's perceived self-efficacy. For example, self-regulation involves not only the ability to understand the why and how of one's thinking, but also the motivation to take control of this process (Zimmerman, 2001). This motivation relies, in part, on one's self-efficacy. Similarly, schema training focuses on making learners aware of their own schemas, as well as how these schemata were/are formed. This allows learners to see how their prior knowledge and experiences influence the way they make sense of new information and experiences. As learners gain these metacognitive skills, they become more critical and flexible in the application of knowledge (i.e., behavior) (Spiro, 1988).

Implicit bias and implicit bias trainings (IBT)

The National Institutes of Health defined implicit bias as "a form of bias that occurs automatically and unintentionally, that nevertheless affects judgments, decisions, and behaviors" (NIH, 2022). Implicit bias refers to the ways attitudes, stereotypes, or prejudices influence our behavior and decision making towards certain social groups. Therefore, the goal of implicit bias training is to promote more equitable and inclusive behavior (NIH, 2022). However, IBT programs do not reliably achieve this goal (FitzGerald et al., 2019). Reviews of the literature on IBT revealed that a majority of IBT implementations involved single-session, knowledge-based interventions (Forscher et al., 2019; Gleicher et al., 2019). Additionally, assessments of IBT programs rarely included behavioral outcomes, or longitudinal data (FitzGerald et al., 2019). Related to this, little attention has been paid to factors that may influence changes in behavior, such as participant defensiveness and/or perceived lack of agency around implicit biases (Vitriol & Moskowitz, 2021).

Design considerations to address current gaps in IBT

Bandura (1977) defined four sources of efficacy expectations: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. Each source influences how an individual perceives their ability to complete a particular task, i.e., their self-efficacy. By attending to each of these four sources, IBT can positively impact individual self-efficacy around issues of bias, thereby impacting behavior. We pulled from both Bandura's social cognitive theory of behavior change (1977; 2001) and the components of metacognition (Osman & Hannafin, 2012) to develop design considerations that attend to each source of efficacy expectations (See Table 1).

Table 1

Design Considerations for IBT by Efficacy Expectation Source (Bandura, 1977)

Efficacy Expectation Source	Definition	Design Considerations for IBT
Performance accomplishments	Experiencing or practicing the behavior change	1. Support development of metamemory (I know how I think and feel) 2. Support development of metacomprehension (I can regulate my thoughts and feelings) 3. Include opportunities for the identification of implicit bias behavior 4. Provide opportunities to develop a plan for specific adaptations (changes in behavior)

Efficacy Expectation Source	Definition	Design Considerations for IBT
Vicarious experience	Observing the behavior change in others	5. Share real world experiences of bias and harm (case studies) 6. Humanize/relate the experiences of those who experience bias to the individual learner
Verbal persuasion	Encouragement and constructive feedback during and after practicing the behavior change	7. Include messaging that supports agency – e.g., implicit does not mean you cannot enact change. 8. Provide constructive and timely feedback
Emotional arousal	Attention to the emotions during the development of the behavior change	9. Explicitly attend to the emotional aspects of bias training (e.g., defensiveness, anger) 10. Provide opportunities to externally visualize emotions around IBT to reduce avoidance behaviors

Instructional strategies that support IBT design considerations

Concept mapping is a key strategy that supports the design considerations detailed in Table 1. Concept mapping demonstrates relationships between ideas, and, as such, is a useful strategy in developing and restructuring schemata (Neumann & Kopcha, 2018). Concept mapping provides a visual representation of a learner's current schema – i.e., the relationships they see between various pieces of knowledge. Engaging learners in reflective discussion around their concept maps may support learners in the development of metamemory (design consideration #1) and metacomprehension (#2) skills. These skills in turn support learners to make connections between their current schemas and newly introduced content knowledge around implicit bias (#3). When coupled with constructive feedback (#8), these concept maps may support learners to not only identify biased behaviors, but also to identify the situational influences that trigger these behaviors and decide to notice and change these behaviors in the future (#4).

Similarly, concept maps can attend to the emotional aspects of IBT that impact its ability to change behavior (#9). Concept maps allow for the adverse thoughts and feelings associated with bias to be externalized (#10). This can be particularly useful for learners who experience less bias, who may avoid and/or become unresponsive during IBT (Vitriol & Moskowitz, 2021). Externalizing adverse feelings associated with bias creates space for critical analysis. Again, when coupled with constructive feedback (#8), emotional concept maps may support learners in recognizing the human impact of biased behavior (#5, #6) while recognizing this behavior is NOT inevitable (#7).

Conclusion

This paper addresses both the reflective and the transformative aspects of AECT's 100-year convention theme. We reflected on foundational learning theories – social cognitive and schema theories – and asked how they can support the present-day needs of our diverse yet inequitable society. We then proposed design considerations to develop the next evolution of implicit bias training. Overall, this work aims to transform IBT from an awareness focused, DEAI checklist approach towards one that supports continuous and sustainable behavior change.

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Designing and Developing a Gamified App for Enhancing Independent Practice in K-12 Music Education

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Practice is essential for skill acquisition in any domain. Research in music education indicates that time spent practicing and effective strategies are both predictors of the achievement level in musical performance. However, many K-12 music students today lack the motivation and self-regulation skills to practice independently. Using design thinking, the researcher creates LessonLink, a gamified mobile application to motivate and cultivate K-12 music students' self-regulation for independent practice. LessonLink serves multiple roles, including a learning management system, an interactive platform to enhance teacher-student-parent interaction, a gamified platform to motivate student practice, and an embedded self-regulation tool for goal-setting and self-monitoring.

Introduction

Many K-12 children receive private music lessons weekly to learn how to play an instrument. In a typical private music lesson, the music teacher instructs and assigns students music to practice during the week. Practice usually takes place at home independently, without the presence of their teachers.

Practice involves playing an instrument repetitively to improve technical skills, musicality, and overall performance (Austin & Berg, 2006). Practice is not only essential in music education; it is a key to skill acquisition in any domain. A music student is typically expected to practice 20 to 30 minutes daily to reinforce the learning they received from their music teachers.

However, independent practice is difficult for many children, especially those who have not yet developed self-regulation skills (Hallam et al., 2012; McPherson & Renwick, 2001). A common problem is that students do not come to their lessons prepared because they did not practice optimally at home, either not devoting enough time to practice or practicing ineffectively (Hallam et al., 2012; Nielsen, 2001).

Challenges of practice

Effective practice takes time and effort. It is characterized by focused, sustained, and purposeful effort, which we call deliberate practice (Ericsson, 2006). A deliberate practice consists of using practice strategies that directly affect the development of students' musical performance (Sloboda et al., 1996; Jorgensen. 2002). Deliberate practice cannot exist without learners' motivation to become self-regulated learners (Austin & Berg, 2006). Therefore, the challenges of practice can be narrowed down to two categories: a lack of motivation and self-regulation skills.

Mobile learning application

A possible solution to the lack of motivation and implementation of self-regulation strategies is a tool students can utilize during the week while practicing at home. This tool should boost their motivation to initiate and persist in independent practice. This tool should also guide students to be self-regulated learners, providing them with a platform to exercise self-regulation strategies. A mobile application is selected because mobile technologies are ubiquitous and a popular platform for young children's learning in this digital age (Callahan & Reich, 2021). Mobile apps can provide personalized or customized user experiences (Melhuish & Falloon, 2010), allowing students to interact with instructors and other learners outside of a classroom setting (Almaiah et al., 2020).

An app analysis revealed that there are minimal tools available in the app store for music practice. Most practice tools in the app store are strictly for ear training, sight reading, or for keeping a practice journal where students can log how many times they practice. However, they neither motivate nor provide opportunities for students to implement self-regulation strategies. Therefore, the first author decided to create an app that music students can use during the week while practicing.

LessonLink

To generate the app's functionality that aligns with users' learning goals, motivation, and values, the first author went through the design thinking process to create LessonLink. Design thinking is a method of understanding problems and producing innovative solutions using a human-centered approach (Valentim et al., 2017). The design thinking process begins with dissatisfaction with the current state of things and an idea of what the end product should look like, which then evolves into a concrete product over time (Razzouk & Shute, 2012).

LessonLink is a gamified mobile learning application. Its two primary goals are:

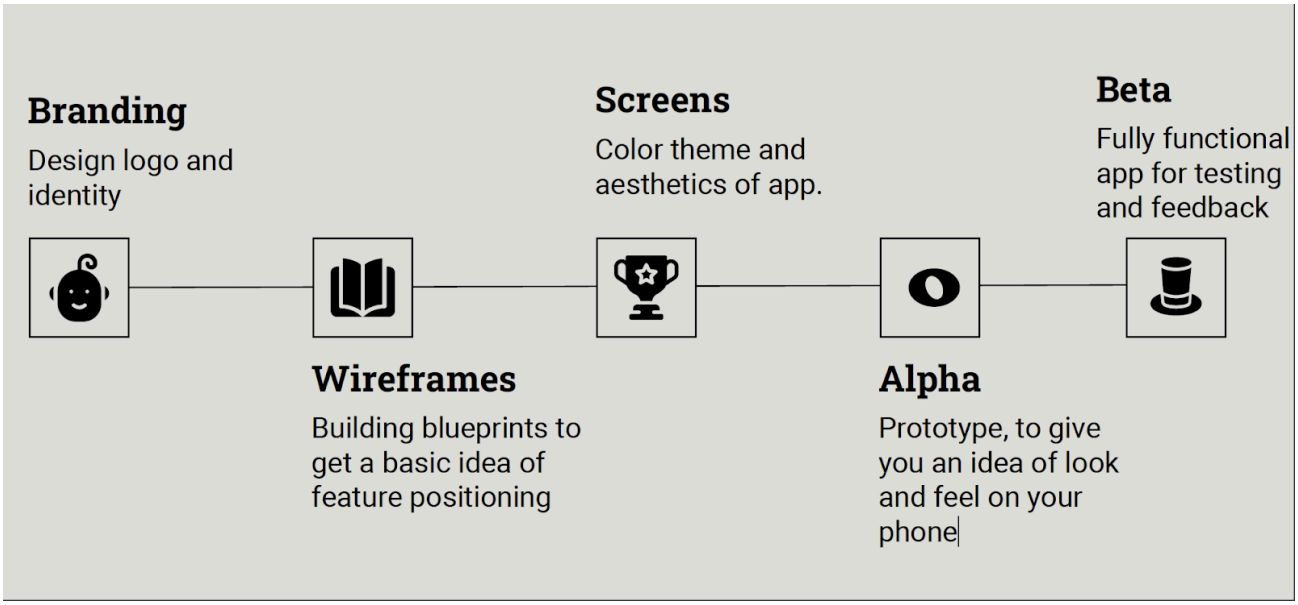
1. To provide a fun and incentivized environment for students to initiate and persist in practice.
2. To provide a platform for students to learn and implement self-regulation strategies.

Development stages of LessonLink

Figure 1 below illustrates the development stages of LessonLink. LessonLink is currently in the Beta stage. After the Beta stage, LessonLink will be ready to be published on the Apple App Store and Google Play.

Figure 1

LessonLink's Development Stages



Features of LessonLink

LessonLink has been designed with the following features to motivate students and support them in implementing self-regulation strategies in music-independent practice.

Gamification

A brief definition of gamification is using game elements in a non-game situation. Gamification in learning incorporates game elements to mediate students' behavior or attitude, leading to learning outcomes (Landers, 2014). Over time, game elements can help increase the value of the task, shaping students' attitudes toward the task, transforming their situational interest into an intrinsic interest, and motivating them to commit to the task. Besides the increased value of the task, game elements can positively influence students by motivating them to engage in the instructional content with more time on the task. Additional time spent often leads to more learning outcomes (Landers, 2014).

Game elements can also promote students' target behaviors, such as deliberate practice, which students might only be willing to do if they are motivated to do so. Game elements that promote such students' self-regulated efforts will likely produce better learning outcomes.

LessonLink has game elements, including a point system, badges, leaderboards, avatars, and quests for two age groups: elementary students (age 4-12) and adolescents (age 13-18). Each time students perform well in lessons and complete self-set weekly missions, they will be awarded points that make them advance on the quests. Once students reach each level of the quest, they will earn badges and customized rewards from their parents or teachers.

LessonLink allows teachers and parents to customize rewards (i.e. ice cream treat, a choice for their favorite restaurant, or a no-chore coupon) for individual students. These personalized performance-contingent rewards aim to help students increase self-efficacy and motivation (Schunk, 1983) and allow students to have a personalized, relevant experience that is meaningful to them, which is vital for a successful experience in a game-based learning environment (Chang & Kuwata, 2020).

Gamification alone is insufficient to sustain long-term value. To prevent students from focusing only on rewards, the reward system must support learning behavior pursued beyond the game. Landers (2014) stated that the instructional content must already be sound for the gamification to be effective. Therefore, it is necessary to combine gamification with effective instructional content and good pedagogical approaches so students can feel a sense of competence, autonomy, and relatedness while practicing during the week.

Three interfaces

LessonLink has three interfaces: Teachers, students, and parents. These interfaces allow instant communication with all stakeholders, involving parents in their children's learning process. An analysis by Hallam (2004) strongly pointed out that parents and teachers influence the value that students place on learning an instrument. LessonLink enables parents to identify both the satisfactory aspects of their children's performance and the areas that require improvement. With the teachers' interface, teachers can listen to students' practice and provide feedback during the week. These three interfaces help strengthen students' sense of relatedness.

Course management

With LessonLink, teachers can create courses, assign homework, provide feedback, and evaluate students' weekly performance by assigning grades.

Forum/Chat

Throughout the week, students can utilize the chat function in LessonLink to ask questions or seek feedback about their practice from their teachers. The forum serves as a platform for teachers to make important announcements and for parents or students to discuss various topics. For instance, it can be used for a parent to request a lesson time change or to showcase students' successful performances via images or videos.

Weekly mission

LessonLink encourages teachers and students to conduct weekly task analyses at the end of their lessons. The task analysis allows students to estimate their capability to accomplish the task before setting reasonable, personalized weekly goals or what we call missions in LessonLink. Once the mission is set, the app will set practice schedule reminders, calculate the mission's progress, and reward students when the mission is accomplished. Teachers' weekly grading criteria can provide students with standards and guidelines for the goal. This feature allows students to actively participate in their learning by setting goals and planning their own practice schedule. Without the proper task analysis during the in-person instructions, LessonLink will not achieve the maximum outcome.

Self-recording

LessonLink enables students to record their practice sessions, keep track of their mission completion, self-monitor, and self-reflect on their practice recordings.

Conclusion

LessonLink aims to transform theoretical concepts into a realistic way of problem-solving. It demonstrates how a familiar tool can help increase the quantity and quality of independent practice. LessonLink is intended to be a supportive tool for teachers to gamify students' independent practice experiences to influence their behavior and attitudes. Future research on LessonLink should include both quantitative and qualitative data from integrating the app into private music lessons and independent practice.

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Development and Validation of a Learner Interactions Behavioral Observation Checklist (BOC).

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The goal of instruction is to improve learning by enhanced quantity and quality of interactions between learners, instructors, and content. Several scholars have criticized the use of self-report approaches that collect perceptions of interaction quantity and quality as a measure of instruction and learning quality. To address this, an observational checklist was created based on the concept of Moore's three types of interaction to collect learner interaction data during active instruction. The validation process included a review of existing literature, item development, and content validation. A high Content Validity Ratio of .91 indicated agreement among semi-experts and experts on the relevance and validity of the items included in the instrument.

Introduction

The degree of Learner interactions is fundamental in shaping the quality of learning experiences (Marco-Fondevila et al., 2022). as highlighted by Moore's three types of interaction (2006, 2018). Moore (2018) suggests that learner interactions involve observable relationships among learners, instructors, and content and the cognitive learning processes, ultimately leading to quality learning. Learner interactions are widely used as determinant for learning quality across different delivery environments (Bernard et al., 2009; Tenenbaum et al., 2020). However, data collection approach has heavily relied on self-report, which has raised concerns about bias, timing, and memory accuracy (Fredricks & McColskey, 2012). To address these issues, Bailey, D. (2022) suggested the use of evidence-driven approaches like interviews and observations. Particularly, observations offer a valuable means to collect learner interaction data during active instruction, minimizing subjectivity. Therefore, we developed a Behavioral Observation Checklist (BOC) that offers an evidence-driven approach to gather real-time behavioral data during active instruction. This paper briefly covers the development and validation of the BOC.

Methods

To create a robust tool for collecting learner interaction data, the BOC was developed based on the concept of Moore's three types of interaction (2018). The checklist's items were designed to capture behaviors aligning with the concept of learner-to-learner (L2L), learner-to-instructor (L2I), and learner-to-content (L2C) interactions.

The development and validation of the BOC followed a thorough content validity approach. Four stages were completed in six phases, involving an extensive literature review, item synthesis, refinement, and validation. A total of 17 items (see Table 1) emerged after the first three stages. The validation process engaged seven semi-experts (advanced doctoral students) and twenty experts (experienced researchers) in the field. Each participant was asked to review and complete as directed on an online survey containing 17 items and accompanying open-ended questions.

Table 1

Second consolidation – 17 items: Interactions, Observation items, responses, examples

Interactions	Observation items	Responses	Examples
Learner-to- Learner	asking other learners questions	Oral/Text	pose questions, problems, or scenarios, seek clarification

Interactions	Observation items	Responses	Examples
		Behavioral	share/show images
Note: learner interactions are likely shown when learners are in proximity; Learners may also prompteach other in far proximity online.	responding to other learners' questions	Oral/Text	respond/state, clarify, add example/experience, new question
		Behavioral	share/show/draw/point out images, shake head, raise hand, etc.
	prompting other learners to respond	Oral/Text	encouragement, repeat, re-ask question, prompt peer to respond
		Behavioral	eye prompts, gestural prompts
	commenting on/ responding to other learners prompts	Oral/Text	praise or critique, question, share new/old ideas
		Behavioral	clap hands, thumbs up/down, nodding, pointing
	responding to other learners' comments	Oral/Text	respond/state, repeat, clarify, add example/experience, new question
		Behavioral	nodding, shake head, raise hand, gesture/ move, show/draw images
	responding to others with new responses or questions	Oral/Text	add response, new questions, agree or disagree
		Behavioral	nodding, shake head, raise hand, gesture/ move, show/ draw images
Learner-to- Instructor	learner asks instructor question	Oral/Text	pose questions, problems, or scenarios, seeks clarification
		Behavioral	share/show images
learner and instructor exchanges – learner leads	instructor responds to learner's question	Oral/Text	respond/state, repeat, clarify, add example/experience, new question
		Behavioral	share/show images
	learner comments on instructor	Oral/Text	praise or critique techniques or style, question
		Behavioral	nodding, shake head, gestures, share/show/draw images
	instructor responds to learner's comments	Oral/Text	respond/state, repeat, clarify, add example/experience
		Behavioral	nodding, shake head, gestures, share/show/draw images
instructor and learner exchanges – instructor leads	instructor presents content, objectives, directions, etc.	Oral/Text	state/provide/show/demo, clarify, add examples/experiences
		Behavioral	share/show images
	instructor asks learners questions	Oral/Text	pose questions, problems, or scenarios, prompts
		Behavioral	share/show images pointing out clarifications
	learner responds to instructor's questions	Oral/Text	respond/state, clarify, add example/experience
		Behavioral	share/show/draw/point out images, shake head, raise hand
	instructor gives learners directions, e.g., activity	Oral/Text	group students, give objectives/directions/material
		Behavioral	show/demo/point out expectations
	learner responds to instructor's directions	Oral/Text	pose questions, seek clarity
		Behavioral	Start interactions with team
Learner-to- Content learner visibly engaging with content resources	learner performs task	Oral/Text	describes/ shares/ collaborates/ critiques own work and/or tasks reads, take notes,
		Behavioral	draws/ marks up/ modifies, demonstrates task, conducts experiments, develops deliverable, shares work
	learner completes task	Oral/Text	presents/ showcases/ reflects on deliverables
		Behavioral	posts/ submits

For the semi- experts' data analysis procedures, we use the Statistical Package for the Social Sciences (SPSS) and the Aiken V formula (1980), following established criteria from previous studies (Merino-Soto, 2018; Torres-Luque et al., 2018). A critical value of 0.70 at a significance level of p = 0.05 and 0.81 at p = 0.01 were applied to determine whether items should be retained, modified, or eliminated. Items with values below 0.70 were considered for elimination, while those above 0.81 were deemed retainable. Additionally, an effect size analysis, following Merino-Soto's procedure (Merino-Soto, 2018), was conducted using confidence intervals at a 95% confidence level to assess the generalizability of item clarity.

For experts, the analysis also focused on content validity using Lawshe's content validity index (CVI) (1975). The content validity ratio (CVR) was initially calculated, based on experts' judgments of item relevance using a 4-point Likert scale. Items were categorized as either "+1 essential/relevance" (ratings 1 and 2) or "-1 not essential/relevance" (ratings 3 and 4). Our panel of 20 experts aligned with critical ratio value of .49, thus was used to determine whether items should be retained or deleted. Further analyses included calculating content validity indexes (CVIs) at the item-level (I-CVIs) and scale-level (S-CVI) to establish item relevance. The I-CVI indicated the percentage of agreement among experts on each item's relevance, while the S-CVI showed the percentage of relevant items.

Qualitative data analysis for both semi-experts and experts was based on responses from the open-ended questions. Data were analyzed to identify common areas of consensus regarding specific recommendations.

Results

Quantitative analysis for the semi-experts confirmed that all items exceeded the critical value of 0.70, indicating strong alignment with their respective categories (L2L, L2I, L2C). Confidence intervals revealed no significant differences between validation questions for each item, suggesting generalizable clarity (see Table 3).

Table 3

Three Aiken's V coefficients for each validation

Observation Items	V1Item content	V2Oral/text examples	V3Behavior examples
1. asking other learners questions	.929	1.000	.929
2. responding to other learners' questions	1.000	1.000	1.000
3. prompting other learners to respond	.857	.929	.857
4. commenting on/ responding to other learners prompts	.857	.929	.929
5. responding to other learners' comments	.929	.929	.929
6. responding to others with new responses or questions	1.000	1.000	.929
7. learner asks instructor question	.857	.929	.857
8. instructor responds to learner's question	.929	1.000	1.000
9. learner comments on instructor	.929	1.000	1.000
10.instructor responds to learner's comments	.929	1.000	.929
11.instructor presents content, objectives, directions,	.929	1.000	1.000
12.instructor asks learners questions	.929	1.000	1.000
13.learner responds to instructor's questions	.857	.929	.929
14.instructor gives learners directions, e.g., activity	.929	1.000	1.000
15.learner responds to instructor's directions	.929	1.000	1.000
16.learner performs task	1.000	1.000	1.000
17.learner completes task	.929	1.000	1.000

For the experts, all items were deemed relevant based on content validity ratio (CVR) analysis, surpassing the critical value of .49. Item-level (I-CVI) and scale-level (S-CVI/A) calculations further affirmed item relevance, exceeding 79% and 90%, respectively (see Table 4).

Table 4

Values of Content Validity Index (ne-num of experts indicated essential; n-number of experts)

Observation Items	Ne	n	CVR	I-CVs	Interpretation
1. asking other learners questions	19	20	0.90	0.95	Relevant
2. responding to other learners' questions	19	20	0.90	0.95	Relevant
3. prompting other learners to respond	20	20	1.00	1.00	Relevant
4. commenting on/ responding to other learners prompts	19	20	0.90	0.95	Relevant
5. responding to other learners' comments	17	20	0.70	0.85	Relevant

Observation Items	Ne	n	CVR	I-CVs	Interpretation
6. responding to others with new responses or questions	19	20	0.90	0.95	Relevant
7. learner asks instructor question	16	20	0.60	0.80	Relevant
8. instructor responds to learner's question	20	20	1.00	1.00	Relevant
9. learner comments on instructor	16	20	0.60	0.80	Relevant
10. instructor responds to learner's comments	20	20	1.00	1.00	Relevant
11. instructor presents content, objectives, directions	18	20	0.80	0.90	Relevant
12. instructor asks learners questions	19	20	0.90	0.95	Relevant
13. learner responds to instructor's questions	18	20	0.80	0.90	Relevant
14. instructor gives learners directions, e.g., activity	18	20	0.80	0.90	Relevant
15. learner responds to instructor's directions	18	20	0.80	0.90	Relevant
16. learner performs task	18	20	0.80	0.90	Relevant
17. learner completes task	16	20	0.60	0.80	Relevant
			S-CVI	0.911765	

For qualitative data analysis, semi-experts and experts primarily emphasized the need for terminology clarity and reduction of item overlap. Consideration was given to enhancing the BOC's wording and reducing item redundancy. As a result, a modified version of the BOC was created to better align with the qualitative data feedback.

Conclusion

Behavioral Observation Checklist's items were found to be valid indicators of learner interactions aligned with the concept of Moore three types of interaction, addressing the need for reliable data collection in the assessment of quality learning and instruction. Most importantly, BOC offers an alternative for collecting real-time behavioral data on learner interactions during active instruction, supporting assessments of quality instructional practices across diverse learning environments. Future research should focus on testing the reliability of BOC in various contexts. Researchers interested in utilizing BOC can contact the authors for access to a modified version of the instrument.

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Development of an Online Teacher Education System for Designing AI-integrated Lessons

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This study aims to develop an online system called AIESTEP (AI for Elementary and Secondary Education Platform) to support teachers in designing AI-integrated lessons for a teacher education program. The online system provides learning content and hands-on experiences, such as taking notes and reflecting on the learning content, reviewing existing cases, practicing data analysis and simple coding, and designing courses. The online system was tested through two pilot-tests with 96 practicing teachers and was revised based on the results of the pilot-tests.

Introduction

Integrating Artificial Intelligence (AI) in education will lead to another educational innovation. AI technologies have potential to influence the future of learning, whether positively or negatively (Roschelle et al., 2020). It is a matter of how we use AI technologies. In a good way, AI can support and guide students to discover their potential and enhance their competencies needed for the future society (Niemi, 2021). AI can also assist teachers in facilitating students' learning and creating authentic experiences (Matsuda et al., 2020; Pelletier et al., 2021). However, adapting AI technologies in education requires overcoming the challenges of the current educational context, such as lack of comprehensive policies for AI-powered education, teacher preparation, development of quality data systems, and ethics and transparency in data collection (UNESCO, 2019). Among these challenges, this study focused on teacher preparation on AI in education. Considering the positive impact of AI, there are many AI-based learning systems designed to assist students. However, there are not many systems available yet to help teachers (Office of Educational Technology, April 23, 2022). Teachers need time and resources to enhance their own experiences and competencies related to using AI in education.

Meanwhile, Korea has implemented a nationwide project in 2022 to enhance teachers' competencies in understanding what AI is and how it can be used effectively and efficiently in education. One of the primary goals of the project is to develop a teacher education program and an online system, and to implement the program for in-service teachers in K-12 education. The online system was developed as a supporting system that offers all users necessary information and practice skills for designing AI-integrated lessons in K-12 education.

The development of computer systems to support individuals' performance is not new. Electronic Performance Support Systems (EPSSs) are well-known systems that improve users' performance and provide on-the-job training. EPSS is popular in the corporate world (Mott-Wilburn, 2020). Although EPSS is not very popular in the education field, Moore and Orey (2000) developed and implemented an EPSS in an educational setting. The development of EPSS has been incorporated into the automated instructional design (ID) process although they provide different functions and elements of instructional development. However, they pursue the same goals to support educators and instructional designers for developing effective and efficient educational performance. Most EPSSs in the existing studies work for narrow and specific domains and results (Spector & Ohrazda, 2004; Sezer, 2021). There is a continuing need to develop support systems for learning and performance in education fields. This study highlights the potential of EPSS in the educational setting, especially for teacher education, and incorporates EPSS into AI technologies.

Many existing systems deliver teacher education courses with video and print-based materials. For example, Online Teacher Training supported by Oxford University Press, Coursera, Udemy, and K-MOOC in Korea provides digital content with short interactive videos, quizzes, and activities. In most lecture-oriented online systems, participants become passive learners most of the time. Not many online systems provide hands-on experiences for teachers to design lessons and courses. Teachers, as learners in training courses, need to actively design lessons and courses.

In this study, we developed a teacher education program and online education system to enhance teachers' competencies for designing AI-integrated lessons, which is called the AIESTEP (AI for Elementary and Secondary Education Platform). The online system provides opportunities for participants to actively engage in the training by taking notes, reflecting on the learning contents, reviewing existing cases, and practicing course design in the ID process. The training course in this study aims to enhance teachers' abilities to use AI tools and techniques in educational settings. The system allows participants to directly practice using AI and digital tools during the training. Participants can work through the ID process while they design the AI-integrated lessons, and then they can develop a lesson plan that can be implemented in their educational practices. During the training sessions, participants have chances to reflect their own learning and reviews learning outcomes produced by other participants. Finally, unstructured data generated by teachers is analyzed using artificial intelligence techniques to help them design lessons.

Purpose Statement and Research Questions

This study aims to develop an online teacher education system for designing AI-integrated lessons. The research questions are as follows: 1) What are the basic principles to support teachers in designing an AI-integrated lesson? 2) How do participants experience the online system that supports designing an AI-integrated lesson? To answer these questions, we developed an online system and analyzed participants' learning results produced throughout the teacher education program.

Methodology

We applied a rapid prototyping method to the instructional design model to develop the online teacher education system. First, we analyzed existing studies and operating online learning systems. Second, we developed a prototype of an online system that supports AI-integrated instructional design, and modified the online system based on reviews by professors, researchers, and teachers. Third, the system was pilot-tested with a total of 92 in-service teachers. The evaluation of the teacher education program and system was conducted in three ways: a participant satisfaction survey, an analysis of learning products, and participant interviews. Between the two pilot-tests, revisions of the online system were made.

Results

As a result, the teacher education program was structured into two domains and 10 sections. The first domain focuses on understanding AI, and includes basic knowledge and skills on AI technology and data science, as well as ethical issues related to AI. The second domain is focused on how to design lessons with AI, and covers core steps for designing lessons such as defining learning objectives, selecting relevant learning content, teaching and learning strategies, and assessment strategies.

The AIESTEP was developed based on the teacher education program, and the following principles were applied to support teachers in designing AI-integrated lessons. First, participants need to work on an authentic task. Second, they can access various information and resources related to lesson design. Third, design guidelines as scaffolding strategies are provided throughout the design process. Fourth, collaboration with other participants is recommended. Fifth, participants can use AI's suggestions on learning topics, questions that provoke students' thoughts, and teaching materials. The system is divided into four main modules: 1) AI basics, 2) Introduction to instructional design, 3) Lesson design, and 4) Showcase. The AIESTEP provides tutorials for knowledge and skills for AI and ID process, examples for AI-integrated lesson plans, resources useful for designing the lessons, and tools for designing the lessons as shown in Table 1. Table 2 indicates main activities of the ID process that participants can perform to design the AI-integrated lessons using the online system.

Table 1

Key components of the online system

Components*	Detail of component
Tutorials	Definition and basic principles of AI Data collection and analysis ID process Digital tools
Examples	AI-integrated lesson plans
Resources	National curriculum Learning materials
Tools	Templates of ID

* The name of the components was adapted from the study by Ugur-Erdogmus & Cagiltay (2018)

Table 2

Main activities of the ID process supported by the online system

ID process	Main activities
Analysis	• Analyzing learning content • Identifying learning setting including learning time and places, and digital devices and tools
Design	• Stating learning objectives • Selecting teaching and learning methods • Selecting evaluation methods before, during and after lesson
Development	• Selecting or developing teaching and learning materials
Implementation	• After training, carrying out the lesson and taking video clips
Evaluation	• Peer evaluating in teacher communities of practices

The AIESTEP was developed using a Python web-framework. The AI technology applied to the system is LLM (Large Language Model). It is designed to receive keywords from users and to make prompts automatically based on the entered keywords, thereby generating the expected information. AI technology is applied to suggest four things useful for lesson design: 1) Academic standards written in the national curriculum requested by teachers as users; 2) Multimedia resources relevant to learning topics selected by teachers; 3) Questions that provoke learners' thoughts relevant to the learning topics; 4) Teaching materials for the learning topics.

Referring to the research question 2, we analyzed participant experiences with a survey, learning product of the teacher education program. First, the satisfaction of the participants with the education program and system was rated at 4.68 out of 5 in total. Second, reflection notes written by participants indicated the difficulties and benefits of the ID process supported by the online system. Some difficulties that the participants faced are lack of time to design a lesson in collaboration with other teachers with different subjects, linking knowledge and skills of AI to school subjects, designing learning strategies adaptive to learners, and combining the learning topics of different subjects to one integrated topic. However, they pointed out some benefits, such as the impressive experience of the online system to support the training, reflection with note-taking throughout the whole process, collaborating with other teachers, and saving and retrieving the learning results during training. Third, the participants rated their lesson plans based on the suggested criteria on the quality of the AI-integrated lessons. Their self-assessment resulted in 4.91 out of 5 in total.

Based on the participant reflection and learning products, we revised some learning content and functions of the system. For example, we developed and provided more online content for explaining the knowledge and skills of AI and data science, and added more exemplary cases of AI-integrated lessons. Also, we specified some guidelines about how to combine content about AI with school subjects.

Conclusions

There is no doubt that integrating AI in education can transform current education. It is a matter of how we incorporate AI in educational settings. In this study, we developed an online system that aims to help teachers learn about AI and design lessons with AI. One of the biggest limitations in the system was to focus less on learners in the design process. Although the training program in the study included learner analysis and guided learner-centered design, the online system had little function to support learner focus in AI-integrated lessons. For further studies, the AIESTEP developed in the study must be validated on a larger scale. To enhance the efficiency and effectiveness of the AIESTEP, generative AI technology should be applied to automate all steps and activities of the ID process. Using the Langchain framework, every data produced by teachers and students can be used for designing quality courses and lessons, and developing various educational resources with multi-modal formats.

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Digital Distraction on Academic Performance: An HLM Study on K-12 Learners

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The purpose of this study is to examine the impact of digital distraction on student performance across courses, and to assess the moderation effect of the average student age, using Hierarchical Linear Modeling (HLM). Multilevel modeling analyses, conducted with 11,237 students across 95 courses revealed that digital distractions negatively affected student performance. However, there was no moderating effect of student average age within each course on the relationship between digital distraction and performance across courses.

Introduction

The pandemic compelled children nationwide to attend school remotely or engage in self-paced online learning using tablet computers, such as iPads and Chromebooks. Concerns naturally arose among educators when students used their own device for learning (Seemiller, 2017; Laxman & Holt, 2017) because the Internet provides 'digital distractions,' leading to student cyberloafing. This involves checking real-time updates, accessing irrelevant web content and applications, and playing games unrelated to course materials during their study (Dursun et al., 2018; Greenfield, 2017; Westervelt, 2016). Cyberloafing behaviors were more prevalent among upper-class students with greater internet seniority and those with personal computers (Arabaci, 2017), negatively affecting students' performance (Dursun et al., 2018). Therefore, measures are needed to minimize digital distractions, consequently, cyberloafing to create a desirable learning environment for our school-aged children.

This study is mainly intended to examine the impact of digital distraction on student performance across courses, as well as the moderating effect of average student age within each course on the relationship between digital distraction and student performance, using Hierarchical Linear Modeling (HLM). The research questions are as follows:

1. Is there a mean difference in student performance within and between courses based on gender, the presence of digital distraction, and the total number of study days?
2. Does the course-level factor (the average student age within each course) explain the differences in student performance between courses?

Method

Learning context

ABC (pseudonym), a Korean company, offers an English language program for learners of all levels, from K-12 students to adults. This program allows learners to study at their own pace using a digital device and a course textbook. ABC's program features a curriculum

with multiple levels. Generally, older students tend to enroll in higher-level courses. While the company permits members to study its program on any mobile device, it also offers a restricted device. This device is a customized version of a commercial device with the same functions as other mobile devices but restricts the download of applications, access to web content, and use of the camera, phone, and messenger. This device only allows access to the company's language program and a few pre-set applications like a dictionary. ABC maintains standardized course structures and test formats across all courses.

Dataset

The researchers were given access to one month of de-identified learning data from all the company's student members. The original dataset was refined to include only cases with more than 20 study days and courses with at least 10 cases. The final dataset consists of 11,237 cases from 95 courses. The subjects of this study were K-12 students aged between 6 and 19 in Korean age, which is equivalent to 5 to 18 in international age. A majority of students opted to use the company's specially designed digital device, which aimed to limit digital distractions. The remaining 629 (5.6%) students used their own devices. Among the students, 5,448 (48.5%) were female, while 5,789 (51.55%) were male.

Variables

The dependent variable was student performance, a continuous variable with a total score of 50. It was comprised of three different test scores: vocabulary (10), pronunciation (10), and 4-skills (30). Upon completing each course, students underwent vocabulary, pronunciation, and '4-skills' test. The '4-skills' test evaluated achievement in four English language domains. At level 1, three independent variables were used: gender, digital distraction, and study days. Gender (Male = 0, Female = 1) and digital distraction (no digital distraction = 0, digital distraction =1) were categorical variables. "No digital distraction" indicated students who used ABC's device, which limited digital distractions. Study days were continuous variables ranging from 20 to 31. At level 2, the average student age within each course was employed. There was no missing data.

Data Analysis

HLM was employed for data analysis due to the hierarchical nature of the dataset, with students nested within courses. Using HLM 7.0, we initially assessed data suitability for multilevel analysis through a fully unconditional model, calculating the intraclass correlation coefficient (ICC) at about 4% (ICC = 4.65/ [4.65+112.30] = .04). This indicates a small proportion of performance variance linked to course-related factors. To account for both within and between variances, level-1 predictors (gender, digital distraction, study days) and a level-2 predictor (average student age within each course) were included. Descriptive statistics analysis utilized the 'psych' package in R Studio.

Results

Descriptive Statistics

At level 1, the mean for study days was 23.16 with an SD of 2.671, and the mean for students' performance was 32.94 out of 50 with an SD of 10.802. The skewness was within ±2, and kurtosis was within ±7, except for digital distraction. This indicates that the variables except digital distraction are normally distributed (See Table 1).

Table 1

Descriptive Statistics of the Level 1 Variables and the Level 2 Variable

	Mean	SD	Variance	Skewness (SE)	Kurtosis (SE)
Level-1 (n=11237)					
Gender	.48	.500	.250	.061 (.023)	-1.997 (.046)
Digital Distraction	.06	.230	.053	3.864 (.023)	12.930 (.046)
Study Days	23.16	2.671	7.133	.914 (.023)	.430 (.046)
Performance	32.94	10.802	116.688	-.848 (.023)	.217 (.046)
Level-2 (n=95)					
Average Age	12.27	2.318	5.371	.131 (.247)	-.900 (.490)

Multilevel Modeling

All level-1 predictors were statistically significant (p<.001) (See Table 2). However, only digital distraction and study days had both fixed and random effects, while gender had only fixed effects. This indicates that female students generally performed better than male students, and this gender difference was consistent across courses. Therefore, in the final level-1 random coefficient model, we excluded gender random variance (u1j).

Level-1 Analysis

In the level-1 final model (Table 2), the results supported the research hypothesis under research question 1. First, there was a significant difference in student performance between groups based on the presence of digital distraction across courses after controlling for gender and study days. There was a negative relationship (=-1.81, p<.001). Since a group of students who used a digital distraction-free tablet was coded as 0, these students performed better than those who used their own device. Also, there was a positive relationship between study days and student performance across all courses, after controlling for gender and digital distraction (β=.56, p<.001). The proportion of level-1 variance was explained by 3% of the three level-1 predictors.

Table 2

Multilevel Model Summaries with Level-1 Predictors

Parameters	Fully Unconditional	Random Coefficient Model (1)	Random Coefficient Model Final
Regression coefficient (fixed effects)			
Intercepts (00)	32.93 (.27) **	19.20 (1.09) **	19.30 (1.12) **
Gender (10)	-	1.76 (0.19) **	1.73 (0.20) **
Digital Distraction (20)	-	-1.83 (0.52) **	-1.81 (0.51) **
Study Days (30)	-	0.56 (0.05) **	0.56 (0.05) **
Variance components (random effects)			
Residuals (2)	112.30 (10.60)	108.85 (10.43)	108.90 (10.43)
Intercept (u0j)	4.65 (2.16) **	22.50 (4.74) *	23.52 (4.85) *
Gender Slope (u1j)	-	0.20 (0.45)	-
Digital Distraction Slope (u2j)	-	3.20 (1.79) *	2.79 (1.67) *
Study Days Slope (u3j)	-	0.03 (0.18) *	0.04 (0.20) *
Model summary			
Deviance statistic	85074.86	84758.66	84760.35
Number of estimated parameters	2	11	7
Pseudo R2	-	0.031	0.030

Note. Parameter estimate standard errors or standard deviation listed in parentheses *p<.05, **p<.001

Level-2 Analysis

Next, to explain between-course variation, we introduced the average student age within each course as a level-2 predictor. This level 2 predictor was added to two level 1 predictors – digital distraction and study days. There was a moderating effect of the average student age on study days across courses (β=.01, p<.05). However, there was no moderating effect of average student age on the effect of digital distraction (β=.30, p>.05). Thus, we can conclude that there was no significant between-course effect on the relationship between digital distraction and student performance based on the average student age within each course. The between course effect based on study days was also minimal because was only .01 (See Table 3).

Table 3

Multilevel Model Summaries with a Level-2 Predictor

Parameters	Without Level 2 predictor	Level-2
Regression coefficient (fixed effects)		
Intercepts (00)	19.30 (1.12) **	19.20 (1.11) **
Gender (10)	1.73 (0.20) **	1.73 (0.20) **
Digital Distraction (20)	-1.81 (0.51) **	-5.17 (2.39) *
Interaction Average Age (21)	0.56 (0.05) **	0.30 (0.21)
Study Days (30)	19.30 (1.12) **	0.43 (0.08) **
Interaction Average Age (31)	-	0.01 (0.01) *
Variance components (random effects)		
Residuals (2)	108.90 (10.43)	108.91 (10.44)
Intercept (u0j)	23.52 (4.85) *	22.52 (4.75) *
Gender Slope (u1j)	-	-
Digital Distraction Slope (u2j)	2.79 (1.67) *	2.71 (1.65) *
Study Days Slope (u3j)	0.04 (0.20) *	0.03 (0.18) *
Model summary		
Deviance statistic	84760.35	84761.68
Number of estimated parameters	7	7
Pseudo R2	0	

Note. Parameter estimate standard errors or standard deviation listed in parentheses *p<.05, **p<.001

Discussion and Implication

In this study, we examined the impact of digital distraction and possible cyberloafing on student performance within courses, also exploring the moderating effect of the average student age within each course on this relationship. At the student level, we considered gender, the presence of digital distraction on their chosen device, and the total number of study days as predictors of student performance. We found that all three variables were significant predictors of student performance on average. In general, female students performed better than male students, and those who used a digital distraction-free device outperformed those who used their own device after controlling for all the other predictors. Moreover, students who studied more days achieved better performance.

Recognizing that students' self-control or self-regulation skills may vary with their age, we conducted a multilevel analysis using the average student age within each course as a second-level predictor to explain variations between courses. However, student age did not moderate the relationship between digital distraction and student performance. It had only a slight moderating effect on the relationship between the total number of study days and student performance. This implies that students tend to perform better when there is less digital distraction and invest more time in their learning, regardless of their age, across all courses.

This study is not without limitations, and these limitations may affect our final results at both level 1 and level 2. One of the limitations is that the majority of students chose to use the digital distraction-free device. Another limitation is the significant variation in the number of data points between courses. However, the study has positive implications for K-12 educators, emphasizing the importance of reducing digital distraction to improve student performance when using tablet computers for their studies. We recommend conducting a larger-scale study with more balanced data and consider additional group-level factors, such as socioeconomic status and the presence of literacy education, to provide further insights into the relationship between digital distraction and learner performance.

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Effects of Nudges by Visualization of Others' Note-Taking on In-Class Learning Behavior

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Visualizing and sharing the others' learning behavior is one way to support note- taking. However, in-class support is insufficient for students to write what the teacher wants. This study aimed to reveal the impact of visualizing others' note-taking on learning behavior and thinking during note-taking revision. We added an after-class visualization function to a tablet-based note-taking support system (Kondo et al., 2023) that can visualize the location of learners' notes and highlights in real time. Twenty-one undergraduate and graduate students participated in the experiment. The questionnaire results suggested that visualizing others' important parts promotes note-taking. In contrast, visualizing unclear parts may promote self- monitoring. On the other hand, visualizing others' notes may be difficult to reference because learners cannot see specific descriptions. We also found that 23% of the descriptions added during the revision process were written by referring to the visualization.

Introduction

Note-taking is a common learning behavior among many learners. Di Vesta and Gray (1972) insisted that note- taking has two processes: encoding and storage functions. Kobayashi (2006) suggested that learners improve their academic performance by reviewing (storage function) their own notes. Furthermore, Nilson (2013) proposed the possibility of fostering self-regulated learning through activities in which learners improve their note taking. However, not all learners are capable of elaborate and organized note-taking. Morehead et al. (2019) suggested that the limited opportunities for learners to learn note-taking strategies can result in ineffective note-taking. One way to support this is to distribute class materials (Kiewra, 1989). Avval et al. (2013) found that learners who wrote class materials directly could grasp key points of a lecture and enhance their understanding. However, Lannone and Miller (2019) suggest that merely distributing materials may not be sufficient, as only a minority of students can effectively organize their notes.

Luo et al. (2016) indicated that note-taking involves a revision process in which students add information to their encoded notes. He suggested that learners can write organized descriptions through the revision process. However, the revision process can be challenging. Flanigan and Titsworth (2020) noted that learners may have difficulty recalling class content if they rely solely on their own notes. Flanigan et al. (2023) also insisted that the note revision process needs to be assessed based on the learner's thinking and judgment.

As an in-class note-taking aid, Kondo et al. (2023) develop NoTAS, a tablet-based note-taking web application. NoTAS supports learners by using color-coded visualizations of the number of notes and highlights made by other learners on everyone's materials using the collected notes and highlights logs. There are three visualization types: notes, important highlights, and unclear highlights. Moreover, the parts written by more learners are highlighted. NoTAS was developed by applying the nudge theory defined by Thaler and Sunstein (2009). Thus, the real-time visualization of others' note-taking situations could play the role of a nudge, facilitating their learning behaviors such as note-taking.

Kondo et al. (2023) indicated that the visualization of NoTAS enhanced learners' motivation for note- taking and attention to explanations through learner interaction. Additionally, the visualization improved learners' sense of classroom community and social presence. However, even with NoTAS, there was no significant increase in the number of annotations, especially not enough writing to organize the class content independently. Furthermore, the results suggested that different types of visualizations could influence various learning behaviors.

Purpose

In this study, we focused on the revision process. This study aimed to evaluate whether visualization of NoTAS promotes learning behavior and thinking. Thus, we added functionality to NoTAS and examined two research questions:

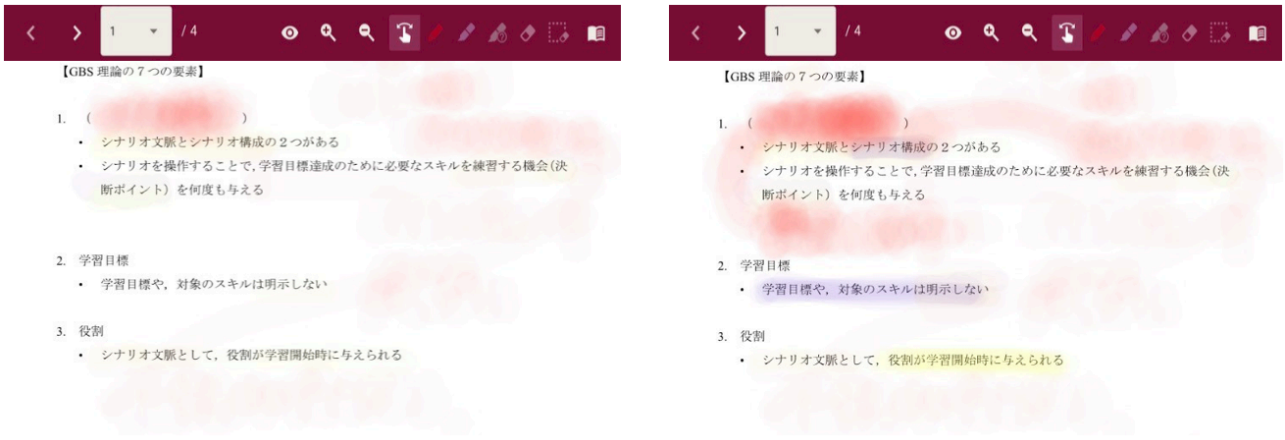
1. What kind of behavior and thoughts are promoted by each type of NoTAS visualization?
2. Do students use NoTAS visualization to revise their notes?

Addition of visualization functionality

We considered it difficult to support the revision process with real-time visualization, as in class, because each learner's revision pace is different. Thus, we added new functions for visualization in and after class (see Figure 1). The "in-class" visualizes only the descriptions of others in class and does not visualize the descriptions of others written or erased after class. On the other hand, "after-class" visualizes the descriptions of others after class together. Therefore, learners can easily see what others have revised their notes by switching between in-class and after-class visualization during revision.

Figure 1

In-Class and After-Class Visualization Functionality



Methods

Procedure

We recruited undergraduate and graduate students enrolled in a science university in Japan. There were 21 participants (14 males and seven females), averaging 21.5 years old. We conducted this study in October 2023.

First, participants signed an informed consent form and then practiced NoTAS system using an iPad (6th generation) and a tablet pen. They then took a 30-minute class using NoTAS. They then had 15 minutes to revise their notes for the test. Furthermore, our collaborators intervened using visualization by writing notes and highlights during the revision. Without learner input, no visualization would have occurred, preventing evaluation. Finally, participants completed a test and a post-questionnaire.

Data collection

Visualization of NoTAS

We created 18 items for the visualization scale. This scale consists of three visualization types (notes, important highlights, and unclear highlights), each comprising of six items related to learning behavior. These items were represented on a 5-point Likert scale.

Reasons for revising notes

We asked what the participants referred to for each description they added during the revision process. We asked five questions (own description, NoTAS visualization, text of class material, memory of class, and others) in a multiple-answer format.

Results

In total, 21 participants answered the questionnaire. None of the participants had studied the class contents before.

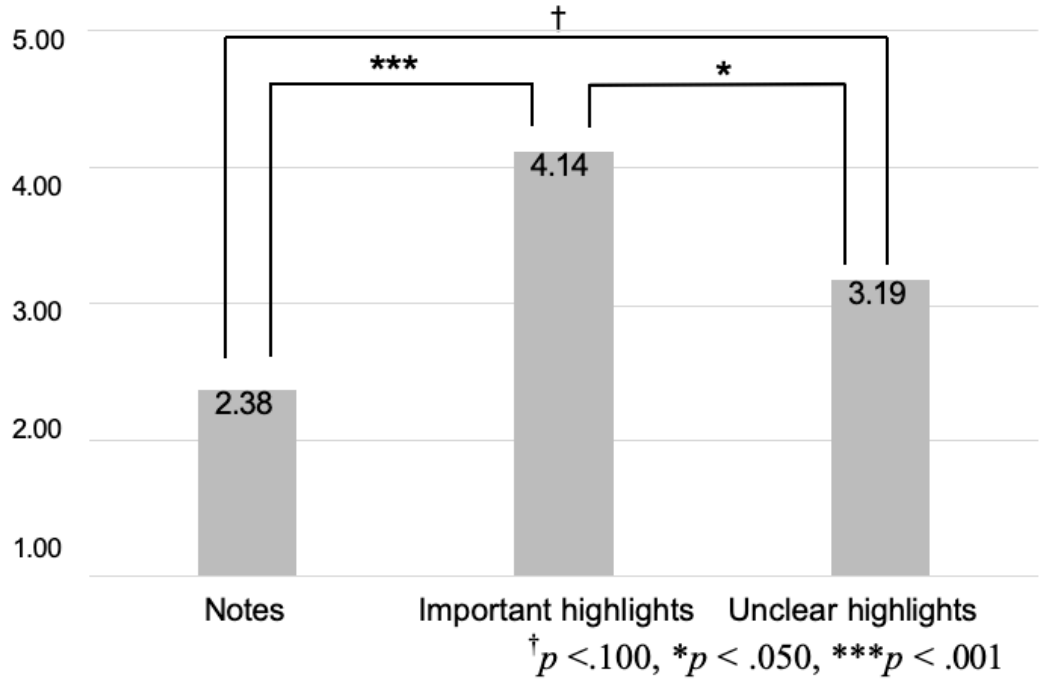
Visualization of NoTAS results

We analyzed each of the six items using the one-way repeated measures ANOVA. The factor was the visualization type, with three levels: notes, important highlights, unclear highlights. We also conducted the Bonferroni's multiple comparison test on the significantly different items.

An ANOVA test for item 1, "I thought to reflect on the class contents by referencing the visualized parts" revealed a significant main effect ($F(2,40)=15.10$, $p<.001$, $\eta 2=.23$). Figure 2 shows the mean and the multiple comparison results for item 1. The visualization of highlights in important parts was the most helpful for reflecting the class. Additionally, visualizing unclear highlights was marginally significantly more than the visuazing others' notes.

Figure 2

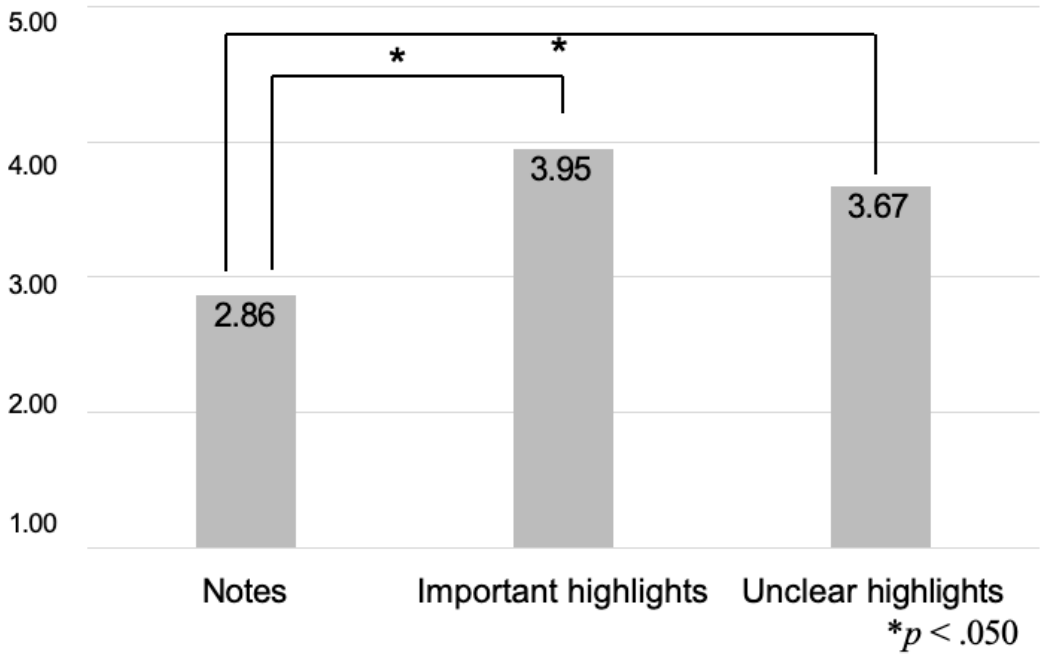
Result of Item 1: Reflection on Class Content



Item 2, "I judged whether I understood the contents by referring to the visualized parts," displayed a significant main effect in an ANOVA test ($F(2,40)=5.60$, $p<.01$, $\eta 2=.09$). Figure 3 shows the mean and the multiple comparison results. The visualization of others' notes was significantly less informative for judging content understanding compared to visualization of important/unclear highlights.

Figure 3

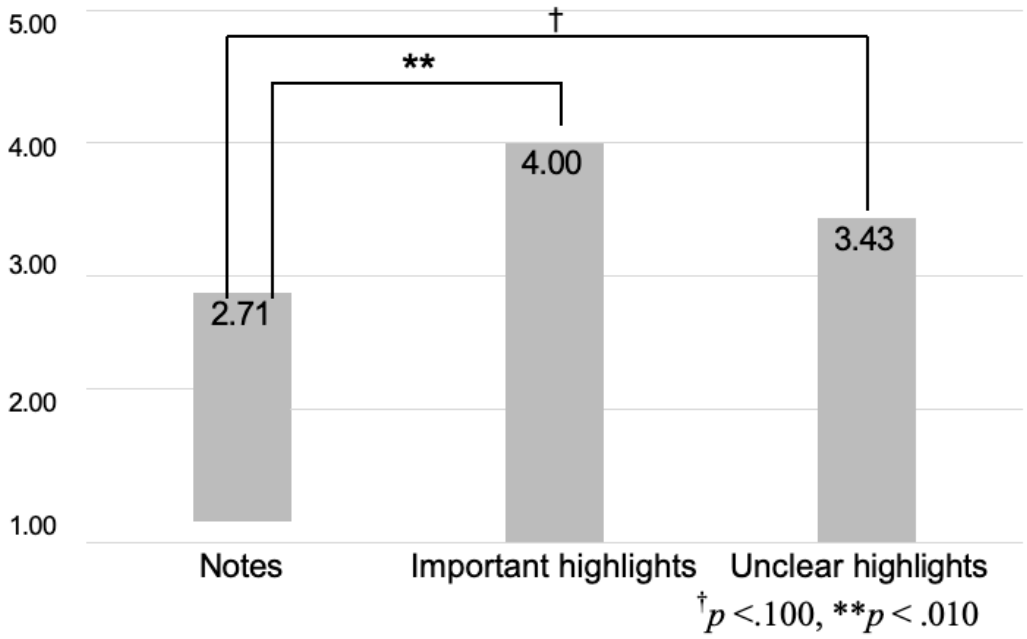
Result of Item 2: Judgments of Understanding



An ANOVA test revealed a significant main effect (F(2,40)=8.19, p<.01, η2=.13) for item 3, "I thought about reading the class material by referring to the visualized parts." Figure 4 shows the mean and the multiple comparison results. Visualizing important and unclear highlights written by others on the materials promoted reading more than the visualization of note parts.

Figure 4

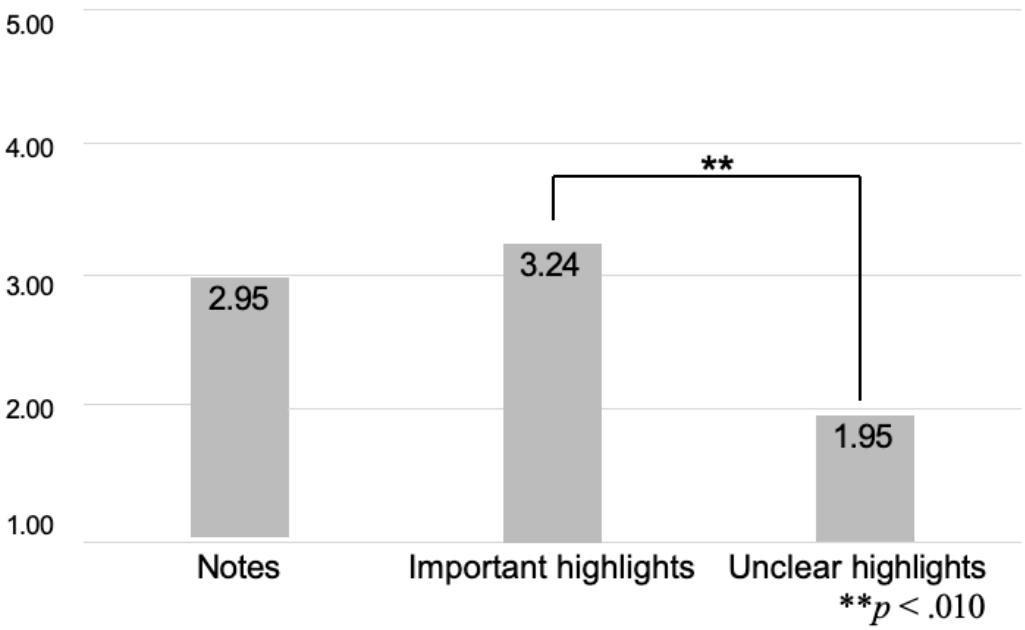
Result of Item 3: Reading the Class Material



An ANOVA test for item 4, "I wanted to write notes and highlights by referring to the visualized parts," yielded a noteworthy distinction (F(2,40)=6.03, p<.01, η2=.12). Figure 5 shows the mean and the multiple comparison results. There was one significant difference. Learners were significantly more motivated to write when visualizing the parts that others considered important compared to visualizing parts where other found things unclear.

Figure 5

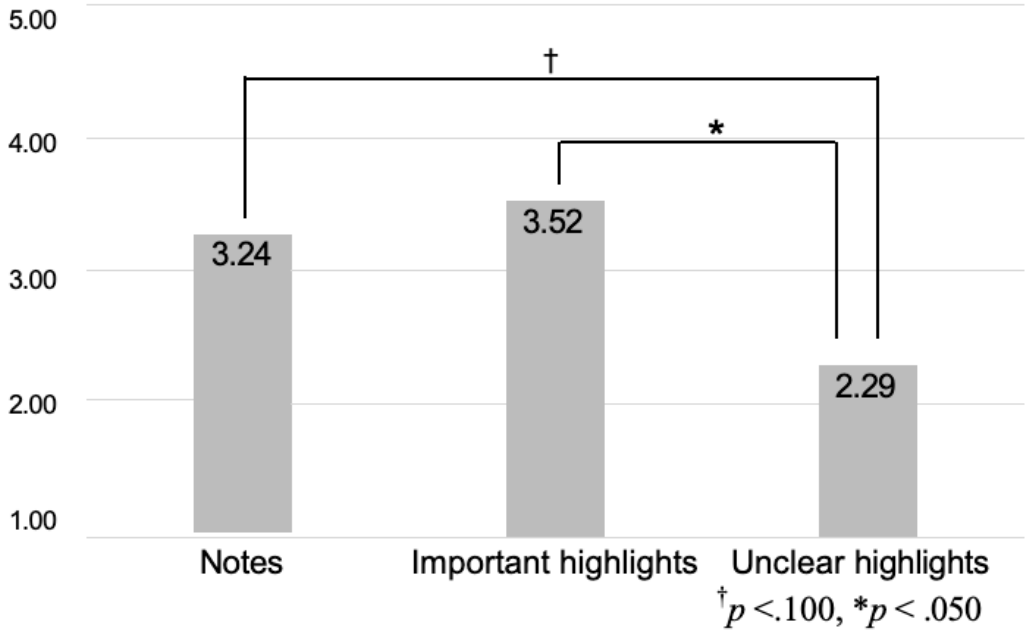
Result of Item 4: Writing Notes and Highlights



Item 5, "I realized that the visualization was useful for me to write notes and highlights," displayed a significant main effect in an ANOVA test ($F(2,40)=5.54$, $p<.01$, $\eta 2=.12$). Figure 6 shows the mean and the multiple comparison results. Visualizing others' important highlights was evidently more useful as a reference for note-taking compared to others' unclear highlights. Furthermore, visualizing others' notes appeared to be slightly more beneficial for nore-taking than others' unclear highlight.

Figure 6

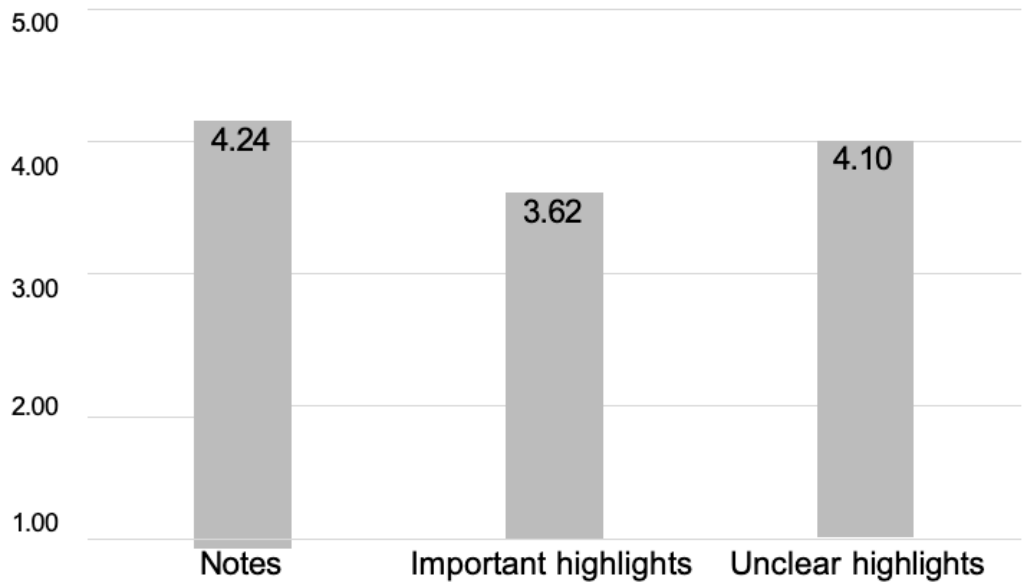
Result of Item 5: Useful for Writing



An ANOVA revealed no difference ($F(2,40)=2.43$, n.s., $\eta 2=.04$) for item 6, "I was interested in what others wrote / why they highlighted by looking at the visualized parts." Figure 7 shows the mean.

Figure 7

Result of Item 6: Interested in What and Why Others Wrote



Reasons for revising notes

Table 1 shows the total number of descriptions written during the revision process and the results of why participants improved their notes.

Table 1

Description Count and Reasons for Writing

Item	n	%
Total number of descriptions written during the revision process	300	-
Referring to own descriptions I wrote in class	48	16.00
Referring to the visualized parts	71	23.67
Referring to texts in the class materials	121	40.33
Remembering the teacher's explanation in class	140	46.67
Others	44	14.67
n = 21		

Discussion

The results of ANOVA and multiple comparisons revealed that participants referred to visualization of others' highlights more than others' notes to revise their notes. Highlight visualization facilitates learning behaviors such as reading the material and recalling the lesson while revising notes. In addition, participants felt that visualization of especially important highlights helped them to revise their notes. On the other hand, when they saw a visualization of unclear highlights, learners may have been interested in why others highlighted and may have checked their own understanding based on the visualizing parts.

In conclusion, visualizing others' important parts promotes learning behavior, such as note-taking, reading, and reflection. In contrast, visualizing others' unclear parts can promote self-monitoring, such as judging whether they understand the contents. However, visualizing others' notes may have been difficult for participants to refer to because they could not see what others wrote specifically and because various parts of the margins on the materials were visualized.

Participants added a total of 300 descriptions during note revision (see Table 1). The results of the reason for revising notes revealed that participants wrote 40% of the descriptions referring to the contents of the materials and memories of the class. These results support previous studies (e.g., Avval et al., 2013) that have shown that writing directly on the material facilitates understanding and makes it easier to focus on the

main points than writing in a blank notebook. Furthermore, participants wrote more than 23% of the descriptions referring to visualization. The results of the multiple responses showed that some participants also referred to their memory of the class and the content of the materials, along with the visualization. This result suggests that visualization may trigger them to reflect on the class and focus on specific parts of the materials. Thus, NoTAS visualization can facilitate participants' note revision. In future work, we need to investigate the relationship between in-class and revision note-taking and the impact of visualization from detailed writings.

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Evaluating Learners' Online Learning Experience of Informal Learning Environments: A LIWC Analysis

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Online video-based content, such as massive open online courses (MOOCs) or educational videos on YouTube, are popular ways for individuals to learn outside of a traditional learning space. Video-based informal learning environments fit in the framework of community of inquiry (CoI), with unique teaching, cognitive, and social presence. Videos on the environment provide direct instruction representing teaching presence, and the feature of online discussion allows learners to comment on instructional materials and interact with other learners, which show social and cognitive presence. Multi-format informal learning environments bring learners diverse learning experiences and analyzing the content of online discussions can help us better understand learners' experiences. This study uses Linguistic Inquiry and Word Count (LIWC) to evaluate learners' learning experiences on YouTube and edX through the construct of CoI. After matching LIWC's keywords with social presence and cognitive presence, we analyze learners' comments (N = 6,938) collected from YouTube and edX. Our findings reveal that there is a more differentiated cognitive presence and a more similar social presence between YouTube and edX.

Introduction

The Internet enables learners to study whenever and wherever and video-based informal learning environments are becoming increasingly important, even more so after the pandemic (Haavisto, 2021). YouTube does not only work as an entertainment platform but also as a place where lots of learners gather (Vizcaíno-Verdú et al., 2019). EdX is a MOOC platform that provides courses from prestigious institutions, and learners visit the website and watch video-based courses at their own pace.

Unlike formal learning, informal learning does not have instructors interact with students, control the pace of content, or identify what learners are understanding. Due to the lack of standardized exams and a low rate of survey response (Oudeweetering, 2018), it is hard to know much about informal learners' experiences. Comments are one way to investigate learners' experiences and both environments include discussion features as part of the interface. For example, YouTube has post-video comments and edX has a discussion forum, which both work as an asynchronous discussion space for learners (Delello et al., 2019). Since Garrison et al. (1999) proposed the theoretical framework of community of inquiry (CoI), it has become a solid foundation for investigating online learning environment. More recently, social network platforms show their potential for fostering a CoI (Wang & Chen, 2020). In YouTube's post-video comments, learners share their emotions (Veletsianos et al., 2018), show gratitude (Lee et al., 2017), and construct knowledge (Dubovi & Tabak, 2020). Similarly, edX's discussion forum is a place where learners share their experiences, ask questions, and report issues. These posts contribute to fostering a CoI and the understanding of learners' learning experiences, thus, helping content producers improve content quality (Liu et al., 2016).

In this paper, we investigate the similarities and differences between learners' experience (i.e., CoI) of two popular video-based informal learning environments containing asynchronous discussion features, YouTube and edX. This is achieved by comparing the frequency of keywords found in learners' comments accompanying educational videos on the two environments and further categorizing them via the constructs of social and cognitive presence.

Community of inquiry

There are three components of CoI: social presence, cognitive presence, and teaching presence (Garrison et al., 1999). Social presence is the extent that learners can express themselves as individuals in the learning environment and includes expressions of emotion, open communication, and group cohesion. Cognitive presence is the extent that learners can co-develop meaning through communicating. Teaching presence is how direct instruction, facilitating discourse, and instructional design facilitate social and cognitive presence.

Research questions

YouTube and edX are popular video-based online informal learning environments that likely foster unique CoIs. Previously, the social and cognitive presence found of these environments has been studied independently by looking at learners' comments. To our knowledge, no work has directly compared differences

in the CoI characteristics of these two popular online informal learning environments. Is there evidence of higher cognitive and social presence to be found in learners' discussion on the more structured edX than the unstructured YouTube? Given this, the following research questions guided this study:

1. How do online informal learning environments foster a CoI?

2. How do social and cognitive presence differ between unstructured (YouTube) and structured (edX) informal online environments?

Based on our research questions, we have two hypotheses:

1. YouTube's social presence (as measured by LIWC keywords) should be significantly different from edX's.

2. YouTube's cognitive presence (as measured by LIWC keywords) should be significantly different from edX's.

Method

This quantitative study focuses on exploring learners' discussion and learning experiences in two online informal learning environments. The data consists of a total sample of n = 2,889 respondents from YouTube and edX with a total of 6,938 comments. For this research, we chose the math course The Magic of Fibonacci Numbers from the TED Channel on YouTube. This video has 1 lecture, but 3,204 comments posted by 2,306 learners. In edX, we chose the math course Calculus 1A: Differentiation, published by MIT. It has 42 lectures with 3,734 comments posted by 583 authors, including one instructor. This research uses the LIWC-22 Dictionary of LIWC analysis (Boyd et al., 2022) to analyze comments' content, a total of 4,785 comments are valid for this analysis.

Two researchers independently categorized each of the LIWC dimensions as either social or cognitive presence based on the definitions of each CoI element and the keywords from the LIWC dictionary representing the dimension. The inter-rater reliability of the coding was high, k = .90, and discrepancies were resolved via discussion. Social presence including the following 6 dimensions: self-identify, affiliation, affect, social process, culture, and conversational. Cognitive presence included the following 7 dimensions: summary variables, drives, cognition, affect, states, motives, perception.

Results

The frequency of keywords in each dimension can be found in Table 1 and Table 2 and the means reflect their percentage relative to the total number of words overall. In Table 2, the summary variables from analytical thinking to authentic are standardized composited variables transformed to a scale from 1 to 100. Independent sample t-tests were conducted on the means and effect sizes calculated to compare the percentage of each category between YouTube and edX. For significant differences, the larger of the two means is highlighted in a color to reflect the size of the effect. The effect sizes are defined, and color coded as follows: d (.01 - .19) = very small/blue, d (.2 - .49) = small/green, d (.5 - .79) = medium/yellow, and d (.8+) = large/red (Sawilosky, 2009).

H1. By highlighting significant effects and their relative size in Table 1, differences in social presence between the environments emerge. Overall, differences range from very small to small. For self-identity words, edX learners express more personal-centered representations by using more 1st person singular and 1st person plural words than YouTube's. EdX comments also have more affiliation words than YouTube's. For affect, YouTube comments have more positive words while edX comments have more negative ones, except for anger and swear words. For social processes, edX comments contained more social words including social behavior, prosocial behavior, politeness, moralization, and communication words, however, YouTube comments have more interpersonal conflict words, social referents words, and acquaintances words. It seems that edX learners perform more politely than YouTube learners. YouTube comments garnered more ethnicity words than edX comments, which may show more diversity characteristics of YouTube. YouTube comments contained more conversational words, except for assent. As an unstructured informal learning environment, the social presence of YouTube shows slightly more positive affect and culture than edX, which shows slightly more affiliation and social processes.

Table 1

Comparisons between YouTube and edX - Social Presence

Dimension	Category	Description/Most frequently used exemplars	YouTube		edX		t	p (two-tailed test)	Cohen's d
			Mean	SD	Mean	SD			
Self-identity	1st person singular	I, me, my, myself	2.5303	5.84189	3.7011	3.81986	8.068	<.001	0.23
	1st person plural	we, our, us, lets	0.386	1.90243	0.7073	1.17497	6.900	<.001	0.20
Affiliation	Affiliation	we, our, us, help	0.6141	2.47913	1.3075	1.94885	7.776	<.001	0.23
Affect	Positive tone	good, well, new, love	6.4264	17.34128	3.6459	5.34667	-7.263	<.001	-0.21
	Negative tone	bad, wrong, too much, hate	1.0594	4.3171	1.1722	1.45418	1.174	0.240	0.03
	Emotion	good, love, happy, hope	3.8641	13.33142	1.5107	2.65349	-8.180	<.001	-0.24
	Positive emotion	good, love, happy, hope	2.8506	11.86941	0.7832	2.27927	-8.081	<.001	-0.23
	Negative emotion	bad, hate, hurt, tired	0.6168	2.85377	0.6759	1.03531	0.925	0.355	0.03
	Anxiety	worry, fear, afraid, nervous	0.0156	0.28285	0.0421	0.25211	3.400	<.001	0.10
	Anger	hate, mad, angry, frustr	0.1082	1.27156	0.0132	0.10805	-3.510	<.001	-0.10
	Sadness	:(, sad, disappoint, cry	0.0427	0.75337	0.1137	0.59641	3.575	<.001	0.10
	Swear words	shit, fuckin, fuck, damn	0.2812	3.40617	0.0051	0.10213	-3.819	<.001	-0.11
Social processes	Social	you, we, he, she	7.4189	13.22121	8.9106	6.38112	4.850	<.001	0.14
	Social behavior	said, love, say, care	3.4832	9.10318	5.4091	5.22171	8.795	<.001	0.26
	Prosocial behavior	care, help, thank, please	0.58	3.75005	1.198	2.09295	6.891	<.001	0.20
	Politeness	thank, please, thanks	0.5828	4.98524	2.102	4.05647	11.449	<.001	0.33
	Interpersonal conflict	fight, kill, killed	0.0684	0.84525	0.0369	0.24354	-1.693	0.091	-0.05
	Moralization	wrong, honor, deserv, judge	0.2817	3.06031	0.2982	0.89726	0.245	0.806	0.01
	Communication	said, say, tell, thank	1.484	6.17349	3.5736	4.40189	13.291	<.001	0.39
	Social referents	you, we, he, she	4.0684	8.94624	3.5162	2.99857	-2.777	0.006	-0.08
	Family	parent, mother, father, baby	0.0981	1.24858	0.0215	0.16934	-2.866	0.004	-0.08
	Friends	friend, boyfriend, girlfriend, dude	0.0906	1.35677	0.0027	0.09972	-3.049	0.002	-0.09
Culture	Ethnicity	american, french, chinese, indian	0.4423	2.7762	0.0217	0.40498	-0.707	<.001	-0.21
Conversational	Conversation	yeah, oh, yes, okay	2.1838	9.58837	1.4776	2.01424	-3.407	<.001	-0.10
	Netspeak	:), u, lol, haha	1.5024	7.03832	1.2308	1.82679	-1.768	0.077	-0.05
	Assent	yeah, yes, okay, ok	0.2674	3.50116	0.2853	1.0206	0.232	0.816	0.01
	Nonfluencies	oh, um, uh, i i	0.1596	2.6186	0.0392	0.2336	-2.160	0.031	-0.06
	Fillers	rr, wow, sooo, youknow	0.4069	5.78751	0.0245	0.51365	-3.103	0.002	-0.09
				2,564		2,221			

The effect sizes are defined d (.01 - .19) = very small, d (.2 - .49) = small, d (.5 - .79) = medium, and d (.8+) = large. According to Cohen's d, the mean values are highlighted in four colors: blue (very small), green (small), medium (yellow), and large (red). Only the higher mean values of the category are colored.

H2. By highlighting significant effects and their relative size in Table 2, differences in cognitive presence between the environments emerge. Overall, differences in cognitive presence range from very small to large (see Table 2). For summary variables, YouTube comments contained more analytical thinking and clout words while edX comments have far more authentic words. EdX learners present more authenticity than YouTube learners. EdX comments contained more drive words such as drive, achievement, and power. For cognition, edX commentshave far more cognitive words, except for all-or-none and certitude. Thus, edX learners show more nuanced argumentation while YouTube comments are more confident and absolute. For affect, YouTube learners use more affect words than edX learners, expressing more positive emotion which also showed in Table 1. EdX comments contained more state words except for fatigue. YouTube commenters use more motive words, except for risk, which shows that edX learners have more sense of risk while YouTube learners engaged with more motivations overall. For perception, edX comments have more perception words, motion words, and space words while YouTube comments contain more attention words, visual words, auditory words and feeling words. As a structured learning environment with more directions and clear learning purposes, edX comments are more authentic, driven, cognitive and demonstrate clear statements. YouTube comments are more motivated, affective, and perceptive.

Table 2

Comparisons between YouTube and edX - Cognitive Presence

Dimension	Category	Description/Most frequently used exemplars	YouTube		edX		t	p (two-tailed test)	Cohen's d
			Mean	SD	Mean	SD			
Summary Variables	Analytical Thinking	Metric of logical, formal thinking	64.5236	35.01239	61.1338	24.94268	-3.803	<.001	-0.11
	Clout	Language of leadership, status	42.2763	26.9404	30.5948	25.96675	-15.211	<.001	-0.44
	Authentic	Perceived honesty, genuineness	24.5146	36.07189	53.2232	32.06854	28.898	<.001	0.84
Drives	Drives	we, our, work, us	1.8785	6.55995	3.0441	2.8159	7.776	<.001	0.23
	Achievement	work, better, best, working	0.9116	5.50675	1.3379	1.84197	3.483	<.001	0.10
	Power	own, order, allow, power	0.394	2.6239	0.414	0.92306	0.341	0.733	0.01
Cognition	Cognition	is, was, but, are	7.7585	11.5149	15.3376	6.45079	27.505	<.001	0.80
	All-or-none	all, no, never, always	0.881	3.59982	0.7872	1.85028	-1.107	0.268	-0.03
	Cognitive processes	but, not, if, or, know	6.8501	10.51882	14.498	6.41054	29.804	<.001	0.86
	Insight	know, how, think, feel	2.3235	5.94278	4.3667	3.39006	14.311	<.001	0.42
	Causation	how, because, make, why	1.1562	3.319	1.8162	1.84403	8.325	<.001	0.24
	Discrepancy	would, can, want, could	0.9003	3.0892	1.9901	1.94239	14.348	<.001	0.42
	Tentative	if, or, any, something	0.9074	3.19691	3.3939	3.16992	26.936	<.001	0.78
	Certitude	really, actually, of course, real	0.6237	3.41373	0.4125	0.96196	-2.821	0.005	-0.08
	Differentiation	but, not, if, or	1.3581	3.61734	3.8255	2.67185	26.490	<.001	0.77
	Memory	remember, forget, remind, forgot	0.0392	0.55844	0.0874	0.45333	3.249	0.001	0.09
Affect	Affect	good, well, new, love	8.1161	18.64844	4.8714	5.40158	-7.917	<.001	-0.23
States	Need	have to, need, had to, must	0.1898	1.43693	0.34	0.85583	4.308	<.001	0.13
	Want	want, hope, wanted, wish	0.1996	1.27754	0.2475	1.0526	1.402	0.161	0.04
	Acquire	get, got, take, getting	0.3032	2.58483	0.7549	1.19083	7.234	<.001	0.21
	Lack	don't have, didn't have	0.0288	0.6125	0.0925	0.47375	3.981	<.001	0.12
	Fulfilled	enough, full, complete, extra	0.0611	0.74532	0.0834	0.36472	1.284	0.199	0.04
	Fatigue	tired, bored, don't care, boring	0.0839	1.54518	0.0043	0.06932	-2.423	0.015	-0.07
Motives	Reward	opportun, win, gain, benefit	0.0852	1.21419	0.0612	0.38375	-0.893	0.372	-0.03
	Risk	secur, protect, pain, risk	0.0173	0.31195	0.1176	0.63769	7.048	<.001	0.20
	Curiosity	scien, look for, research, wonder	1.0312	5.94579	0.3613	1.09548	-5.233	<.001	-0.15
	Allure	have, like, out, know	5.0734	11.54325	4.5425	3.2876	-2.095	0.036	-0.06
Perception	Perception	in, out, up, there	4.5223	9.53375	6.9168	4.06494	11.002	<.001	0.32
	Attention	look, look for, watch, check	0.6572	4.51205	0.4012	0.87469	-2.632	0.009	-0.08
	Motion	go, come, went, came	0.5253	3.09634	0.9077	1.45415	5.334	<.001	0.16
	Space	in, out, up, there	2.3938	6.00938	4.7048	3.21251	16.226	<.001	0.47
	Visual	see, look, eye, saw	0.8841	3.58755	0.7937	1.33601	-1.123	0.262	-0.03
	Auditory	sound, heard, hear, music	0.2301	2.46712	0.0644	0.4421	-3.122	0.002	-0.09
	Feeling	feel, hard, cool, felt	0.2188	2.74183	0.1344	0.45804	-1.433	0.152	-0.04
				2,564		2,221			

The effect sizes are defined d (.01 - .19) = very small, d (.2 - .49) = small, d (.5 - .79) = medium, and d (.8+) = large. According to Cohen's d, the mean values are highlighted in four colors: blue (very small), green (small), medium (yellow), and large (red). Only the higher mean values of the category are colored.

Discussion

The social presences of edX and YouTube are similar, in general. However, a few differences are interesting to explore. A higher positive tone and attitude score reflects their choice of a more relaxed approach to learning (Khan, 2017). This might be influenced by the overall environment of YouTube, an entertainment-oriented social media platform. In contrast, edX expects students to create a structured learning community in the discussion, and students are expected to respond to other students' comments sincerely. Thus, this could explain the greater level of social processes words found in the edX comments. The cognitive presence of EdX is more differentiated from YouTube, the comments contain far greater frequency of authentic, drives, cognition, and states. This could be due to its structured nature, which may promote a higher expectation of cognitive presence for learners.

Learners' written comments on the two informal learning environments represent different learning experiences they had with each environment. By examining the comment data, we identified a more differentiated cognitive presence in edX and a more similar social presence between YouTube and edX.

Limitations

The limitations of this research should be considered. First, typos existed in comments, which are not as totally "clean" data for LIWC analysis. Second, emoji-mediated communication also plays an important role in comments of informal learning environments, however, this research did not take emoji-based data into consideration. Future studies could combine the teaching presence of video features and discuss the impact of teaching presence, while also finding a way to code for the use of emojis.

Conclusion

This study revealed that there are some representative characteristics representing the unstructured (YouTube) and structured (edX) informal online environments in the social presence and cognitive presence of CoI. YouTube and edX are similar in social presence but different in cognitive presence. As a structured informal learning environment, edX's curriculum design is more similar to formal learning environments by providing structured courses, helping students be more authentic, driven, and cognitive. Thus, structured informal online environments could provide learners with more cognitive perceptions.

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Exploring AP English Students' Experience with the Open World Simulation of Henry David Thoreau's Experiment

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Technological advancements continue to present a variety of learning opportunities for students. The purpose of this interpretative phenomenological analysis (IPA) study is to seek an understanding about students' experiences with a virtual reality (VR) activity in an Advanced Placement English course. Analyzing the observations and interactions the participants undergo with VR informs the story of their journey with the technology. Additionally, their immersion in the VR environment emphasizes active learning and experiential learning theoretical concepts. The benefits of this study may help educators understand students' interpretations of VR and ways in which they engage with interactive digital activities.

Introduction

Initiated in the 1950s, the Advanced Placement (AP) program aimed to academically excel high-achieving students enrolled in elite prep schools and was later integrated into public schools (Schneider, 2011, as cited in Parker et al., 2013). Because AP courses are well-known for their rigor and conceptually challenging curriculum, AP students experience a disconnect with canonical texts hindering their appreciation for literature. The purpose of this study is to reveal AP students' experiences with the digital environment within a virtual reality (VR) activity, specifically, an educational game designed for ELA titled Walden: A Game.

Problem Statement

Advanced Placement (AP) programs have expanded quickly due to their reputation of holding a spotlight on college applications, for these courses offer the rigor expected from college students and potentially offer college credit based on scores on the AP exam. Given the structure of the exam, AP students are limited, for they are preparing structured responses to a multiple-choice question or a free-response prompt due to the mode of evaluation for this standardized assessment, which narrows their field of engagement with the content. Experiencing the process of reading a text opens the opportunities to form subjective connections, whether they be text-to-self (identifying oneself in the context), text-to-text (relating the content to other works), and text-to-technology (researching information or creating digital innovations based on context) (Keene & Zimmerman, 1997 as cited in DeLaGarza, 2014). Text-to-technology connections is a significant ELA strategy to develop literacy awareness, so choosing the right innovative mechanism to fulfill the learning objective, promote student engagement, and teach literary appreciation can be productive for instructional time and successful academic achievement.

Virtual reality (VR), a technologically advanced computer system-generated simulation in which the user reacts with the virtual world in a realistic manner, has recently emerged as an educational tool that highlights interactive modalities and self-directed learning (Matome & Jantjies, 2019, p.93). By utilizing computerized commands to navigate and accomplish tasks, VR provides "immersive experiences" through engagement and active learning (Hutchinson, 2018, p. 343). This multimodal activity blends visuals, sounds, and movement similar to a video game, creating "sensory experiences that involve, sight, touch, hearing, and motion to allow users to feel as though they are physically in that environment" (Hutchinson, 2018, p. 343). The text-to-technology connections bridge the gap between canonical literature and post-secondary readiness fluently, for these innovative activities elevate literary contexts through real-world tasks.

Purpose

The purpose of this study was to explore Advanced Placement (AP) students' experiences with a virtual reality (VR) activity. This purpose is driven by the significance of building AP students' literary awareness to formulate distinct textual connections to the difficult canonical literature integrated into the AP Language and Composition curriculum. Because the research question for this study examines student experiences with VR, an interpretive phenomenological analysis (IPA) is the methodology for this study, for this approach "makes sense of the participant trying to make sense of what is happening to them" (Smith et al., 2009, p. 3).

Methodology

While "the assumptions underlying qualitative research is that reality is holistic, multidimensional, and ever-changing" and therefore not validated, it is because of the human element that validates qualitative research (Merriam & Tisdell, 2016, p. 242). The phenomenon in an IPA study is "the thing itself that influences the interpretation; [essentially,] the aim is to allow the new stimulus to speak in its own voice" (Smith et al., 2009, p. 26). While "there will be multiple constructions of how people have

experienced a particular phenomenon, how they have made meaning of their lives, or how they have come to understand certain processes," (Merriam & Tisdell, 2016, p. 243) it is through these genuine responses narrated throughout the study that offers the reader the opportunity to also feel a part of the narrative.

Data Collection

The data collection for this study was conducted during the AP teacher's instruction of the transcendentalism literary genre, a unit taught over a month period covering canonical texts written by transcendentalists Henry David Thoreau and Ralph Waldo Emerson. In his autobiographical text titled Walden, Henry David Thoreau "wrote about his famous transcendental experiment of self-reliant living at Walden Pond" (Farber, 2022). Even though Thoreau highlights important "concepts of civil disobedience, and connections to the environment hold important lessons for understanding issues affecting today's world," (Farber, 2022) students tend to struggle with Thoreau's canonical literature, for his words and abstract ideas are difficult to digest.

To address Thoreau's purpose, the AP English Language and Composition instructor assigned a VR activity for homework, a web-based simulation titled Walden: A Game created by the Walden Team, led by lead designer, Tracy J. Fullerton, director of the University of Southern California's Game Innovation Lab. This VR game, free for all educators by USC Game Innovation Lab, explores the nature of Thoreau's thoughts on self-reliant living as well as his critique of the materialism he saw developing in early industrial society in America (Fullerton, 2020). Split into "a series of three 20- to 30-minute standalone episodes with supporting lessons" for educators (Farber, 2022), the AP teacher assigned the "Self-Reliance" episode as the required activity to fulfill the assignment on Google Classroom, the AP teacher's learning management system (LMS). The AP teacher posted the other two episodes, "Where I Lived" and "What I Lived For" as extra credit on Google Classroom as well. The teacher instructed the students to complete the activities individually in their home environment, for it is pertinent that each student experiences the VR activity without frequent distractions or influence from others.

Research participants were high school students in an AP English Language and Composition course. Students who were eligible to participate in the study were those who had completed at least two Walden: A Game episodes at home and who chose to submit the player reflection journals for the episodes on Google Classroom. Completing two episodes and reflection journals took about one hour and 20 minutes, two hours if the student chose to complete all three episodes. After reviewing the students' submissions, seven students were eligible and participated in the research study. Participants' names remained confidential in this study, for I assigned a number to each participant and then randomly matched these numbers to a pseudonym as follows: Participant 1-Betty, Participant 2-Emily; Participant 3-Rebekah; Participant 4-Mary; Participant 5-Abigail; Participant 6-Esti; Participant 7-Taylor.

I conducted seven semi-structured interviews, during which I recorded my own notes to identify patterns among the participants' responses to the interview questions. In addition to the interview recordings, transcripts and notes, I collected a total of 20 participant reflection journal entries from the seven eligible participants. The students' reflection journal entries were scanned for common words or threads of categories to compare to the conversations in the interviews in the NVivo version 14 computer software for data analysis. By comparing the participant responses for commonalities within their statements, I was able to identify themes applicable to broader contexts (Creswell & Poth, 2018). I documented the coding process as well as the findings to emphasize transparency and maximize the study's reliability and validity.

Hermeneutics is essential to analyzing data for IPA, for making sense of and interpreting the communication provided from each of the participants entails careful analysis. Examining each participant's story of their lived experiences for "how the story is constructed, what linguistic tools are used, and/or the cultural context of the story" (Mischler, 1995, as cited in Merriam & Tisdell, 2016, p. 36) should not be tainted by my interpretation of their narrative. I retold the respondents' accounts through my analytic redescriptions, for through my research strategies, data samples, transcription procedures, and interpretive perspectives, (Mischler, 1995, as cited in Merriam & Tisdell, 2016, p. 36) I, too, told their story.

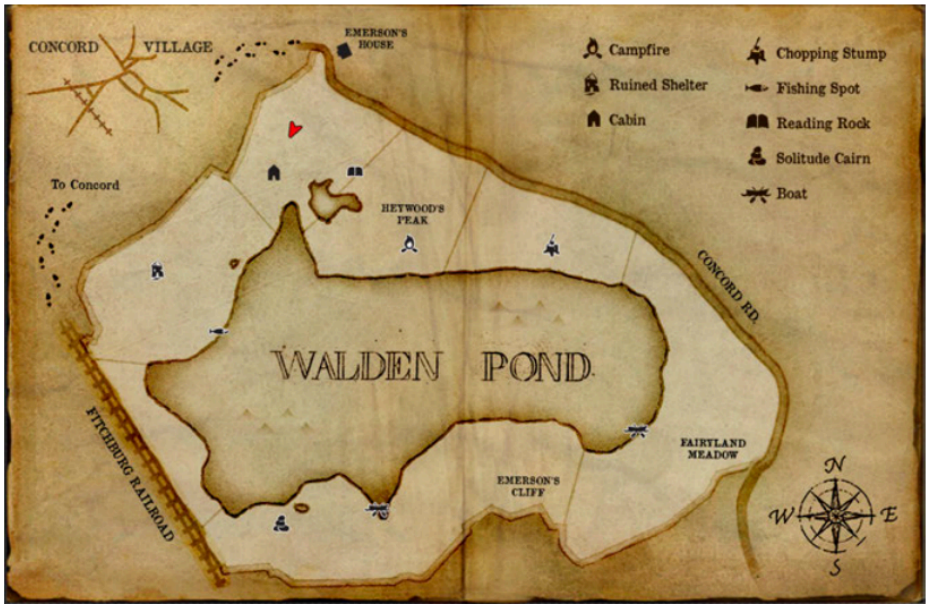
Findings

While this study does not explore students' experiences with VR headsets, it does find that students make connections with the literature they read in ELA courses through digital immersive environments that simulate the contexts of the books incorporated in the curriculum. VR does not need to be a time-consuming lesson, nor does it need to involve expensive tools. VR's digitized immersion is an experience that brings educational context to life through its visual, audible, and kinesthetic means of engagement.

Mary's positive evaluation of the game in her reflection journal demonstrates the impactful contributions of Walden: A Game: "This experience shed light on Thoreau's assertion that enjoyment could be derived from the simplest and humblest of lives. The audible and visual effects from gameplay "allowed [the participants] to truly envision Thoreau and his life at Walden Pond. The game incorporated the actual map of Walden [Pond] and made it come to life" according to Mary (Fig. 1).

Figure 1

Game Map of Walden Pond; Red triangle indicates Player Location



Through this VR experience "students are encouraged to think at a metalevel and to make connections between their world and the world of the text" (Moran & Woodall, 2019, p. 91). Mary explained the concept of being self-reliant: "You have to survive on your own and that's part of the objective. It's your main focus." Esti, specifically, spoke to her connection to nature when she described fishing in her journal reflection: "Fishing was quite fun, and I appreciated the way the arrow popped on the screen showing me how to complete a task the right way with the mouse" (Fig. 2).

Figure 2

Demonstrating the Motion of Fishing

To achieve self-reliance as a transcendentalist, this philosophical experiment focuses on one's connection to nature and its beauty. Participants were given ample opportunities to spend time with their own thoughts, to reflect on the meaning of life by drowning out the sounds of the busy world; it is a "therapeutic experience," according to Taylor.

Overall, through this experience with the immersive simulation Walden: A Game, most of the participants claimed that they gained a better understanding of Thoreau, expressing that the game "enhanced their understanding of the text" (Mary) because "it helped go into his mindset" (Abigail). The VR experience provided realistic feelings applicable to the process of developing self-reliance, appreciation for nature, reflection, and independent thinking. This study sheds light on the potential benefits of pairing a canonical text with a twenty-first-century technology tool, highlighting the deeper understanding gained by encouraging the student participants of this study to experience how differently place and time may mean for the events and concepts of the book.

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Exploring EdTech Policies in Africa

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National Educational Technology (EdTech) policy analysis research is essential for various reasons. For example, identifying factors that influenced the formulation of policies, informing the use of EdTech for policymakers, investigating cost-benefit analysis and comparison of national plans across countries and regions. There is a lack of updated research on African nations' educational technology (EdTech) policies analysis resulting in a lack of knowledge on current EdTech policy landscape of Africa. This paper examined the EdTech policies for selected African countries. By adapting Zhao et al. (2006) 's policy analysis framework, this study aimed to investigate what EdTech policy documents are in place, by which government bodies, and the role of teachers, students, and technologies in the education sector are depicted in these documents.

Introduction

EdTech policy analysis research focuses on identifying factors that have influenced the formulation of policies (McGarr & Johnston, 2021), informing the use of EdTech for policymakers and practitioners (Culp et al., 2005), investigating if the cost-benefit analysis is enough in low-resource areas (Kozma & Vota, 2014) and comparing purposes of national EdTech plans of different countries (Hodges et al., 2022). However, apart from an analysis of 53 African nations' policy status reported by Farrell and Isaacs (2007) and a policy rationale and structure analysis conducted by Kozma and Vota (2014), there is no updated research on African nations' EdTech policy analysis resulting in a lack of knowledge on current EdTech policy landscape of Africa. This paper examines the policies for integrating educational technologies in select African countries namely South Africa, Nigeria, Kenya, Ghana, and Ethiopia. The research question that guided this study is: *What documents are in place, by which governing bodies, and what are the roles of various stakeholders and technology as depicted by the policy documents?* The study is primarily directed towards policymakers, education professionals, researchers, and stakeholders involved in EdTech in the specified countries. The purpose of the study is to examine EdTech policies from five specific African countries, shedding light on the approaches taken, the roles defined for EdTech in student learning, teacher practices, and its broader implications for education.

Theoretical framework

Zhao et al. (2006) analyzed national EdTech plans of 13 countries, and they identified teachers, students, educational goals, and technology images as key educational factors in a nation's education technology policy plan. Their analysis focused on implementing Information Communication Technologies (ICT) in the education sector, which differed from the national ICT policy of nations that covers all other sectors. Given the remarkable development in technology integration in schools over the years, this study used a revised analytical framework that included educational goals, the role of students, the role of teachers, and the role of technology.

Literature review

Based on the literature, understanding the development and implementation of ICT in education policy and investing in technology integration at the national level is crucial. McGarr and Johnston (2021), in their analysis of 10 years of evolution of ICT in education policies in Ireland, highlighted educational, economic/vocational, social, and catalytic rationales for having ICT in education policies. Culp et al. (2005), in their analysis of the United States' 20 years of evolution of EdTech policy documents, identified technology as a tool for addressing challenges in teaching and learning, technology as a change agent, and technology as a central force in economic competitiveness. Mao et al. (2019) analyzed policy changes and technology initiatives in five countries (China, Germany, Italy, the US, and Japan). The authors emphasized the importance of understanding the policy's impact on EdTech adoption and funding for research. More importantly, they concluded that adopting EdTech is influenced by local culture and can change traditional educational practices (Mao et al., 2019). Thus, conducting this present research in an African context is crucial to investigate the EdTech development, implementation status, challenges, and visions from national EdTech policies perspectives. The government bodies responsible for ICT in education policies are often responsible for budget allocation. By identifying these bodies, it becomes easier to understand how resources are allocated to support implementation plans and hold the relevant authorities accountable. By analyzing how stakeholders' roles are defined, it becomes possible to assess whether these roles align with the educational goals. This is crucial to ensure working cohesively towards a common vision.

Recently, the African Union (AU) Digital Education Strategy and Implementation Plan, which runs from 2023 to 2028, was created as a framework for engagement and the acceleration of digital technology adoption (African Union, 2022) in accordance with the Continental Education Strategy for Africa (CESA). Considering the AU's focus on digital education and its reliance on member states' network readiness and education strategy plans African Union (2022), it becomes evident that a significant challenge exists. This study aims to bridge this gap by examining the most recent EdTech policy documents in South Africa, Nigeria, Kenya, Ghana, and Ethiopia.

Method

This study focused on the national EdTech policy published between 2015 and 2022 for five countries (Ethiopia, Kenya, Ghana, Nigeria, and South Africa). The study employed qualitative content analysis, as suggested by Williamson et al. (2018). First, an initial research frame was generated based on the analytical framework. Then, we conducted data pre-processing. With a focus on trends and challenges of the educational technology landscape at a national level, two researchers independently analyzed the policy documents to extract relevant information. After the data pre-processing and intensive group discussions, the coding scheme was gradually expanded with more categories and then finalized. The documents were coded and recorded in a spreadsheet and then imported to MaxQDA software to conduct inductive coding and gain insight from the ground level. Due to the considerable variation of the plan documents, the unit of analysis was decided on meaning.

Preliminary Results

Approaches to EdTech Policy in National Education Plans

In many countries, different parts of the government are responsible for preparing ICT in education policy documents (Moonen, 2008). For example, in Nigeria, the Ministry of Education is responsible for issuing the 2019 National Policy on ICT in Education. Similarly, in Ghana, the Ministry of Education has the 2015 ICT in Education Policy. On the other hand, in Ethiopia, the Ministry of Education has no separate policy document for ICT in education. However, the 2021-2025 Education Sector Development Plan VI (ESDP VI) has ICT as an integral part of the education sectoral plans. Kenya also has ICT as part of the National Education Sector Strategic Plan 2018 – 2022 issued by the Ministry of Education. On a slightly different approach, South Africa's 2020 National Digital and Future Skills Strategy is the latest document issued by the Ministry of Communication and Digital Technologies.

Focus of educational goals

Examination of educational goals shows Ethiopia and Nigeria share a similar vision of providing inclusive and equitable education for all learners. South Africa and Ghana identified digital citizenship with technology proficiency as one of their educational goals, stating:

> *"To confidently and creatively use ICT tools and resources to develop required skills and knowledge needed to be active participants in the global knowledge economy at all times" (Ministry of Education of Republic of Ghana, 2015, p. 20).*

Kenya's policy focuses on ensuring learning continuity and quality focusing mainly on improving access and participation rate in competence-based learning for primary, secondary, higher education, and CTE levels and promoting acquisition of market ready skills at TVET level (Kenya Ministry of Education, 2018).

Focus of student roles

In terms of student roles, these countries discussed students as active digital learners with specific expectations such as to raise awareness and build basic and intermediate digital skills for all students (e.g., Ethiopia, South Africa, Nigeria).

> *"The students/learners are transformed from passive recipients of the knowledge of the teacher/trainer to active participants in knowledge-seeking and knowledge-construction, with the teachers/trainers often learning new technology programs along with them" (Nigeria, 2019, p. xi).*

However, others promote higher levels of digital proficiency with the capability to think, apply and digitally create (e.g., South Africa, Ghana), stating:

> *"By giving students the skills to be successful in a 21st century workplace, they will more likely find jobs or start ICT-focused enterprises which can bring long term driven economic growth in Ghana" (Ministry of Education of Republic of Ghana, 2015, p.19).*

Focus of teacher roles

The primary role of teachers in the five countries has been defined as leaders/advocates of technology (e.g., Kenya, Ethiopia, Ghana, Nigeria), which requires teachers to be able to use technology to support all teaching, learning and management. Additionally, South Africa has identified the teacher role as a fluent user of technology, which calls for educators with digital skills and competencies to use technology effectively.

Focus of technology's roles

The roles of technology have been described in multiple dimensions with a common purpose of improving the education process and outcomes (e.g., South Africa, Ethiopia, and Ghana). The roles include 1) a fundamental level as

an information tool (e.g., Ghana); 2) a decision-making tool and a tool to reform or transform education. For example, Ethiopia's plan states:

> *"Aims to transform the practice of data collection, storage, analysis, and reporting of the school inspection system from a paper-based to a digital system, thereby improving the effectiveness of the system in establishing, evaluating, and promoting the highest standards of quality in educational provision" (Ethiopia Ministry of Education, 2021, p. 111).*

Challenges in Implementation

Kenya and Nigeria mentioned a lack of educational resources as a challenge whereas Ethiopia and Kenya indicated the insufficient and ineffective training for teachers and school leadership which results in a lack of understanding, willingness, and proficiency in using technology in teaching and learning.

Conclusion

This research provided an in-depth view of EdTech policies in select African countries, highlighting their decentralized nature. While some countries integrate ICT into their national education sectoral plans, others have separate documents for ICT in education policies. Kenya and Ethiopia have integrated ICT as part of their national education sectoral plans, while Nigeria and Ghana have separate ICT in education policies published by the respective ministries of education. Though they share commonalities, the specific approaches to educational goals, students' roles, teachers' roles, and technology's roles vary. These differences reflect the unique contexts, priorities, and challenges in each nation. Contextually relevant policies are essential for driving positive educational outcomes across the continent.

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Exploring Faculty Development Frameworks in Medical Education: Challenges and Opportunities

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This review examines the intersection of faculty development frameworks in medical education and instructional system design (ISD) principles. A systematic review of existing literature follows the PRISMA guidelines, and data analysis combined inductive and deductive approaches to examine key framework components, strategies in faculty development frameworks, and alignment with instructional system design principles. The findings show a tapestry of shared components and diverse approaches, each offering unique value. Incorporating ISD principles can amplify the impact of medical faculty development programs. The study can deepen our understanding of medical faculty development frameworks and provide valuable insights for creating reliable solutions.

Background

Faculty development (FD) is crucial in medical education as it helps educators in various aspects of their teaching, research, and professional journey (Hibbert & Semler, 2016). Faculty members benefit from FD programs which aim to enhance the quality of teaching, increase research productivity, and promote professional advancement growth (Johnson et al., 2023; O'Sullivan & Irby, 2011; Phuong et al., 2020;). In order for faculty members to succeed in their roles as educators, researchers, and professionals, it is crucial that they have current knowledge, skills, and abilities (Charlier & Lambert, 2020; Esterhazy et al., 2021). Well-structured FD programs enable faculty members to adapt swiftly to the rapidly evolving healthcare landscape and stay up-to-date with evidence-based practice (Hitchcock et al., 1992).

Instructional system design (ISD) is a systematic approach which guides the structured process of creating effective instructional solutions (Reigeluth, 1983). ISD applies learning theory and principles to ensure evidence-based instructional programs and interventions (Cook & Steinert, 2013; McGriff, 2001). The ADDIE model is a widely recognized ISD framework, comprising five stages: Analysis, Design, Development, Implementation, and Evaluation. The comprehensive approach ensures instructional solutions are pedagogically sound and adaptable to needs and learning outcomes of learners (Branch, 2009). Medical education institutions can better equip faculty with practical strategies for teaching, research, and professional growth using ISD principles.

Several FD frameworks have been proposed in medical education (Alhassan et al., 2022; McLean et al., 2008; Sullivan et al., 2011). In addition, review studies have been conducted to determine what specific content and elements (Fallis et al., 2022; Sirianni et al., 2020) and key features- such as content relevance, reflection with feedback, community building, and longitudinal intervention (Steinhart et al., 2012, 2016)- should be included in competency-based FD. However, further work is needed on how such content and features should be designed, developed, and delivered effectively.

Purpose of the Study

The study aimed to systematically review existing literature to guide an in-depth examination of the connections between existing FD frameworks in medical education and ISD principles. The findings shed light on implications and recommendations for enhancing medical FD programs. The research questions are threefold:

1. What are the essential components of the faculty development framework in medical education?
2. How do these frameworks guide faculty development program development?
3. How do these frameworks align with ADDIE principles of instructional system design?

Method

Search Database and Strategy

The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The literature search was conducted using electronic databases (i.e., Google Scholar, Eric, Web of Science, PsycINFO, JSTOR, PubMed, BEME, OpenMD) and other methods (e.g., reference and website search). The search terms included ["faculty development framework" and "medical education"] or ["teaching," "research," or "professional"]. In the search process, two authors refined criteria, conducted abstract and full-text reviews, and extracted data.

Selection Criteria

Inclusion criteria for the study were empirical studies published in peer-reviewed journals between 2000 and 2022 which examine FD frameworks in improving teaching quality, research productivity, and professional development in medical education. Exclusion criteria were studies which needed to provide more information on the FD framework or report its foundational principles.

Data Extraction and Quality Assessment

Data were extracted from the selected studies using a data extraction form. Out of a total of 481, 13 articles were included in the analysis. The extracted data included the author(s), year of publication, foundational theory, academic discipline, associated domain, specific element, and unique values. The quality of the selected studies was assessed using the predefined inter-rating selection bias tool (Whiting et al., 2016).

Data Analysis and Procedure

Next, a content analysis was conducted using a codebook to identify critical components, strategies, and alignments related to FD frameworks in medical education (Krippendorff, 2018). After reviewing the criteria to improve the accuracy, a member check was applied. The coding process involved an inductive approach to identify emergent themes and patterns for RQ#1 and 2, and a deductive approach to examine alignments with ISD principles for RQ#3. The intercoder reliability was calculated to ensure coding accuracy and agreement. (k=.79-1.0).

Results

The selected studies encompassed various frameworks, principles, and concepts to enhance faculty development in medical education. A total of five countries were represented by the 13 studies included in this review. The references marked with an asterisk are included in the meta-analysis. North America was the continent with the highest percentage of studies (USA: 5, Canada: 5), and others include Australia (1), Africa (1), and Asia (1). Of the studies included in this review, eight proposed a conceptual framework, and five explained foundational principles for medical FD development.

Components of FD Frameworks

Some key components included specific learning theories, foundational content, and faculty/institutional needs. The common components included: (a) delivering relevant content, (b) providing effective feedback, (c) employing longitudinal approaches, (d) establishing a shared vision, (e) institutional support, and (f) evaluating effectiveness. Overall, medical FD frameworks are multifaceted and can be improved heuristically with the use of these key components.

Approaches within Frameworks

The approaches used within the FD frameworks to guide program development are varied. Findings show sequential, comprehensive, and mixed approaches are constructed to engage faculty in development efforts. Additional emphasis is on the importance of iterative and interactive processes, longitudinal and parallel approaches, and the application of new lenses to enhance faculty development. These approaches collectively highlight the significance of a multi-dimensional approach to improving the FD processes and outcomes.

Alignments with ADDIE

The frameworks were examined using the ISD lens using the ADDIE model for effective FD programs and interventions. The included studies indicated different combinations of phases within the ADDIE principles. Most frameworks prioritized specific phases or their combinations, while some focus on the entire ADDIE process. This variability highlights the lack of an ISD model in tailoring faculty development to meet specific needs and contexts in medical education.

Discussion and Implications

The study revealed that FD frameworks in medical education share core components and approaches, though it is evident that no single, universal approach exists. These shared components and approaches collectively contribute to a well-rounded approach to FD, with each framework offering unique values. However, most frameworks do not highlight the importance of systematic approaches in designing, developing, and delivering solutions. Notably, the focus on FD underlines the commitment to connecting FD with the overarching goals of institutions or enhancing faculty's teaching and professional development. Research-related components are included only in two frameworks. FD often concentrates on individual participants; however, a broader perspective can enrich FD by integrating community building and workplace learning.

Tailoring FD programs to meet the specific needs and contexts of faculty and institutions is a challenge. One of the reasons for this challenge may be the lack of ISD integration. The frameworks include the different combinations of the ADDIE phases. Some frameworks prioritize the analysis phase through a

needs assessment and program outcomes. Others emphasize the development and implementation phases to provide FD solutions in a timely manner, and the evaluation phase to ensure that the FD resources remain aligned with changing needs and contexts. The other comprehensive approaches encompass all the phases, with iterative and interactive processes.

The challenge lies in determining which combination of the ADDIE principles best aligns with an institution's unique requirements, resources, and goals of its PD programs. By incorporating the ISD standpoint, medical FD programs can be more effectively tailored to address the specific needs and contexts of different institutions, departments, and individuals. By embracing ISD's agile and flexible principles, medical FD can be finely tuned to cater to the specific needs and contexts of diverse medical settings.

The study has some limitations. Our search for relevant studies may not fully represent the entire literature on the topic. Subsequent steps should involve validation through conducting an expert survey and field interviews and the formulation of evidence-informed guidelines for FD development.

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Exploring the Evolving Landscape of Simulation-Based Education in Nursing Undergraduate Curricula 2018-2023: A Bibliometric Investigation

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This study conducts a bibliometric analysis of 2,724 highly cited articles on simulation-based nursing education published between 2018 and 2023. The study evaluates the simulation-based nursing education research landscape using the Web of Science database and specialized bibliometric analysis. Various visualization techniques were applied to construct co-citation networks and conceptual maps, revealing an interdisciplinary landscape that includes higher education, virtual reality, and medical education as pivotal themes. These interconnected domains underscore their importance in crafting effective educational interventions. The study stresses the value of comprehending the evolving bibliometric trends for enriching nursing education and healthcare practice. The insights generated from this analysis are significant for academia and the healthcare sector, offering a structured understanding of the developments and emerging research avenues within simulation-based nursing education.

Introduction

The landscape of clinical nursing practice has significantly transformed over the past decade. The emphasis on incorporating clinical simulation education into nursing curricula has been prominent, given its potential to emulate real-world scenarios (Wang et al., 2022). Simulation-based teaching methods are pivotal, allowing nursing students to hone vital clinical skills in controlled environments (Cant & Cooper, 2009). The COVID-19 pandemic has further underscored the importance of this shift as clinical practice opportunities dwindled (Smith et al., 2018).

Our bibliometric analysis scrutinizes 2,724 peer-reviewed papers from January 2018 to September 2023, sourced from the Web of Science (WoS). We centered our eligibility criteria on articles written in English within Education and Educational Research, focusing on document types like Articles and Review Articles. The review elucidates evolving trends in simulation-based nursing education, highlighting the trajectory from traditional curriculum approaches to embracing advanced technologies (Blandford, 2023) like Virtual Reality (VR) and Augmented Reality (AR).

Evolving Trends in Simulation-Based Nursing Education

Historically, the impetus behind simulation-based nursing education was integrating scientific methods into nursing curricula (Reese et al., 2011). By 2020, research expanded to encompass emerging technologies like VR and AR, the evaluation of learning outcomes, and strategies for emotional and stress management (Chen et al., 2019; Gudadappanavar et al., 2021). The pandemic propelled research toward alternative clinical experiences through simulation education (Cobbett & Snelgrove-Clarke, 2016).

Game-Based Learning and Technological Advancements

Game-Based Learning (GBL) has gained traction as an innovative pedagogical technique, captivating students with game-centric elements (Pellas et al., 2019). Within nursing education, GBL enhances learning outcomes by fostering problem-solving, collaboration, and critical-thinking skills (Wan et al., 2021). The evolution of VR and AR technologies further refines GBL, furnishing immersive experiences instrumental for clinical skill acquisition (Fealy et al., 2019).

Challenges and Gaps in Research and Practice

Despite these advancements, hindrances still need to be addressed. The pandemic unveiled the constraints of conventional clinical education, heightening the significance of simulation-based methods (Smith et al., 2018). Integrating VR and AR technologies is imperative to mitigate these challenges. The retention of psychomotor skills, crucial for clinical efficacy, is a paramount concern addressed by consistent simulation-based learning. A chasm persists between research insights and educational implementation. Bridging this gap requires a cohesive effort from educators, researchers, and clinical professionals (Smith et al., 2018; Um, 2023).

Bibliometrics Utility in Research

Bibliometrics offers researchers a quantitative perspective to discern thematic trends in academic research (Callon et al., 1983). Combined with Social Network Analysis, these methods generate visual representations of academic citation networks.

In nursing simulation education, bibliometrics provides a unique view of evolved knowledge structures. This study employs co-word analysis to define these structures, identifying research voids. Bibliometrics remains an invaluable tool in academic research, providing a view of the publication landscape and illuminating the path forward for fields like nursing simulation education.

Methodology

Database Selection and Tools Utilized

Based on the range of bibliometric analysis tools offered, we decided to establish our research on the Web of Science (WoS) database. We specifically focused on WoS because of its features like co-citation, co-authorship, and keyword co-occurrence, which played a crucial role in our article selection process (Falagas et al., 2008). It is worth noting WoS stood out due to its academic coverage, setting it apart from databases like PubMed, which mainly focus on life sciences and biomedicine.

Search Strategy

To improve the accuracy of our search, we utilized the "Web of Science Subject Categories and Keywords," a controlled vocabulary used in WoS. Like PubMed MeSH terms, these vocabularies enhance the precision of categorization and article indexing. This approach greatly enhances the effectiveness of our search by ensuring an exploration of key research themes. We designed our strategy based on a customized WoS query string which included terms in the field like "simulation," "virtual reality," and "nursing education." To broaden the scope of our search, we also incorporated variations and synonyms of these terms, ensuring a thorough investigation (Moher et al., 2009).

Temporal and Inclusion/Exclusion Criteria

Our research focused on articles published from January 1, 2018, to September 5, 2023. The results were further narrowed down by well-defined inclusion and exclusion criteria based on document type, language, and research area. The inclusion criteria comprised articles, review articles, and early access papers primarily in English and focused on education and educational research. Exclusion criteria were implemented to avoid irrelevant fields like chemistry, psychology, and computer science.

Data Analysis Framework

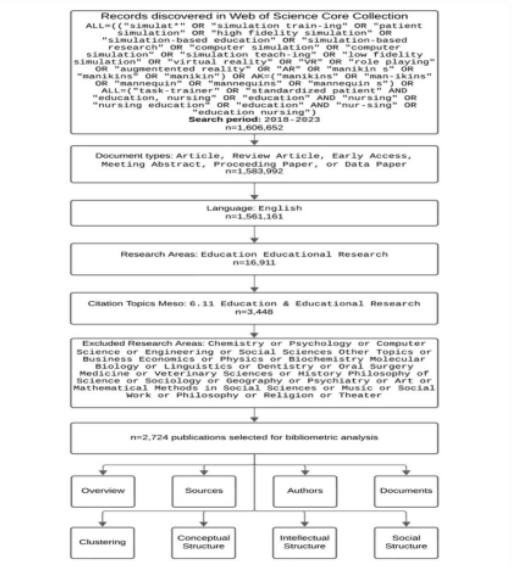
We utilized the PRISMA framework (see Figure 1) to synthesize our information. Our method organized data by publication date, co-citation, keywords, and themes, ensuring a comprehensive dataset for bibliometric analysis (Moher et al., 2009).

Using the built-in functionality of the WoS database to filter our dataset based on our inclusion and exclusion criteria, we fine-tuned our research dataset to focus on our research objective: *How have the research themes in simulation education specific to nursing education in undergraduate nursing programs evolved over time?*

Our approach was dedicated to accuracy and thoroughness. The WoS database played a role in our work, providing various academic resources and analytical tools. With a search strategy, strict selection criteria, and a clear plan for handling data, we were well-positioned to uncover detailed insights into the development of educational technology and the growing field of simulation science.

Figure 1

Prisma Table

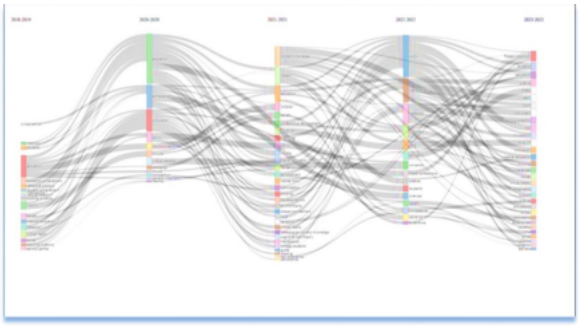


Results and Analysis

Our bibliometric approach used the online tool Biblioshiny (Aria & Cuccurullo, 2017). This method emphasizes the frequency of concurrent keyword appearances within the academic dataset, suggesting thematic or topical coherence in the subject matter (Van Eck & Waltman, 2010).

Figure 2

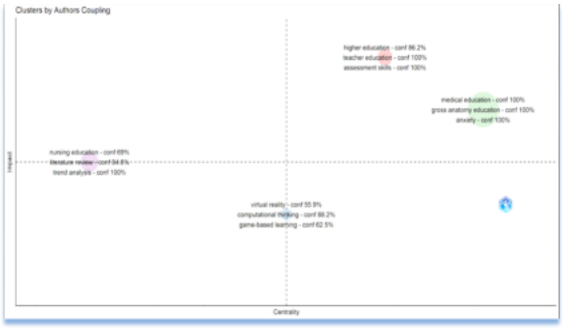
Network Analysis



The network analysis (see Figure 2) visually demonstrates these inter-relationships. Keywords served as nodes and their co-occurrence frequencies were represented as edges, giving insight into prevalent themes, critical areas, and potential research gaps (Pons & Latapy, 2005).

Figure 3

Co-Occurrence Matrix



Similarly, the co-occurrence matrix (see Figure 3) quantifies how often keyword pairs appear together within a specific collection of academic documents, with frequency encoded in each matrix cell (Huang et al., 2009).

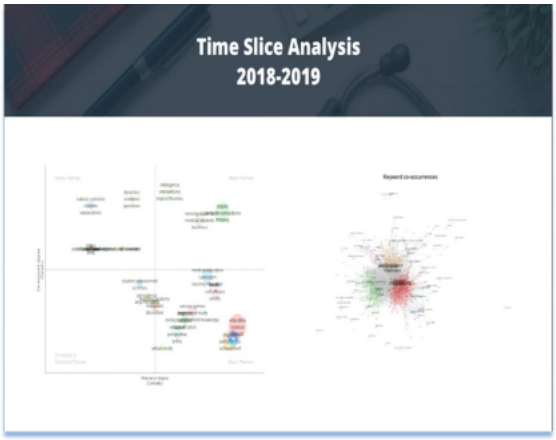
Notably, the diagonal elements of the matrix frequently indicate the total number of occurrences for each keyword across the dataset. This kind of matrix serves a dual purpose: it acts as both the foundational data layer for constructing a network graph and a basis for any ensuing statistical analyses that may be conducted (van Eck & Waltman, 2010).

This matrix laid the foundation for constructing the network graph and subsequent statistical analyses (Van Eck & Waltman, 2010).

Discussion

Figure 4

Time Slice Analysis: 2018—2019



Keyword analysis showed a shift from VR integration in 2018-2019 to wider educational strategies and foundational research by 2019 (see Figure 4).

Figure 5

Time Slice Analysis 2020

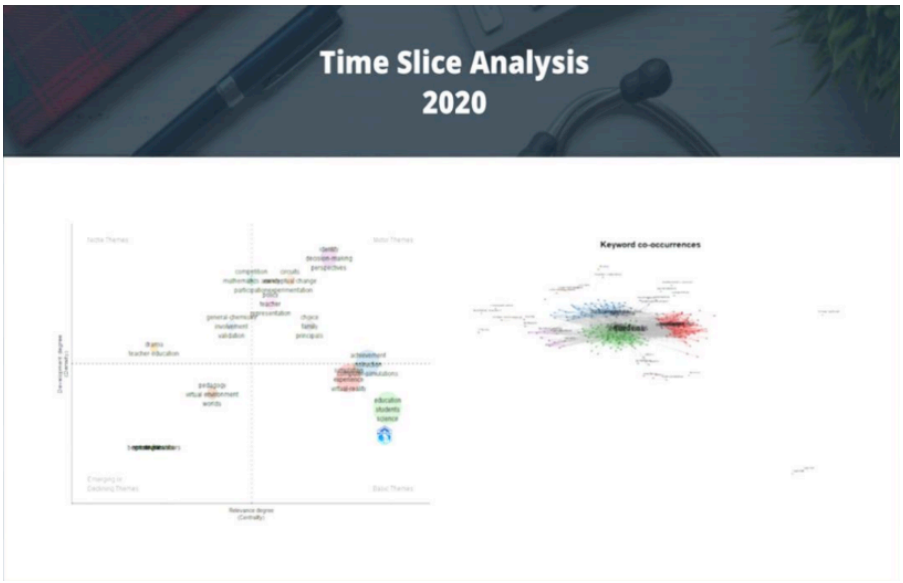
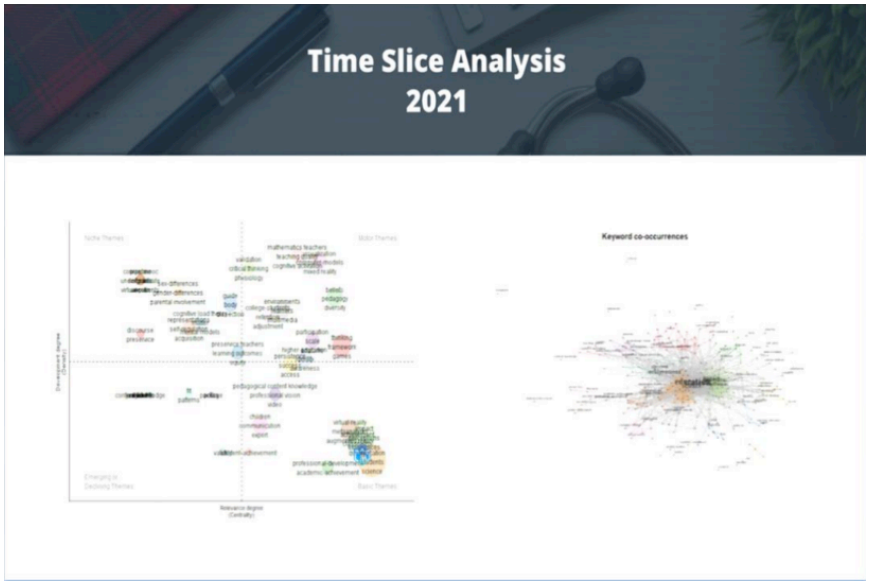


Figure 6

Time Slice Analysis 2021



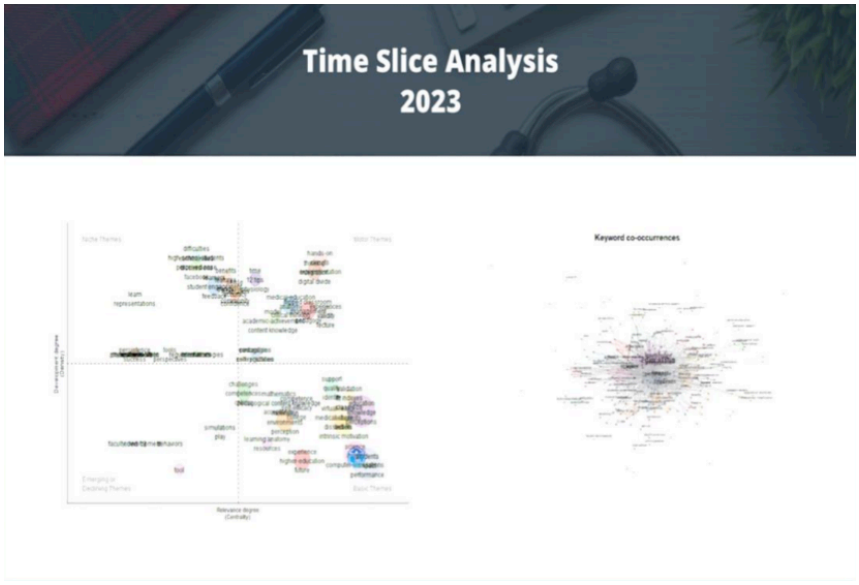
During 2020-2021 (see Figures 5 & 6), the literature emphasized performance metrics, interconnectedness, and knowledge tracing. There was a straightforward merging of science with educational technology in the context of simulation research.

Figure 7

Time Slice Analysis 2022

Figure 8

Time Slice Analysis 2023



During 2022—2023 (see Figures 7 & 8), trends in nursing education underscore the rising prominence of VR and AR (Heesung et al., 2017), game-based learning, and simulations, particularly during the pandemic when traditional instructional methods faced limitations.

Conclusion

Our analysis reveals that simulation-based nursing education is an expanding field, bridging higher education, virtual reality, and medical education. The COVID-19 pandemic highlighted the constraints of traditional clinical education, necessitating the adoption of VR and AR technologies to maintain critical psychomotor skills. While these technologies offer enhanced learning through consistent exposure, they also present challenges including cognitive overload, and potential neurological and behavioral issues, indicating a need for further investigation. This study provides a vital framework for educators, researchers, and practitioners, highlighting the dynamic nature of nursing education and the need for adaptive educational strategies. Future research should focus on the pedagogical effects of these technologies to improve the quality and efficacy of nursing education.

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Exploring the presence of marginalized populations in OER texts dealing with matters of EDI

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The purpose of this research is to build on the growing body of literature that seeks to identify how often open educational resouces (OER) material used in higher education references historically marginalized groups in matters pertaining to equity, diversity, and inclusion (EDI) with an emphasis given to the contexts in which they are mentioned. The guiding research question of the study posits that EDI discussions within OER tend to place added emphasis on certain marginalized population groups while others are routinely overlooked

Introduction

Open educational resources (OER) are often extolled for their capability to equalize higher education by alleviating the associated costs which disproportionately affect people of color and other marginalized populations (McCabe & Jackson, 2016), yet the literature surrounding how such OER incorporate social justice issues to represent marginalized groups is sparse and largely non-existent. A noted area of contention lies in just how few existing studies into the matter establish a connection between the increased participation of these populations at the university level and the inclusion of OER within the course material being used (Lambert, 2018). This is further supported by research indicating the presence of marginalized groups within OER mirrors traditional textbooks in that they are systematically underrepresented and even omitted from certain historical contexts completely (Brandle, 2020). Thus, the purpose of this study is to build on the growing body of literature which seeks to identify how often OER material used at the university level references historically marginalized groups in matters pertaining to equity, diversity, and inclusion (EDI).

Impetus for OER content to be more inclusive

Despite established connections to implied themes of social justice both in theory and practical discourse, there is a scarcity of studies on the topic of diversity in representation and authorship within OER as the central element of discussion (Seiferle-Valencia, 2020). Therefore, research into how OER plays a role in expanding accessibility is still in its infancy. Significantly more needs to be done in this regard to support its ability to be inclusive and equitable for all learners. In response, Lambert (2018) proposes a social justice focused definition of "Open Education" which is aligned with one or more of the three principles of redistributive, recognitive, and representational justice. With this adoption, new empirical studies can be conducted to measure the impact of initiatives to provide marginalized learners with more resources, recognition, and representation.

In the same way society uses models of communication to subtly instill the values of its dominant groups upon the greater populace, the ideology and discourse used in academic texts become part of the greater normative culture surrounding academia. This hidden curriculum plays a large role in the process which socializes students, their identities, and how they perceive the world (Lapum et al., 2022). As a result, students belonging to relegated groups are taught their cultures and histories are not important and are thus barred from the greater societal conversation resulting in decreased opportunities for academic and professional success (Ladson-Billings, 2009). Conversely, studies have shown modified content has been linked to an increase in student's overall satisfaction with their coursework as well as a heightened sense of belonging which serves to bolster their motivation and engagement within academia (Nusbaum, 2020). Doing so has the added benefit of enhancing social empathy by expanding critical consciousness and helping people discern situations in a new light after experiencing an emotional connection through another person's lived experience (Powell et al., 2020). Consequently, dedication to inclusion provides benefits which extend beyond the a sense of belonging among marginalized groups since a plurality of perspectives expands the collective knowledge and understanding of the world as a result.

Methodology

This study is replicative in nature since it adapts the methods of previous studies by employing a quantitative approach and descriptive statistics to obtain data. It consists of a full-text content analysis of selected OER tied to current EDI topics within specified academic fields using a list of unique terms which are coded to associate with selected historically marginalized groups. This data was then compiled into a categorization dictionary along with the record of their resultant instances within the selected texts to identify which populations are receiving priority focus. These results serve to establish how much coverage the groups receive collectively, and in relation to one another, which can then be expanded upon to determine trends of representation within OER.

Population group categories and demographic terms

The population groups chosen for this study consist of marginalized communities that are traditionally excluded from mainstream social, economic, and educational life based on race (African American, Asian American/Pacific Islander, Latinx, Native American, Middle Eastern), gender (female), sexual orientation (LGBTQ+), and persons with disabilities. Additionally, a general category was created to encompass catch-all terms that relate to the greater marginalized populations as a whole and are thus not tied to one demographic exclusively. Careful consideration was given towards selecting various demographic terms that are widely used in both academia and the common-English language to represent the different population groups being studied. Most terms stem from online publications and databases which explore definitions of ethnicity, race, and social justice such as those offered by the National Education Association (NEA Center for Social Justice) and the Journal of Epidemiology and Community Health (Bhopal, 2004) while others were subsequently found within the OER texts themselves and were added accordingly.

OER texts used in study

The initial stage of the study focused on selecting a sample of pertinent OER texts that met defined criteria using the advanced search functions offered within four popular OER databases (OER Commons, OpenStax, MERLOT, and EdTech Books). Search parameters focused on instructional textbooks that are available with unrestricted user licenses developed for university level and equivalent higher-ed courses in the subject areas of education, arts and humanities, and the social sciences. Qualifying content was restricted to full text offerings, so no other form of media was considered. Search results were then subjected to further individual scrutinization to ensure content was relevant and fits the parameters of this study with extra consideration being given to those which were specifically focused on cultural studies tied to the human element in relation to matters of EDI.

Each text was screened to ensure discussions within were purposely centered around the different population groups instead of tangentially as part of wider thematic studies. Additionally, consideration was given to the selection of a wide variety of texts across the different subject areas to provide a suitably sized sample of genres to minimize potential overlap of topics being discussed. The rationale for using this method is that it leverages several ranking devices within popular OER databases to identify a wide assortment of relevant samples of OER texts intended for instructional use within higher-educational EDI discussions while allowing for an in-depth analysis of the target populations mentioned within.

Findings

Taken as a whole, the population group which received the most mentions across the selected OER (see Table 1) was Women followed by African Americans and then General representing a cumulative total of 72.46% of all in-text citations. Collectively, the remaining six population groups received far less attention with a combined total reflecting only 27.54% of the cumulative in-text references.

Table 1

Mentions of Population Groups Across Chosen OER

Population Group Category	Total Number of Entries	% of In-Text References
African American	3430	21.52%
Asian American/Pacific Islander	676	4.24%
Persons w/ Disabilities	521	3.27%
Latinx	800	5.02%
LGBTQ+	1118	7.02%
Middle Eastern	410	2.57%
Native American	864	5.42%
General	3257	20.44%
Women	4860	30.50%
Total	**15936**	**100%**

Discussion

While all the chosen OER texts dedicate substantial space to discussions centered around EDI topics pertaining to the different marginalized population groups of this study, it is also apparent certain demographics receive substantially more attention than others. More specifically, it is the omission of these groups from EDI discussions which is particularly telling. For example, while Asia is estimated to be home to roughly 60% of the total world population, references to its inhabitants comprise only about 4% of the cumulative in-text references. Furthermore, it is noteworthy that many of the mentions of these same groups within the texts were of a historical nature. Thus very few discussions were centered on the ongoing issues these communities face today. Similarly, many contemporary EDI discussions use statistics to show how the different populations groups are faring in comparison to one another in measures of economic success, such as education and employment. Yet doing so creates a tacit implication that some groups are not in as much need as the others since they are doing well in these specific measures. Such findings have often contributed to the myth of the "model minority" where certain populations are held to higher standards despite their facing many of the same challenges and discriminations of other minority groups.

While none of the OER texts specifically make this assertion, the lack of content relating to certain groups in EDI discussions nonetheless serves to reinforce notions that certain demographics are more deserving of attention. This can lead to a disparity in real world outcomes due to unfounded generalizations which rise as a result. Worse yet, such a lack often ignores the reality that many population groups represent diverse and varied cultures. This can lead to misconceptions where the high-profile accomplishments of certain subgroups are subsequently extended to the greater community as a whole. The implications of these findings are not to suggest any one group is underserving of the time and attention they are receiving in ongoing EDI discussions. To the contrary, an argument could be made that there still remains a need for further representation of diverse perspectives in academic discussions if true equity is to be achieved. Thus, the data obtained within this study serves to reinforce claims that OER must extend its focus beyond issues of perceived need. Failig to do so threatens to ignore or otherwise skew issues marginalized populations are facing, diminishing the likelihood that true equity can be achieved within academia as a result.

Future research

The implications of this study will help address future questions of what populations are receiving attention in discussions of EDI as well as help address which ones require further presence within OER texts being used in higher-ed.

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Exploring the Transformative Integration of Immersive Makerspace for Teaching Abstract Science Concepts

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This study outlines the design and implementation of an Immersive Makerspace (IM) using the Mozilla Hubs, an online Virtual Reality (VR) platform accessible across geographical boundaries through mobile devices, personal computers (PCs), and web-enabled VR headsets. This Design-Based Research (DBR) study explores the effectiveness and challenges of "making" in an IM. Learning from the challenges through different iterations, this study aims to platform to foster elementary students' learning of abstract science concepts.

Introduction

Makerspaces are innovative, collaborative, hands-on spaces that allow learners of all ages to learn through making (Sheridan, 2017), inventing, and exploring their interests through creating objects. Making is an active process which involves creating shareable artifacts by constructing, designing, and inventing with tools and materials (Martinez & Stager, 2019). Chen and Cao (2022) found an increased interest in using makerspaces in K-12 settings. However, limited facilities and high maintenance costs hinder rural school districts' makerspace integration (Loertscher, 2015). Additionally, physical makerspaces can have exorbitant membership fees, serve limited affluent audiences, and narrowly focus on electronics, robots, and high-end fabrication tools (Radu et al., 2021; Ratto, 2011). Consequently, these challenges lead educational researchers and practitioners to explore creative ways to support makerspace integration in this context.

One creative solution makes use of Mozilla Hubs, an online social virtual reality (VR) platform accessible through mobile devices, personal computers, and VR headsets. Mozilla Hubs is an applicable, innovative platform which mitigate some of the previously listed challenges. For example, Asino et al. (2022) demonstrated that using a free version of Mozilla Hubs alleviates cost-related and accessibility issues. They designed immersive educational experiences which promoted water and drought monitoring activities via rural and small libraries backyard explorer programs. Learners in this study entered the immersive learning space as avatars to explore the topics of water, drought, and environmental monitoring, interacted with each other, and participated in activities. With this precedent in mind, we followed the same approach and applied similar concepts in designing the Immersive Makerspace (IM) in this study.

Research Questions

This study's purpose is to investigate the effectiveness of IM using Mozilla Hubs in developing a deeper understanding of abstract science concepts, which are often challenging to visualize (Mørch et al., 2023). The following research questions guide this study:

1. What are the perceptions and experiences of doctoral students regarding the usability, accessibility, and overall effectiveness of IM in learning elementary school-level abstract concepts of science?
2. What challenges do participants face in the "making" process inside the Mozilla Hubs virtual space?

Theoretical Perspective

This study operates on the belief that people, means, and activities interconnect through a shared purpose (Hira & Hynes, 2018). The people/participants in this study's first iteration are doctoral students at an R1 University, some of whom are current or former teachers. Means in the context of the study entails the technology-driven practices people use in the virtual makerspace setting. The activities include the making challenge "All About Carbon" and discussions happening in the IM. The shared purpose catalyzes a profound understanding of abstract science concepts through making in a digital environment. In addition to interconnectedness, Papert's (1993) constructionism theory indicates how learners build their comprehension in the IM. Precisely, participants in the IM will actively construct knowledge when engaged in "meaningful" making activities (Martinez & Stager, 2019, p. 34). They can create shareable objects, like different carbon molecule structures.

Literature Review

Previous studies explored using makerspaces as professional development tools (Paganelli et al., 2016; Shively et al., 2020). However, there is limited research on IMs impacting teacher's knowledge sharing within a professional development (PD) setting. Chen and Cao (2022) designed virtual maker-centered activities for K-12 teachers,

while Chen et al. (2022) embedded virtual field trips for rural teachers in a makerspace with telepresence robots. Lock et al. (2020) explored the participants' experiences as a maker community in a synchronous virtual makerspace; other researchers expanded on the scope of this space. Furthermore, Radu et al. (2021) developed a mixed-reality makerspace system accommodating on-site augmented reality (AR), remote desktop, and remote VR participants to engage in the making process in a virtual three-dimensional space. However, our study is unique as we aim to design an IM focused on learning abstract science concepts in a social VR platform for rural teachers with limited access to physical makerspaces.

Methods

This study uses the Design-Based Research (DBR) methodology to collect data. Wang and Hannafin (2005) defined DBR as a systemic but flexible methodology aimed to improve educational practices through collaborative analysis of different iterations, design, development, and implementation. This paper reports on the study's first iteration, which includes intervention design and implementation. The research team's primary collaborators, or "co-participants," are doctoral students from an R1 university, some of whom are current or former teachers (Barab & Squire, 2004, p. 3).

The researchers configured the IM using Mozilla Hubs, dividing it into multiple rooms. The 30-minute making challenge took place in Room One with six participants. Data collection involved pre and post-questionnaires, screen recordings of the participants' making processes, observation notes, and interviews. The participants accessed the IM through mobile devices or personal computers (PCs), with the option of using head-mounted displays (HMDs). Three participants used the VR headset for a fully immersive experience, and the other three participants used a PC. All participants chose their avatars and entered the IM room, which contained a 3D carbon molecule model (Figure 1). Participants used 3D construction materials provided by the research team, which included tennis balls and broom handles, to build their molecules (Figure 2).

Figure 1

Carbon Molecule prototype in Room One

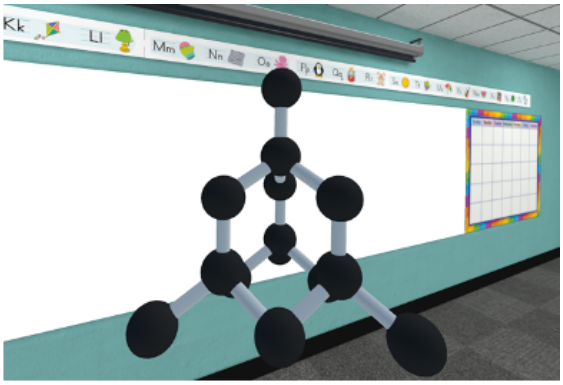
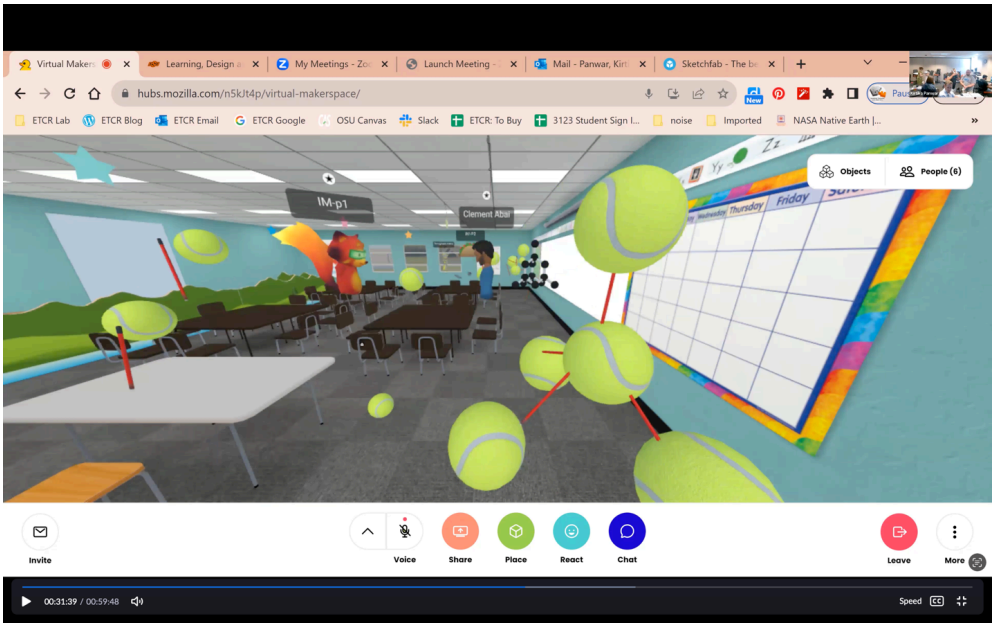


Figure 2

Participants as avatars with 3D materials making carbon molecule



Findings

The research team examined the collected data from all sources. We present the participants' responses in this section. A few participants reported they found Mozilla Hubs to be reasonably user-friendly, offering a simple interface, and reminding them of other games they played. One participant using a PC found its creation capabilities particularly impressive. Another participant using an HMD stated the HMD's rotational capabilities provide a comprehensive field of view, making navigation enjoyable and intuitive. Nevertheless, other players disagreed. First-time VR headset users found it challenging to use the controls and required more guidance. Experienced VR headset users said, "It would resemble more like the tactile experience of makerspace if your controller was the actual hand." Navigation initially presented a confusing challenge for participants using PC and HMD. However, after a few minutes of interacting with the IM, they learned the mechanics of the tennis balls and broom handles, as well as the methods for rotating, cloning, pinning, and unpinning them. Other participants said they struggled to make the carbon molecule because the 3D objects were difficult to manipulate, and the broom handles did not rotate along a specific axis as anticipated to configure the carbon molecule correctly. The participants' responses showed their preferences and curiosity in exploring the IM. One participant wished they had selected VR instead of the PC and said they would try VR in future instances to challenge them. One participant was curious to explore other rooms, the lobby, and the main hall in the Mozilla Hubs. Some participants preferred to have individual makerspace stations so everyone worked in their space without disrupting others' work, while other participants enjoyed navigating the virtual world, as they could observe others' efforts. They also liked seeing the avatars of participants with whom they were not acquainted. Other participants would like more guidance about how to work with 3D elements in Mozilla Hubs, like cloning and linking them together. Two former teachers mentioned that students would thrive in a 3D, interactive educational setting. They also looked forward to the potential for tangible tools to enhance their students' understanding of abstract scientific topics with the inclusion of more 3D elements in the IM.

Discussion

The research team gained insights from the data collected and participants' feedback and will adjust the design based on these findings (Armstrong, 2020). The overall research findings suggest that Mozilla Hubs has good usability and provides an immersive experience for users. Even still, some new players may find the controls challenging. The research team had an additional realization about how participants' preferences about working collaboratively or individually may influence their behaviors in the IM. Based on the participants' feedback, the research team will focus on providing additional makerspace rooms, structured instructions, and more 3D elements to interact with in subsequent iterations. The challenge would be to learn what makes our DBR study effective as we implement future iterations. Expected results from further iterations include a fully developed IM to improve rural teachers' access to makerspace education across geographical boundaries. We also anticipate that PD about IMs could lead to empowered teachers providing engaging science lessons.

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Getting to the <3 of Things: How Game Feedback Enables Failure for Learning

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Failure in serious games and its implications for scaffolding learning towards exploration remain understudied. We hypothesize providing more opportunities for safe failure leads to higher retention of concepts. Our case study examines the difference between including extra lives into a prototype serious game for geography through a quasi-experimental design that captured learning outcomes and failure rates. Participants reported more frustration when given fewer chances, and when having less familiarity with games in general. Our findings align with studies suggesting low-stakes environments allow comfortable experimentation and create opportunities for player persistence.

Introduction

Serious games are increasing in popularity as a learning technology and their effectiveness is well-documented. Nearly 80% of adults and over 90% of children in the United States regularly play video games by choice for fun (NPD Group, 2020). Research has demonstrated video games facilitate learning in a variety of ways (Gee, 2003, 2007; Squire, 2011). Video games have been described as powerful learning tools which require players to respond to simulated environments, progressively developing new knowledge and skills within game worlds (Gee, 2003) and support learning related to a variety of cognitive processes such as inductive reasoning (Greenfeld, 2014) and decision-making (Gros, 2007).

Background

Students prefer collaborative, active learning which is technology-rich, making a good case for digital games adding value in education (Bekebrede et al., 2011). Prince (2004) defined active learning as an instructional approach which involves engaging students in the learning process through meaningful activities, thereby promoting reflection on their actions, active inquiry, critical thinking, and problem-solving skills. Serious games take advantage of active learning through a balance of challenge and skill. This balance exists through "Flow" where learning occurs when a person is interested, focused, and controlled during a task (Egbert, 2004).

Gee (2003) emphasizes the importance of failing as part of the learning process and argues video games play a particular role in encouraging that attitude. Video games offer players a low-stakes environment for experimenting and making mistakes, which builds resilience and persistence when players fail. Furthermore, Gee emphasizes successful game design often incorporates failure as a necessary step towards success and encourages players to keep trying until they succeed. Various scholars view failure not as a setback, but as a necessary and valuable component of the learning process (Gee 2003; Kapp, 2012; Salen & Zimmerman, 2005).

Problem Statement

Research exists on many topics related to digital game-based learning, but there are not many results for applying serious games in higher education (Liberona et al., 2021). This study takes a look at a serious game currently used in higher education in an introductory geography course. Feedback is something digital games have mastered (Gee, 2007; Kapp, 2012). The feedback we receive when playing video games is timely and well-scaffolded. For example, in a game like the classic Nintendo Entertainment System (NES) Super Mario Brothers, Mario blinks and shrinks or falls when he encounters an enemy that he does not squish, and an additional sound plays. This indicates to the player that the non-playable character (NPC) on screen has the ability to harm Mario.

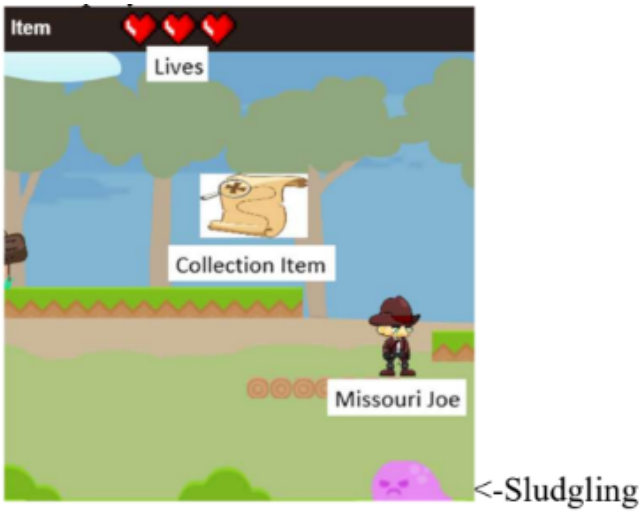
Methods

In the serious game selected for this study, Biomes Rescue, the player receives feedback in the form of a "deathscreen" when encountering a harmful NPC, which in this game are called "Sludglings." For this study, we redesigned the game to give the player more chances, or "lives," so the player does not need to break flow in order to continue gameplay and proceed with learning.

The feedback in the second iteration of the game is in the form of hearts at the top of the screen. When the player begins, they have three "lives," or chances, rather than being forced to restart gameplay every time the player encounters a Sludgling. When the player encounters this harmful NPC, the player will flash briefly and a "life" will disappear from the user interface at the top of the screen. The third time a player takes damage, the deathscreen appears.

Figure 1

Gameplay UI with Hearts

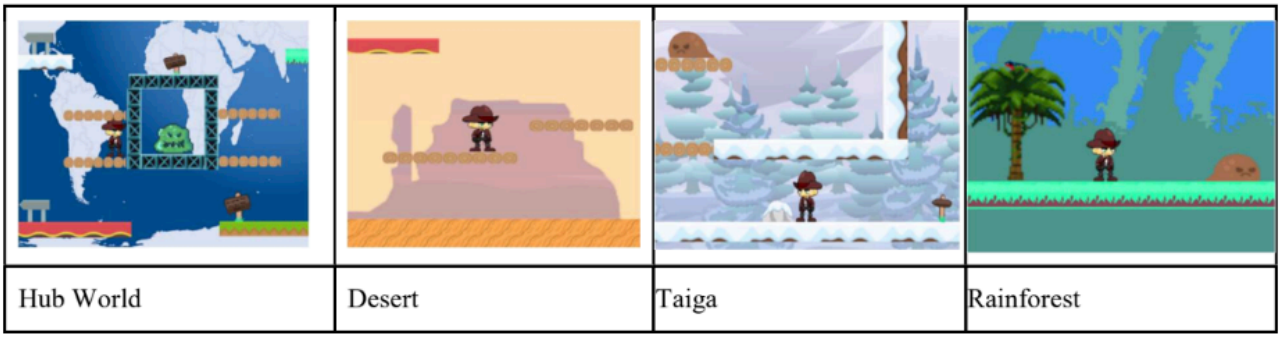


A collection and matching dynamic enables players to associate different characteristics with biomes. Driven by a simple narrative, to restore the biomes from anthropomorphized NPCs representing pollution, the player explores this puzzle-platformer.

We conducted a quasi-experimental case study to investigate the usefulness of immediate feedback in the form of additional "lives" to player learning. The goal of Biomes Rescue is to teach the player basic concepts about the characteristics of various biomes. The player collects clues about the biomes and goes between them through the Hub World. Matching clues to the correct biome unlocks more of the level and allows the player to collect additional clues. The win condition for the game is to fully unlock all biomes and battle the "SludgeKing," who wants to eat the world's biomes. The player's role is to stop him. We hypothesized the differences in feedback would impact the learner's knowledge retention when playing this serious game, in that if they had more chances they would retain more information.

Table 1

Biomes and the Hub World



Hub World	Desert	Taiga	Rainforest

Data was collected with eight participants from a purposeful convenience sample - three expert gamers and five novice gamers. Some of the participants had the condition of extra chances in the form of three "lives" while others were given the no-lives condition. The participants virtually attended a one-hour session of recorded gameplay. The post-test asked players to match facts to the correct biome and was scored for accuracy.

Results

Players died frequently in this game. Those with multiple "lives" were allowed to continue playing without immediately reaching the deathscreen, and could be hurt by enemies up to 3 times without starting over. All novice players without multiple lives quit before completing the game - one stopped on the first level after matching only two clues. The post-test did not reflect this, as many simply guessed, and some had more prior knowledge than others. Expert players finished the game relatively quickly, with the quickest time by an expert player without multiple lives.

Figure 2

Results

#	Gamer Level	Age	Condition	Times Started Over	Time on Death Screen	Complete Play Run	Post-test Score	Experience with Games
1	Novice	30	-	20	1:20	N/A	4/12	Boring.
2	Novice	48	❤❤❤	14	0:56	11:01	7/12	Nostalgic
3	Novice	63	-	16	1:04	N/A	6/12	Relaxing, entertaining
4	Expert	21	❤❤❤	4	0:16	13:52	8/12	Co-op, fun
5	Novice	32	❤❤❤	3	0:12	6:45	8/12	Aggressive
6	Expert	19	-	1	0:04	9:35	5/12	Fun, skill-building
7	Expert	33	-	5	0:20	5:51	9/12	Relax, chill & detach
8	Novice	52	-	5	0:20	N/A	12/12	Doesn't play much, frustrating, "bad" at it

When asked their favorite part of the game, participants who completed the game said they liked the animals, who appeared once the biome was complete, and squishing the Sludglings. Participants who did not complete the game had similar answers, although they tended to express higher levels of frustration with the game, as well as animosity towards the Sludglings. When asked their least favorite part, participants with the multiple lives condition who completed the game disliked the desert level, whereas no-lives participants expressed exasperation with having to restart the game. Participants who did not complete the game expressed greater frustration with dying, there being no checkpoint within the game, and other minor frustrating game mechanics or bugs.

The willingness of "lives" participants to provide more in-depth feedback probably reflected their relatively lower degree of frustration with the game than those who had to start over constantly. When asked what they would change to make the game more successful as an educational tool, participants all responded with notes about either making the biomes more clearly delineated or improving the inventory to make clues more readily accessible.

Discussion

The frustration our participants described feeling when playing the game made them less inclined to learn, less likely to achieve a state of flow, and less likely to complete the game. We found participants with experience playing games ("expert" gamers) were more likely to persevere, even though they expressed a similar state of frustration as novice gamers. Tolerance for frustration had a limit for all participants, but expert gamers understood the broader scope of trial-and error as a game mechanic from their own past experience, and saw that as part of gameplay, while novice gamers were simply discouraged by the difficulty of the game. We also found that those who had multiple chances (lives) when playing the game were more likely to complete the game. Players who enjoy a challenge are more likely to find competence and enjoyment within failure (Frommel, 2021), so it makes sense our expert gamers (or those who enjoy ultra-difficult games) were not hindered by the absence of additional chances.

Our participants with lives all completed the game, whereas our participants without multiple lives had only a 40% completion rate. All participants who completed the no-lives condition game were expert gamers. The no-lives condition was so frustrating for novice gamers that they were unable to complete the game. The number of correct results in the post-test assessment seemed to have little connection to what the players were doing in the game. Their two major points of frustration were novice status and restarting. This implies serious games aimed at novice gamers should gravitate toward less difficult gameplay if they wish to induce states of flow, learning, and enjoyment in the player, while serious games aimed at expert gamers may have more latitude to include extreme difficulty as part of play.

Conclusion

Frustration is an important tool in game design, but "pleasant frustration" is difficult to achieve when the audience is at different levels of expertise. When the player, despite multiple attempts, is unable to make satisfactory progress, learning dissipates because the challenge is too high. Our "lives" participants seemed less frustrated when starting the game over, even in the case where they were novice players who had started over several times. The no-lives condition did not provide ample opportunity for safe failure, because when challenges and skills are not balanced, it results in frustration (Egbert, 2004). Immediate feedback allows players to both remain in a state of flow and see direct progress as they play (Cheng et al., 2015). Doing as little as possible to interrupt flow during play allows the tasks of learning and playing to occur sequentially, or in an alternating fashion, rather than simultaneously (Nadolski & Hummel, 2017). A low-stakes environment for experimenting and making mistakes builds resilience and persistence when players fail (Gee, 2007). Our findings show that making the stakes lower, or giving more opportunities for safe failure, does result in a better outcome for the learners.

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Impact of Metacognitive Awareness Prompting on Students' Learning Performance: A Pilot Study in a Genetics Undergraduate Course

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The objective of this pilot study was to understand to what degree making students aware of their metacognitive strategies impacts their metacognitive and academic performance. A quasi-experimental design, with a control and an intervention group, was used for this study. Scores from a metacognitive awareness survey were provided to the intervention group during a classroom activity. Our findings indicated the potential of this strategy in increasing students' overall performance, enabling them to transform their own learning.

Motivation and objective of the study

Higher education institutions are more and more often encouraged by employers to find ways to add to their graduates' technical knowledge and competencies a set of soft skills such as team skills, communication and interpersonal skills, emotional intelligence, or leadership qualities (Deepa & Seth, 2013; Thompson et al., 2021). These skills became especially important for STEM graduates that traditionally were seen as more individualistic and focused on technical skills (e.g., Ahmed et al., 2013; Lumague, 2017).

Researchers have found that, similar to the development of cognitive skills, soft skills can be enhanced through the implementation of metacognitive strategies (Mitsea et al., 2021). Previous research indicated that students who were exposed to prompting strategies to become metacognitively aware were more likely to (a) have better critical thinking skills, (b) be more strategic in their learning process, (c) be better at self-regulating their learning, and (d) perform better than unaware learners (Kim, 2018; Saks & Leijen, 2019; Saraff et al., 2020; Schraw & Dennison, 1994). Enhanced metacognitive skills proved to be beneficial across multiple areas such as architectural design (Kurt & Kurt, 2017), programming performance (Çakiroglu & ER, 2020), or nursing (Hsu & Hsieh, 2014).

The objective of this pilot study was to understand to what degree making undergraduate students aware of their main metacognitive strategies (strengths and weaknesses) impacst their performance, both as part of a team and individually.

Research intervention

Undergraduate students at a Midwestern university enrolled in two sections of a science course (Genetics) were randomly designated as a control and respectively an intervention group, following a quasi-experimental research design. During the first week of the semester, all students enrolled in the Genetics course completed a metacognitive awareness survey.

During the second week of the class, the intervention group was exposed to an activity that included a presentation and short interactive exercises conducted by the instructor and an instructional designer. The presentation focused on the impact of collaboration, active learning, and metacognitive awareness on learning. For each of two metacognitive strategies, students scored themselves on the questions associated with that strategy, then the presenters explained the strengths of that strategy on the learning process and asked them to discuss in small, ad-hoc groups, what strengths each of them is bringing to the team. Following these exercises, students were provided with their survey data in the form of a metacognitive score card (Figure 1). The instructor then recommended that students use these cards to enhance the effectiveness of their work during the weekly in-class small-group projects.

In addition to the presentation for the intervention group, the instructor added a brief required reflective essay to two in-class projects for both groups; these essays were guided by prompting questions focusing on metacognitive aspects of learning related to the topic of the project and were intended to serve as metacognitive awareness refreshers for students. Therefore, besides the in-class activity and the individual metacognitive score cards handed to the students in the intervention group, the instructional process was identical for the control and intervention sections.

Figure 1

Sample Metacognitive Score Card

Metacognitive Skills (% of maximum score)

	%
Comprehensive Monitoring	69
Planning	61
Evaluation	67
Information Management Strategies	77
Debugging Strategies	74

COMPREHENSION MONITORING
Assessment of one's learning or strategy use

PLANNING
Planning, goal setting, and allocating resources *prior* to learning

EVALUATION
Analysis of performance and strategy effectiveness after a learning episode

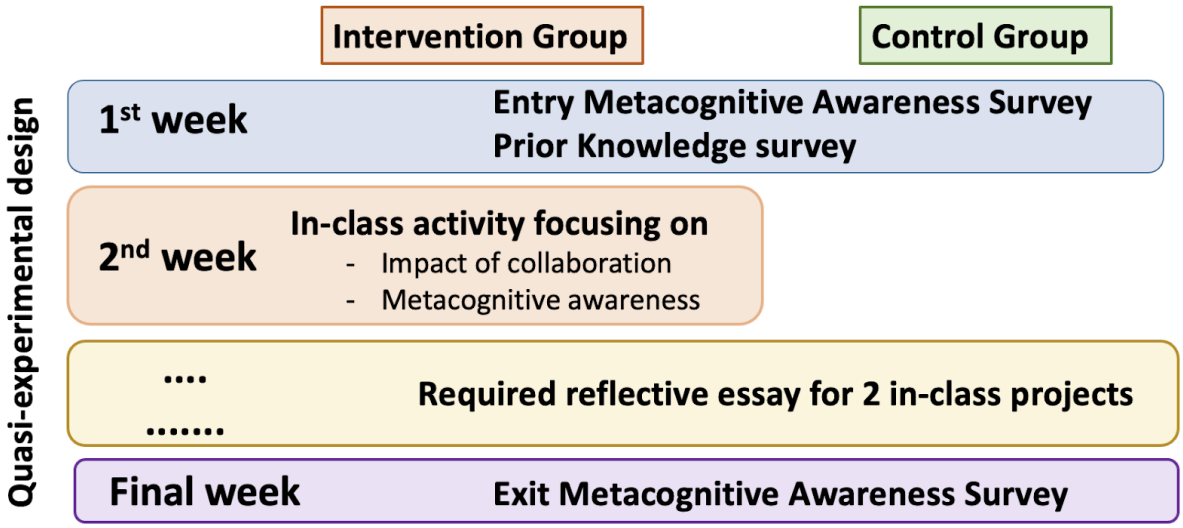
INFORMATION MANAGEMENT STRATEGIES
Skills and strategy sequences used to process information more efficiently (e.g., organizing, elaborating, summarizing, selective focusing)

DEBUGGING STRATEGIES
Strategies to correct comprehension and performance errors

During the last week of the semester, all students completed the same metacognitive awareness survey administered at the beginning of the semester and, once the grades were officially uploaded, the research team retained for analysis students' performance scores for the assignments and assessments associated with this study. Figure 1 summarizes the timeline and the structure of the research intervention associated with this study.

Figure 2

Timeline and Structure of Research Intervention



Research methodology

All students enrolled in the course, 52 in the control group and 50 in the intervention group, were invited to participate in the study. Of these, 38 (73%) students in the control group, and 36 (72%) students in the intervention groups completed a matching pre- and post-intervention metacognition awareness survey. Participation was voluntary and there was no bonus points or other type of reward for their participation in the study. The study was approved by the university institutional review board.

The metacognitive awareness survey was adapted from the Metacognitive Awareness Inventory (MAI) instrument proposed by Schraw and Dennison (1994). Five strategies from the original MAI instrument were used in this study: The Information Management strategies (10 items), Debugging strategies (5 items), Planning strategies (7 items), Monitoring strategies (7 items) and Evaluation strategies (6 items). The evaluation used a 7-point scale with 1 (never) and 7 (always). The results were presented to the students in the intervention group as a percentage of total score from the maximum possible.

SPSS v28 ® was used to analyze the data. Internal reliability for the five metacognitive constructs used in this study was strong, with Cronbach's Alpha values ranging between 0.73 and 0.81.

Summary of findings

An independent-samples t-test found no statistically significant differences between the mean prior-knowledge scores of the control and respectively intervention groups. This result indicated that the two cohorts involved in the study were homogenous at the entry point in the study.

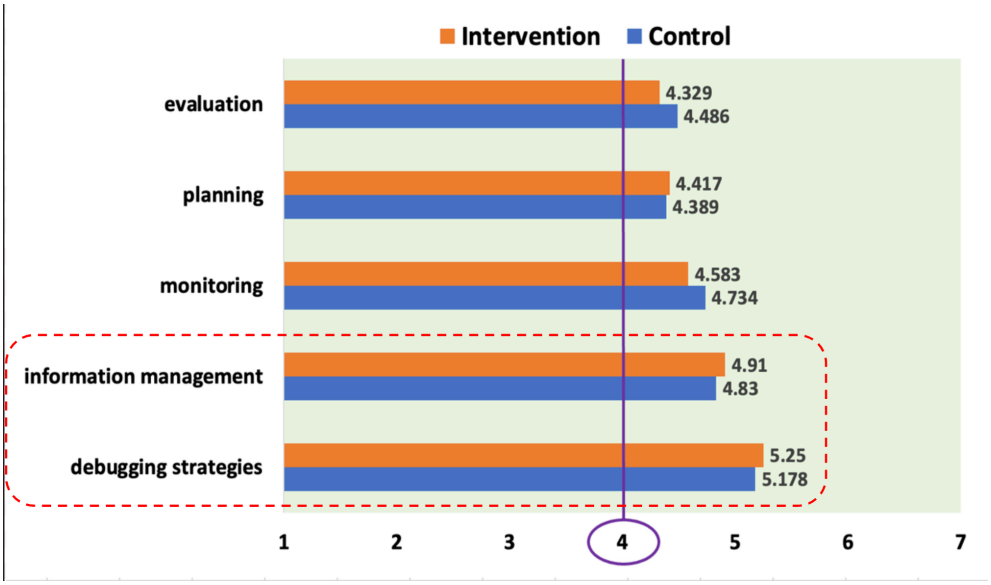
Metacognitive constructs

An independent-samples t-test showed no statistically significant differences between the mean values of all metacognitive constructs for the control and respectively intervention group (Figure 3). The debugging and information management metacognitive strategies were the top two strategies self-reported by the participants in this

study.

Figure 3

Comparison on Mean Values for the Metacognitive Constructs Post Intervention



However, an independent-sample t-test using as test value 4, the neutral point of the scoring scale indicated a statistically significantly higher mean scores than the neutral point of the scale for planning, monitoring, information management and debugging strategies for both control and intervention group and the evaluation strategies for the control group ($p<0.05$). The evaluation metacognitive strategy for the intervention group was the only one that had a mean score that was not statistically significantly higher than the mean of the scoring scale.

When the mean values for top two metacognitive constructs, debugging and information management, were compared between the pre and the post intervention for each group it could be observed that the direction of mean score change from pre to post for the control group was different from intervention group (Figure 4).

A repeated measures ANOVA indicated that the control group had a pre-intervention lower information management mean score than the control group and increased post intervention, and the control group lost from the pre to post intervention for both information management (Figure 5a) and debugging (Figure 5b) strategies. While the interactions were not statistically significant, the higher exit mean values for the intervention group (see Figure 5) suggested that it might be worthwhile to explore if a stronger intervention focused on the metacognitive processes would generate statistically significant interactions.

Figure 4

Change in Mean Metacognitive Scores for the Information Management and Debugging Constructs

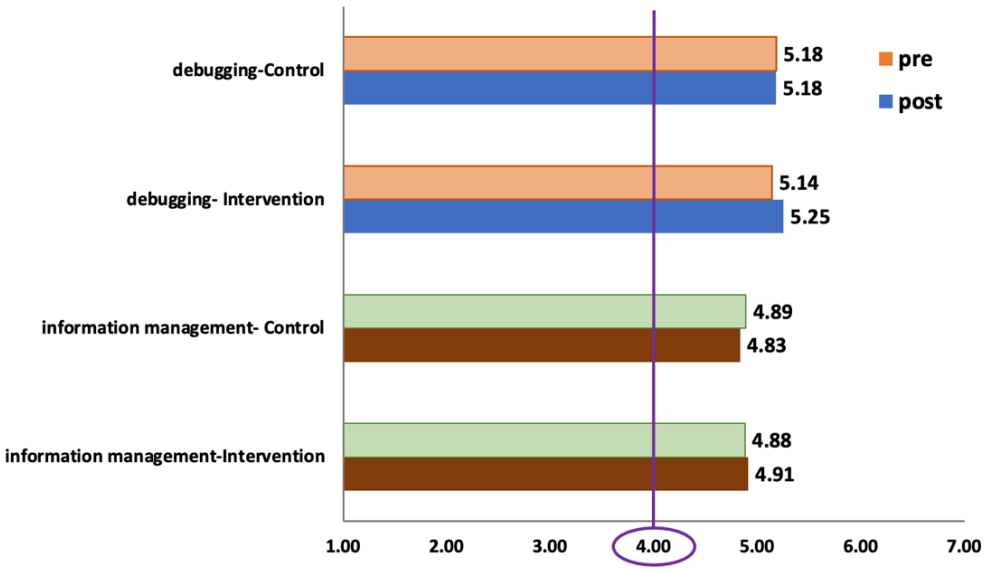
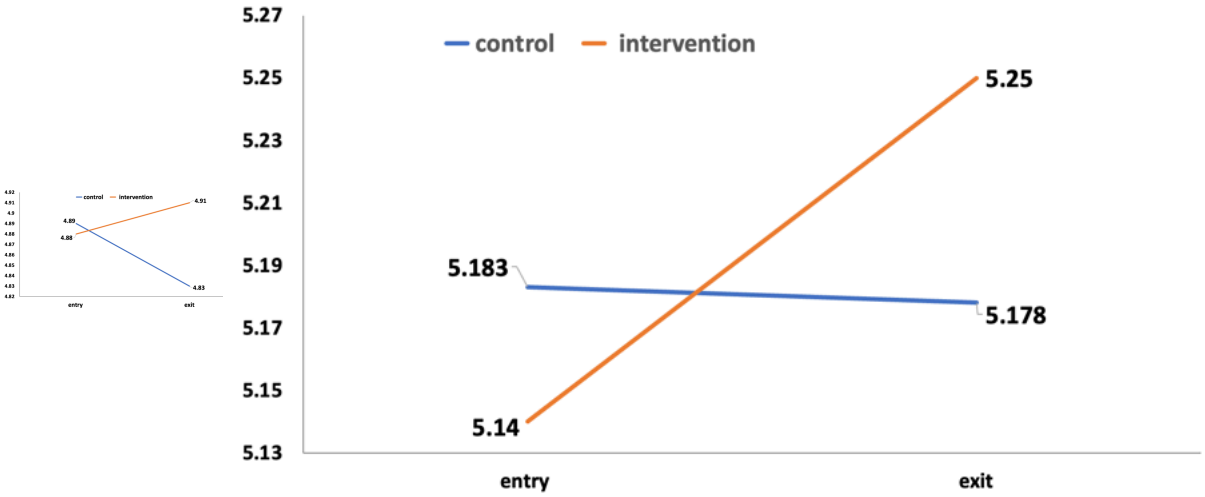


Figure 5

Interaction of Mean Metacognitive Scores from Pre to Post Intervention a) Information Management Metacognitive Strategy; b) Debugging Metacognitive Strategy



Analysis of student performance

When we analyzed the impact of the intervention on the three weekly projects closely linked to the focus of the intervention due to their complexity and link to the additional reflective essays, an independent-samples t-test indicated that intervention group had statistically significant higher mean weekly projects scores (90.7%) than the control group (85.4%), $t\ (72) = -2.14$, $p < 0.05$. In addition, a regression analysis indicated that the weekly project scores that were selected because they required the greatest metacognitive investment, were a statistically significant predictor for the total exams score, $F\ (1, 72) = 21.8$, $p < 0.001$, and explained 23% ($R2=0.23$) of the variance in the total exam scores.

In addition to the analysis of the quantitative data, a quick comparison of the reflective essays introduced to targeted weekly projects indicated that in the control group, most answers were either a reiteration of the question, or a statement indicating that students had looked through their notes as shown below.

> *"I looked at Mendel's postulates and mitochondrial genes and how these were different."*
>
> *"Recalling information we talked about in lecture today and using these step by step to explain my answer"*

In the intervention group, multiple students mentioned peers as a resource (compared to none in the control group). There was also a little more diversity and depth (on average) among the student responses in the intervention section, as shown in the next examples.

> *"I pictured how one would find genetics using a Mendelian route and contrasted it with the idea of mitochondrial DNA and how they differ from one another in transmission from parent to progeny."*
>
> *"I first thought about Mendel's postulates and how mitochondrial genes are different. Then, I also thought about the cell cycle, mitosis and meiosis."*
>
> *"We looked over Mendel's postulates and compared with mitochondrial genes. As well as collaborating with other groups."*

Conclusion

Despite the fact that the metacognitive awareness intervention in this study was relatively reduced in amplitude, the analysis of data showed the potential of this strategy in:

- Increasing students' overall performance on more open-ended instructional tasks such as the weekly projects in the focal course of this study;
- Potentially increasing students' overall performance in the course.

The overall score increase for the metacognitive awareness intervention was also supported by a higher quality of reflective essays associated with the weekly projects in the intervention group. Together, our findings suggest that making students aware of their metacognitive strengths and weaknesses prompts them to capitalize on their strengths when working with peers and pushes them to become better learners and contributors, enabling them to transform their own learning.

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Implementation of Deep-Learning Strategies that Support Development of Adaptive Expertise in Two First-Year Pharmacy Courses

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The objective of this study was to describe the implementation of two deep-learning strategies targeting the development of adaptive expertise skills in two first-year Doctor of Pharmacy courses. To stimulate the development of an environment conductive to building adaptive expertise skills, productive failure and concept mapping were integrated in two courses. The results showed the benefits of building an instructional structure that supports the development of adaptive expertise skills through high self efficacy and perceived value of the two tools on own learning.

Motivation and conceptual framework

Pharmacy doctoral (PharmD) programs are preparing professionals in a healthcare field which is continuously evolving. PharmD programs are required by the external accrediting agency to equip future pharmacists with transferable skills needed to analyze and synthesize new information, draw valid conclusions, and collaboratively solve new, complex, emerging tasks in their healthcare field. To meet these requirements pharmacy instructors need to help students switch their focus toward transferable skills aligned with their professional dynamics.

The conceptual model of adaptive expertise proposed by Hatano and Inagaki (1986) provides a framework which can help instructors achieve this goal. According to this model, learners need to move from procedural knowledge (what, how), useful in stable, routine-type of environments, to conceptual knowledge, needed to explain why something works, in new contextual constraints.The adaptive expertise model stimulated a series of studies in pharmacy education to identify and define strategies to support the development of adaptive expertise (Mylopoulosa et al., 2018; Steenhof, 2020). Three critical strategies were proposed (Steenhof, 2020): (a) engaging students in explaining why questions, (b) encouraging struggle in a safe environment, and (c) asking what if questions. Concept mapping and productive failure align with these strategies. Concept maps are mindtools which engage students in the process of building complex mental models by helping them to build structural knowledge needed to answer why questions (Bilik et al., 2020; Jonassen, 2000). Productive failure is an instructional strategy developed around the role acknowledgment of errors by the learner plays during problem solving while providing a safe learning environment. It builds on the assumption that when a learner is confronted with a task which is similar to a previously failed one, that previous failure will activate needed prior knowledge and skills (Kapur, 2008). Researchers also found productive failure promoted future learning better than both direct instruction (Steenhof et al., 2019) and indirect failure (Steenhof, 2020).

The objective of this study was to describe the implementation of two deep-learning strategies, concept mapping and productive failure, targeting the development of adaptive expertise skills in two first-year PharmD courses.

Instructional context and interventions

Foundational courses in PharmD programs help students building strong competencies which integrate foundational pharmaceutical and pharmacy practice knowledge (Medina et al. 2023). Pharmaceutics I is a course focused on helping first-year students (P1) to bridge the foundational chemistry course in pre-pharmacy curriculum and clinical courses and build transferable problem-solving skills. Pathophysiology I, on the other hand, is a course which focuses on the comprehensive study of physiological processes and the mechanisms of disease important to the understanding of pharmacology and drug therapy.

The implementation of concept mapping and productive failure, two instructional strategies focused on stimulating the development of adaptive expertise skills, followed the adopter categories proposed by the Diffusion of Innovation Theory (Rogers, 2003). The instructor in Pharmaceutics I, an innovator, is continuously interested in implementing new instructional ideas which can positively impact the learning process (Rogers, 2003). He initiated a collaboration with an instructional designer (ID) to address students' failure to connect the conceptual aspects of chemical structures with the corresponding algebraic equations.

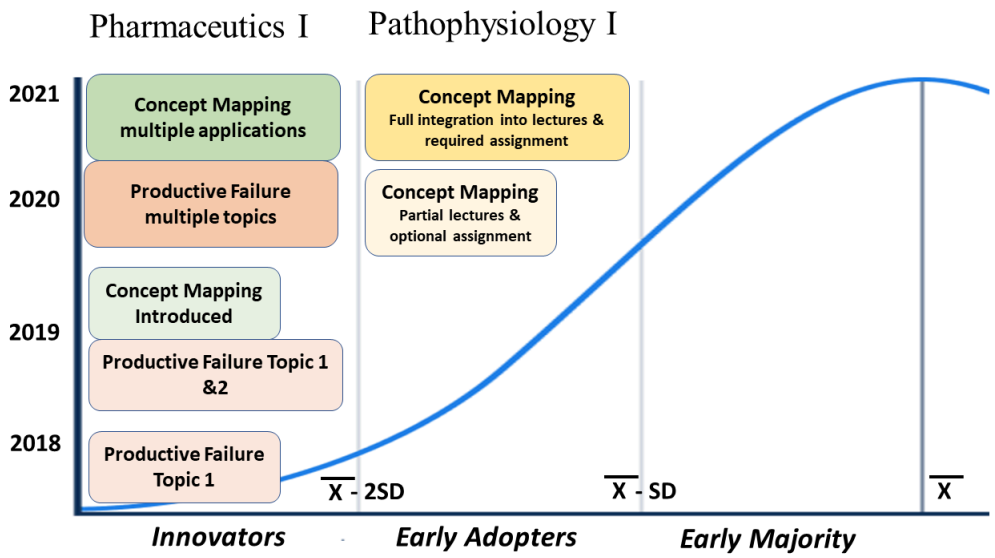
To address this lack of knowledge transfer, the decision was made to implement productive failure as one of the course strategies. A quasi-experimental research showed students in the productive failure intervention scored significantly higher on the examination than students in the previous cohort, serving as control (Cernusca & Mallik, 2018). The use of productive failure was then expanded to a second challenging topic; however, the instructor observed students were not able to consistently analyze the structural chemistry concepts for the problem to decide on the appropriate analysis. In 2019, the instructor started to integrate a series of structural concepts maps in the instructional process. The positive impact of this strategy on students' self-efficacy convinced him to expand the use of concept maps (Cernusca & Mallik, 2022). After an informal presentation of the results from Pharmaceutics I, the instructor of a module in another P1 course, Pathophysiology I, was interested in the potential of concept mapping. She had a course-coordinating role and played a leadership role in adopting of new ideas in her professional field, an early adopter according to Rogers (2003).

In 2021, the second instructor started to implement concept mapping by: (a) using concept maps in lectures to connect introduced topics and (b) introducing an optional concept mapping activity for students. Encouraged by the implementation results, the instructor decided, in 2022, to formalize the use of concept mapping by: (a)

completing the integration of concept mapping for all lectures; (b) inviting the ID to introduce effective concept mapping how-to tips in class, and (c) introducing a required concept mapping assignment. Figure 1 synthesizes the adoption process of the two expansive learning strategies for the two courses.

Figure 1

Stages of Adoption of Productive Failure and Concept Mapping



Research methodology

An exploratory quantitative design research was used to analyze: (a) the change between 2020 and 2021 in student self-efficacy, perceived impact of productive failure, and concept mapping for each of the two courses, and (b) the differences in self-efficacy and perceived impact of concept mapping between the two courses.

A convenience sampling strategy was used, all students in the two courses being invited to participate in the study. Online end of module (Pathophysiology I) and end-of-course (Pharmaceutics I) surveys were administered. Survey items were adapted from constructs validated in the literature for: (a) perceived impact of productive failure/concept mapping on own learning (Grasman & Cernusca, 2015), (b) self-efficacy (Cernusca & Price, 2013), and (c) perceived engagement due to concept mapping (Gebre et al., 2014). All constructs used a 5-point Likert scale. Internal reliability for all three constructs was very strong with Cronbach's Alpha scores ranging between 0.89 and 0.97.

Summary of findings and conclusions

For Pharmaceutics I course, as shown in Table 1, while the values for the 2022 cohort were very slightly higher than for the 2021 cohort, an independent-samples t-test showed no statistically significant differences.

Table 1

Comparing two consecutive implementations in Pharmaceutics I

	2021		2022		df	t	p
M	SD	M	SD				
Self-efficacy	4.06	0.52	4.09	0.78	95	-0.19	0.85
Concept mapping impact	4.02	0.78	4.05	0.90	95	-0.17	0.87
Product failure impact	3.82	0.81	3.88	1.04	90.4	-0.28	0.78

The results were similar for concept mapping impact on own learning and engagement due to the use of concept mapping in Pathophysiology I course (Table 2). However, the self-efficacy for the 2022 Pathophysiology I cohort was statistically significantly higher than for the 2021 cohort (see Table 2). Also, a one-sample t-test indicated the mean values for all constructs across the two years were significantly statistically higher than the neutral value of the evaluation scale ($p < 0.01$).

Table 2

Comparing two consecutive implementations in Pathophysiology

	2021		2022		df	t	p
M	SD	M	SD				
Module self-efficacy	4.11	0.55	4.40	0.49	104	-2.87	<0.01
Concept mapping impact	3.25	0.97	3.30	1.04	106	-0,23	0.82
Engagement due to concept mapping	3.33	0.93	3.60	0.94	106	-1.15	0.15

Finally, perceived impact of concept mapping for the Pharmaceutics I implementation was statistically significantly higher than for Pathophysiology I implementation for both years of implementation (Table 3). On the other hand, for self-efficacy the significant increase in mean values in Pathophysiology I from 2021 to 2022 previously discussed was reflected also in a statistically significantly higher mean for self-efficacy when compared to Pharmaceutics I course (Table 3).

Table 3

Comparing Pathophysiology I and Pharmaceutics I for two consecutive years

	2021				2022			
M	SD	t(100)	p	M	SD	t(101)	p	
	Self-efficacy							
Pharmaceutics I	4.06	0.52	0.10	0.92	4.09	0.78	-2.48	< 0.05
Pathophysiology	4.05	0.69			4.40	0.49		
	Concept mapping impact							
Pharmaceutics I	4.02	0.78	4.39	< 0.001	4.05	0.90	3.92	< 0.001
Pathophysiology	3.25	0.97			3.30	1.04		

To summarize, the results from this study indicate a cross-courses implementation for the same cohort produced high self-efficacy and perceived values on own learning. That is, both self-efficacy, a proxy for future performance, and perceived impact on own learning were scored toward the higher end of the evaluation scale.

Limitations and Future Research

There are two major limitations for this study. First, we compared a full course with a module which covered about one third of the course. This could impact students' perceptions and beliefs related to the use of the two adaptive expertise strategies used in this study. Second, due to the exploratory nature of this study we focused on self-reported measures rather than student outcomes.

The results also indicate increased length and the depth in the implementation process increased students' perceived benefits of the instructional tools and strategies on own learning. This finding suggests the potential of future research built on expanding the adoption of concept mapping in the other modules of Pathophysiology I course. Future research might be also focus on the impact of the use of these two adaptive expertise strategies in future courses by using coincidence analysis which allows the study of implementation of multifaced interventions which involve multiple elements working together.

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Implication of a Case Study using Generative AI in Elementary School: Using Stable Diffusion for STEAM Education

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This research investigates the use of generative artifical intelligence (AI) in elementary school STEAM education. The workshop involved 46 students and in-depth interviews with 7 participants. The results show students found using AI for creative expression enjoyable and personalized, potentially improving the creative process. The study also highlighted concerns about ethics and bias in generative AI that need further investigation. This study suggests generative AI can enhance art education for elementary school students.

Introduction

In the realm of generative artifical intelligence (AI), two categories are primarily well-recognized: those which generate text and those which produce images. While ChatGPT, the leading example in the text-generating category, has received extensive attention for its potential in interactive learning and personalized tutoring, there is less focus on the educational applications of image-generating AIs like Stable Diffusion (Baidoo-Anu & Owusu, 2023). Various studies have touched upon the pros and cons of using ChatGPT, some viewing it as revolutionary, while others suggest AI tools must be used to cultivate unique human skills (Zhai, 2023). To capitalize on the benefits of AI in education, curriculum should include AI concepts, focus on fostering creativity and critical thinking, and adopt evidence-based strategies (Miao et al., 2021). There is growing academic interest in utilizing AI in art education, especially as AI-generated content becomes more accessible (Ali et al., 2021; Fadel et al., 2019).

STEAM was coined, incorporating the "A" for humanities and arts into STEM education, designed to emphasize the integration of engineering and technology strategies to solve problems using concepts and procedures from science and mathematics (Aguilera & Ortiz-Revilla, 2021). The benefits of STEAM education, especially in early childhood and primary education, are that learning becomes more relevant to real life and fosters creativity (Dejarnette, 2018; Mohana et al., 2022; Shatunova et al., 2019). How and Hung (2019) emphasize most research in Artificial Intelligence in Education (AIED) focuses on empirical investigations which employ computer programs or robots to provide specific knowledge in STEM. Similarly, a study by Jang et al. (2022) underlines the value of AIED in STEM education in content and methodology. This study also advocates for integrating STEAM with AIED by proposing a K-12 educational model which does so. However, the field still needs more research on STEAM-focused AIED and relevant case studies.

Moreover, there needs to be more research exploring the use of generative AI within STEAM education. Therefore, there still needs to be more case studies on the design of classes incorporating AI in the STEAM context. In light of these needs, this study seeks to ascertain learners' reactions to generative AI and to identify the implications of these reactions for class design.

The study aims to examine the applicability and efficacy of leveraging generative AI tools in learning settings, mainly focusing on artistic expression for elementary school students. In this study, a qualitative method approach was employed. The first step involved a comprehensive literature review in gathering information on the use of generative AI in education and related concepts such as creativity, literacy, and the role of AI in enhancing students' artistic abilities. This information was then used to inform the design of a lesson plan for teaching an interdisciplinary class incorporating generative AI.

Method

The workshop occurred at an elementary school in Incheon, South Korea. Forty-six students participated in the one-day workshop for 90 minutes as part of an after-school program (Female: n=22, Male: n=24) ages between 10 to 11 years old in 5th grade. We conducted semi-structured interviews with seven students to understand students' thoughts and impressions of the workshop. We interviewed the seven students because of their quality and rigor in the project, as recommended by educators.

The workshop consisted of a warm-up, practice, creating artwork, and writing imaginative diaries. The workshop started with an introduction to the AI techniques it was anticipated students would use. The researchers used Dream Studio, a web application which generates images using Stable Diffusion, as a generative AI tool. Students were also introduced to Google Translate (since most students' native languages are Korean) and Google Docs to prepare and document their diary entries. We designed a prompt manual inspired by the previous study (Liu & Chilton, 2022) and gave it to the students. We asked them to consider three components: subject, additional explanation, and trend of art, and to generate prompts using Google Translate. Before inputting the prompts, we designed a prompt manual to give to the students, asking them to consider three components: subject, additional explanation, and trend of art, and to generate prompts using the translator. After that, the students were asked to generate images using Stable Diffusion (Stability AI, 2023) by typing in prompts as input as many times as they wanted. After selecting the most desirable outcomes, students began documenting their diary stories with the generated AI images.

The researchers took field notes during the workshop and collected students' artifacts for creating an imaginary picture diary. We video-recorded the semi-structured interviews and transcribed the script. The research team analyzed interview data using a thematic analysis technique (Creswell & Poth, 2017), categorizing the themes using deductive coding procedures. Using thematic analysis of the interview transcript and observations from the workshop, we have classified the themes into three categories (engagement, expressiveness, and effectiveness). We coded inductively based on the themes which emerged from the transcript to understand the efficacy of the generative arts AI in learning settings.

Result

After an interview with students, we found that their experiences with AI in creative art programs significantly impacted their perspective on learning and expression in three ways. First, using AI in the creative process enhanced their interest and participation. The analysis revealed that most students showed interest in leveraging AI in creative expression. Students stated that the activities were fun and exciting because they used the new tools (i.e., AI art generator) as they learned to create images. For example, P2 mentioned, “The tool is marvelous and so autonomous!”

Most students stated the experience was unique and original, and they were willing to continue learning more about using AI for creative expression. As students explained, the activity allowed them to create unique images, supporting personalized learning. The study showed art generators used with AI systems further initiated the learning process of AI systems and boosted youths’ perceptions about how to collaborate with AI. As P5 stated,

> *“Okay, first, because AI doesn’t have a brain or mind so my first assumption was that AI couldn't do any creative work, but I was surprised at how it generated such a creative and unique piece of work.”*

A second impact on students' perspective of their learning dealt with the capability of AI to extend human imagination in art creation. We highlighted expressiveness to understand whether the AI art generator could create expressive image outputs and investigate whether students thought the image result aligned with their own intentions regarding artistic expressions. P2 mentioned, “This is cool, it generates images that I didn’t even imagine.” P4 stated, “The AI generates things that I don’t even know exactly”, implying the means of expanding one's imagination.

Two distinct views of expressiveness (i.e., positive and negative) emerged. Students (n=4) stated they thought AI art generators created images as they imagined or even better than they initially anticipated, which allowed them to enhance their creative expressions. The other three students, though, claimed that AI somehow generated awkward visuals, suggesting a need for researchers to investigate further the issues around ethics and bias in AI art generators and appropriateness for education with youth (Ali et al., 2021).

Third, the AI tools increased the efficiency and convenience of the creative process. In order to examine the efficacy of the learning program designed using generative art AI tools to create picture diaries, we sought to understand the students' perspectives. The interview data revealed most students saw the great potential of using the tool to make their creative process easy and fast. P1 and P3 mentioned,

> *“If I needed to draw by hand like this, I would have hurt my hands and gotten tired, but AI does it so easily without giving me any stress on how to make it all by myself.”.*

> *“I like AI art generators because I get to choose the one that I like the most from many options as they generate images as fast as I want, it’s so convenient because I don’t need to spend a ton of time.”*

Discussion

The study examines the applicability and efficacy of leveraging generative AI tools in learning settings, mainly focusing on artistic expression for elementary school students in a class setting. We found workshop experiences with AI in creative art programs affected students’ perspectives on learning and artistic expression. Firstly, the students were fascinated by what generative AI could do for their creative expression, which inspired their enthusiasm and motivation towards art activities. In addition, students highlighted the efficiency of leveraging generative AI for their art activities to enhance their ideation and iterative design processes. However, there are contradictory views regarding AI-generated art, Some students pointed out AI did not generate as they intended, yet they are willing to customize and edit by themselves. Others suggested they want more agency over their creations. As a result, we developed design implications which enable students to openly edit and customize their art pieces, thereby co-creating with AI. Another implication is the need for promotion of generative AI literacy education (i.e. ability to understand and use the system). Also, students should be engaged in various methodologies to develop better prompts which may impact their results to improve child-AI co-creative interaction through prompt engineering education. The study results remain limited due to the small sample size and certain socioeconomic status. (The study took place in a privileged location with high STEM education demand.) It also emphasizes the importance of careful and ethically informed tool selection and implementation, ensuring the technology enriches the educational experience without inadvertently introducing biases or limiting students' creative potential. As researchers and educators continue to explore the intersection of AI and art, it will be essential to prioritize student feedback, adapt to their needs, and remain vigilant about this technological integration's potential pitfalls and challenges. Nevertheless, it would be worthwhile to investigate how AI-infused art-based STEM education can be accessible to a broader audience.

Conclusion

Generative AI has shown promising potential in STEAM education for elementary students, particularly in creative arts (Lee et al., 2023). Incorporating AI into creative programs boosts students' interest due to the novelty and potential of the tools. Generative AI tools, which can often amplify or surpass a student's artistic vision, offer excitement and challenges. While many students appreciate the unexpected creativity, some find the outputs must be aligned with their intent, highlighting the need to address AI's ethical and bias implications. Additionally, AI allows students to rapidly explore creative possibilities, removing manual skills and time constraints.

In summary, while generative AI can significantly enhance STEAM education, educators must balance its advantages with ethical considerations. Future studies should delve deeper into the nuances of how AI interacts with student creativity, aiming to address and rectify any biases and ethical concerns. Additionally, understanding the long-term implications of AI integration in STEAM education will be crucial to ensure a balanced and holistic learning experience.

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Improving Student Performance in Higher Education Instructional Design Courses using Virtual Reality Integration

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Researchers from Full Sail University decided to examine the effects of student performance in a higher education Instructional Design online class when integrating virtual reality (VR) into its curriculum. The researchers used Action Research as their methodology for the study with the notion that incorporating VR would better student performance. The researchers utilized quantitative analysis of course evaluation data and grades, and qualitative methods, including student-instructor communication and open-ended student surveys to measure VRs effect on student grades, course satisfaction, and feelings about performance. During their examination of the qualitative data, the researchers identified themes of learning styles, prior experiences, motivation, and inspiration when students specifically discussed VR. Quantitative results of the study indicated a small increase in student grades and course satisfaction. However, the researchers conclude that more research is needed in this area of study.

Introduction

Researchers have conducted a myriad of studies focusing on the effects of virtual reality (VR) on student attitudes in classes. However, studies on VR's effect on student performance are lacking (Johnson et al., 2019). Of the few published studies which focus on VR's effect on student performance, researchers note the use of VR is happening across all grade levels and subject areas within K-12 and higher education with mostly positive effects on students, though not all the time. Bower and Jong (2020) also suggest "given the expanding use of IVR in education, the wide variety of disciplinary, age, technological and pedagogical contexts in which it can operate…, there is undoubtedly pressing need for more IVR educational research." In other words, more research is needed to determine whether incorporating VR in a course affects student performance.

Purpose of the study

The purpose of this article is to determine whether student performance in a four-week, online, higher education Instructional Design class improves with the integration of VR. In previous iterations of the IDT574: Digital Media and Learning Applications course, students engaged in "audio" learning activities for the first week. For Week 2, they participated in "video" learning activities. For Week 3, they learn about "interactive media" learning activities, which included a brief discussion about VR, but not the actual usage of it. For Week 4, students applied the concepts, principles and theories from the previous three weeks, integrating them all together in a final project. The final project was a "video proposal" where students create a video pitch on how they could apply the modalities of audio, video, and interactive video to enhance patrons' experience while visiting the Osceola County Welcome Center and History Museum.

Starting in May 2022, the researchers incorporated the use of VR into Week 3 of the course, where students interacted with VR applications, such as YouTube 360. The researchers specifically chose higher education students since they are currently working with Master students in the Instructional Design & Technology Master of Science degree program and are involved in their instruction. In addition to contributing to the general body of knowledge, the researchers wanted to explore various avenues of enhancing their online degree program, including the incorporation of VR into the third and fourth week of their online classes, and to determine whether incorporating VR affects their students' performance. The researchers specifically focused on the following research questions, developed from the IDT574 course learning outcomes:

1. *Does including VR in an online class help students consider designing and delivering instructional content using a variety of software applications?*
2. *Can incorporating VR in an online class encourage students to effectively present information and data visually and verbally?*
3. *Does using VR in an online class motivate students to better assess the effectiveness of media used in an instructional module?*

Literature review

VR integration into training environments and courses provides numerous benefits to adult learners. These benefits include increased learner engagement, greater motivation, more support for differentiated learning styles, increased sense of belonging, and more collaboration among peers (NC State, 2024). In other words, the recognized benefits of VR integration are seen to positively affect the affective state of adult learners. Similarly, current research which examines the integration of VR into face-to-face or online educational environments confirms its positive effect on the affective state of adult students after they utilize VR in their learning (Johnson et al., 2019).

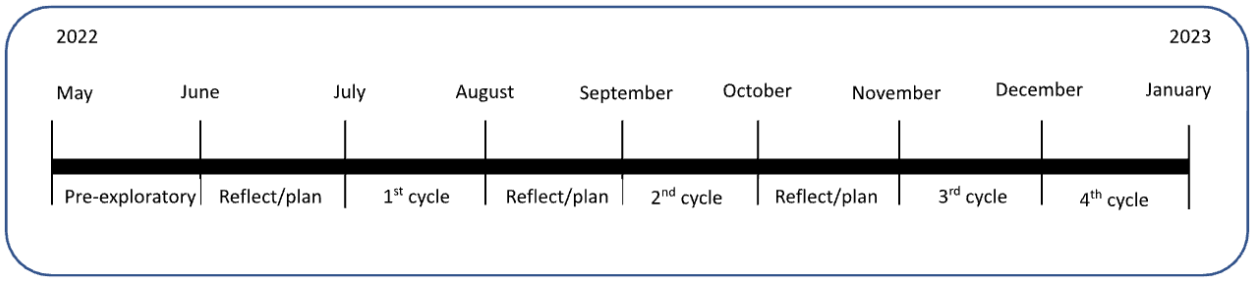
However, a limited number of studies exist which look at student performance in relation to their use of VR in learning environments (Bower & Jong, 2020). Of the studies which investigate VR's effect on student performance, studies indicate VR integration led to development in knowledge and skill as well as prolonged learning over a period of time in younger students (Wu et al., 2020). In studies involving older students, results indicate positive effects on learning and motivation (Di Natale et al., 2020). Yet, another recent study indicates VR end users in higher education have a relatively low perception of its usefulness and UX (Matsika & Zhou, 2021). In this study, researchers from Full Sail University hope to add on to this body of knowledge.

Methodology

The researchers decided to take an Action Research (AR) approach for this study (see Figure 1). The AR process includes the steps of "planning, acting, observing, and reflecting on the results generated from a particular project or body of work" (Dick, 1999; Zuber-Skerritt, 2002). The reason researchers chose this methodology is that course development is still ongoing and is a work in progress.

Figure 1

Timeline for the action research of the study



Data collection design

Methods included comparing past and current grades, examining course evaluation ratings, distributing open-ended surveys to the enrolled students, and coding student-instructor communication through one-on-one Zoom sessions (see Table 1).

Table 1

Data sources

Type	Explanation
Past and current grades	Grade averages of students from IDT574 courses starting from August 2021 to December 2022.
Course evaluation ratings	Average of positive instructor experience ratings on a scale of 1-5 from August 2021 to December 2022.
Surveys	Distributed at the end of each month, starting from May 2022 to December 2022, to students with open-ended questions on VR utilization and the project they developed with VR.
Student-instructor communication	Zoom sessions (recorded), starting from May 2022 to December 2022.

Participants

The population of this study consists of Instructional Design Master students enrolled in a Digital Media and Learning Applications class at Full Sail University. A total of 56 students participated in the study. Twenty-two of the students were from the IDT574 classes which did not incorporate VR into their third week assignment, and 34 of the students were from the IDT574 classes which incorporated VR into their third week assignment.

Findings

When comparing past and current grades of students before and after the implementation of VR within the IDT574 course, the researchers noticed a small increase in grades; however this increase was not significant enough to indicate studet performance improved due to use of VR. Similarly, the course satisfaction ratings within the course evaluations rose slightly, but the researchers did not see this as a significant improvement.

However, themes appeared when the researchers used constant comparative method to analyze the qualitative data from the student interviews and open-ended surveys. After coding the data and analyzing it, the themes of prior experiences, learning styles, motivation, and inspiration appeared when students discussed the effects of VR on their performance in the class. A few students indicated prior experiences with VR caused them to already have a negative perception of VR and therefore resist using it within the class. As one student said, "Performance-wise I still feel [VR] isn't ideal, but I am being apprehensive due to my own personal opinion [and] experience with it." Others indicated similar feelings during their interviews. Students also mentioned their use of VR in assignments was based off their own personal learning styles. Some felt using VR matched their learning style and therefore helped their performance, while others felt it was not a match and did not assist them in their overall performance.

Others stated that designing with VR for their assignments motivated and inspired them in the class, which aligns with results from other studies which feature the addition of VR in the classroom (Soto et al., 2020). A participant share "I would say that I... improved because I never thought about, um, the Virtual Reality part [until] now...Some of those modules [from my workplace] ...could be so much more engaging if they actually was having us looking in a virtual reality." Another student stated, "[VR] gave me so many ideas on the things that I can do to, um, liven and engage...this week's project." Interestingly, other themes appeared in the qualitative data to indicate different factors were responsible for increased student performance besides VR. These themes included peer interaction, real-world context, student examples, problem-solving situations, learner support, and next-step opportunities. Suggestions from the student interviews were added over the eight months of the Action Research process to further develop the course.

Conclusion

Lack of significant increase occurred within the course satisfaction numbers and the grades themselves. However, the increase in rigor of the course may have hindered the numbers and grades from considerably increasing. A further look into the qualitative data indicates that VR only affected the performance of those who have minimal prior experience with VR or those who believed their learning style matched the way VR presents information within a particular learning environment. The researcher of this study believe more research and participants are needed to explore the connection among performance, VR, and learning styles coupled with prior experiences.

What was also of interest to the researchers was the other themes revealed in the one-on-one interviews not related to VR. The themes of peer interaction, real-world context, student examples, problem-solving situations, learner support, and next-step opportunities occurred at various times throughout the interviews while asking students questions about what affected their performance. Over eight months of the study, the course instructor implemented these suggestions. The researchers continued to interview the students about their performance while the instructor applied these course improvements. The researchers plan to analyze this additional data and publish their results in future studies.

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Innovative Use of Grammarly Feedback for Improving EFL Learners' Speaking: Learners' Perceptions and Transformative Engagement Experiences in Focus

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This study adopted a mixed-methods approach to investigate the innovative use of Grammarly feedback for improving the speaking skills of learners who speak English as a foreign language (EFL). We explored learners' perceptions of the efficacy of Grammarly for enhancing their speaking abilities and how learners integrated Grammarly feedback into their everyday life experiences. The results revealed that Grammarly feedback significantly improved learners' speaking skills. Additionally, it became evident that learners held positive views towards Grammarly. We also observed traces of motivated use, expansion of perception, and experiential value related to Grammarly feedback reflected in learners' everyday lives.

Introduction

Automated writing evaluation (AWE) systems are predominantly used for providing feedback for writing. Inadequate attention has been devoted to investigating the potential of such systems for enhancing speaking (Shadiev & Feng, 2023). Studies (e.g., Ranalli, 2021; Thi et al., 2022) exploring learner engagement with automated feedback (AF) have mainly considered engagement with in-class instructional activities. Out-of-class engagement has gone unaccounted for. Considering the prevalent application of AWE systems for language learning and the scant attention given to the innovative use of AWE systems for improving speaking, as well as the scarcity of investigations studying transformative experiences in language learning and teaching contexts, we aimed to explore the effect of the innovative use of Grammarly feedback on improving the speaking skills of English as a Foreign Language (EFL) learners. EFL learners are individuals who learn English in countries where English is not the primary language. Moreover, this study attempted to uncover learners' perceptions of the efficacy of Grammarly feedback for enhancing speaking. Additionally, we sought to examine learners' transformative engagement experiences as a result of Grammarly feedback provision. Conducting this study is important as it not only fills the lacuna in the extant empirical literature but also expands the line of research on engagement from in-class contexts to out-of-class settings. Moreover, the results can provide insights into the innovative use of AWE systems for developing speaking skills. According to these objectives, the following research questions guided the study:

- *RQ1: Does the use of Grammarly feedback on EFL learners' transcribed speech significantly enhance their speaking performance?*
- *RQ2: What are EFL learners' perceptions towards the use of Grammarly feedback on their transcribed speech for improving their speaking performance?*
- *RQ3: Do learners have any transformative engagement experiences as a result of receiving feedback from Grammarly?*

Relevant Literature

The advent of advanced technological tools has given an ever-growing rise to the implementation of AWE systems, such as Grammarly, in language learning contexts (Koltovskaia, 2020). A strand of previous investigations on Grammarly (e.g., Fahmi & Cahyono, 2021; Koltovskaia, 2020; ONeill & Russell, 2019) indicates this AWE system has been mainly utilized for feedback concerning writing. Scholars have predominantly explored teachers' and learners' perceptions of the efficacy of Grammarly in this regard. As Shadiev and Feng (2023) maintain, the use of automated corrective feedback should not be focused solely on writing and can be extended to other language skills, such as speaking. Another strand of studies (e.g., Ranalli, 2021; Thi et al., 2022; Tian & Zhou, 2020; Zhang & Hyland, 2018) focused on learner engagement with automated feedback. These studies, however, have dealt with engagement from an instructional and educational lens and failed to consider engagement beyond the classroom from a transformative engagement experience (TEE) perspective.

TEE refers to the involvement with learning experiences outside the classroom based on the ideas learned in class to experience everyday life in the world differently (Pugh et al., 2017). As Pugh et al. (2017) maintain, transformative experience encompasses three dimensions: motivated use, expansion of perception, and experiential value. Motivated use refers to applying the in-class learned ideas in free-choice settings; expansion of perception constitutes viewing the issues and events via the perspective of in-class learned content; and experiential value pertains to valuing the content for enriching everyday life experiences. A review of investigations on TEE shows this construct has been explored mainly in science education (e.g., Girod et al., 2010), and higher education (Clifford & Montgomery, 2015). As for language teaching and learning contexts, inadequate attention has been paid to transformative experiences (Abdollahzadeh et al., 2022).

Methods

This study adopted a mixed-methods design. The population consisted of 456 intermediate-level learners studying at three branches of Safir Language Academy in Tehran, Iran. Out of the 456 learners, 107 expressed their willingness to take part in this study. Thus, a convenience sampling technique was used. The target participants were comprised of 63 Iranian EFL learners who were selected out of the initial pool of 107 students based on their performance on a Preliminary English Test (PET). To

this aim, only those learners whose PET scores fell within the range of +/-one standard deviation from the mean were selected. The 63 selected learners were within the age range of 18 to 41 (M=27.30, SD=4.23), and Persian was their mother tongue. Table 1 displays the participants' demographic information.

Table 1

Demographic Information of the Participants

Number of Participants	Gender	Age Range
31	Male	19-41
32	Female	18-40

The participants were divided randomly into two groups: experimental (N=33) and control (N=30). The speaking test scores obtained on PET, administered for homogeneity purposes, were used as pretest scores (see Table 2). To make sure that the two groups were homogenized before the treatment, an independent samples t-test was run. With t (61) =1.02, p=0.31>.05, it was concluded that the mean difference between the speaking pretest scores for the experimental and control groups was not statistically significant. After making sure that the two groups were homogenized regarding their speaking pretest, the treatment was administered.

Table 2

Descriptive Statistics for Pretest Scores

Groups	N	Mean	Std. Deviation	Std. Error Mean
Experimental	33	8.81	1.07	.18
Control	30	8.53	1.13	.20

In the experimental group, the participants were given a speaking topic and asked to deliver a 3–5-minute speech each session. Their speech presentations were audio-recorded, and learners were required to transcribe the speech content and submit the text to Grammarly to receive feedback. Learners were asked to give a second revised presentation on the same topic, drawing on Grammarly feedback. The learners in the control group were also asked to give a 3–5-minute speech presentation each session. They received feedback from the teacher and were required to deliver a second presentation based on the teacher's feedback. However, they were not asked to transcribe their speech and/or submit it to Grammarly. The treatment lasted for 15 sessions over two months. Upon finishing the treatment, the learners in both groups were given the speaking test of PET from another version as a posttest. Fifteen participants from the experimental group, who expressed their consent to attend interviews, took part in semi-structured interviews (see Table 3). The same 15 learners were also interviewed to uncover how EFL learners relate Grammarly feedback to their everyday life experiences from a transformative engagement perspective.

Table 3

The Demographic Information for the 15 Interviewees

Number of Participants	Gender	Age Range
8	Female	18-37
7	Male	20-41

To develop the semi-structured interview questions, initially, the literature on transformative engagement (e.g., Abdollahzadeh et al., 2022; Pugh et al., 2017) and learners' perceptions towards Grammarly (e.g., Fahmi & Cahyono, 2021; Koltovskaia, 2020; Oneill & Russell, 2019) was reviewed. Then, an initial list of interview questions was developed and reviewed by an expert panel consisting of three Ph.D. holders in the field of Teaching English as a Foreign Language (TEFL). TEFL experts teach English to non-native speakers in environments where English is not the primary language. Afterward, the questions were piloted on a sample of five participants to enhance clarity.

Results and Discussion

To investigate any significant difference between the speaking posttest scores for the experimental and control groups, an independent samples t-test was run (see Table 4). With t (61) =7.15, p =0.00<.001, it was concluded the mean difference between the speaking posttest scores for the experimental and control groups was statistically significant. Moreover, the posttest score mean for the experimental group was higher than that of the control group (11.54>9.20). Thus, it was concluded that the use of Grammarly feedback significantly enhanced EFL learners' speaking performance.

Table 4

Descriptive Statistics for Speaking Posttest Scores

Groups	N	Mean	Std. Deviation	Std. Error Mean
Experimental	33	11.54	1.25	.21
Control	30	9.20	1.34	.24

To analyze the interview contents, steps provided by Auerbach and Silverstein (2003) were followed. The results suggested that learners held positive views towards Grammarly feedback as it provided them with motivation, engagement, satisfaction, and convenience in the feedback process (see Table 5).

Table 5

Content Analysis for Participants' Perceptions Towards Grammarly Feedback

No	Theme	Frequency	Percentage
1	Motivation	12	79.92%
2	Engagement	10	66.66%
3	Satisfaction	8	53.28%

No	Theme	Frequency	Percentage
4	Convenience	6	39.96%

Concerning motivation, for example, one of the interviewees stated, "Grammarly feedback was good because it made me want to speak more since the feedback was full of points." With respect to engagement, one of the interviewees pointed out that "The feedback from Grammarly made me pay more attention to my speaking because I had everything recorded, and I really wanted to have fewer mistakes."

The content analysis results also revealed traces of motivated use, expansion of perception, and experiential value in relation to the application of in-class ideas and contents related to Grammarly feedback in learners' everyday lives (see Table 6). As for motivated use, as an example, one of the interviewees wanted to receive similar feedback for a presentation in his biology course at university, even though his instructor emphasized the importance of content over grammar. He decided to transcribe his speech and use another similar application to check his speaking and receive feedback. He stated, "When I learned that Grammarly could give me such great feedback, I wanted to receive this feedback for my presentation. I wanted to check my speaking myself."

Table 6

Content Analysis for Participants' Transformative Engagement Experiences

No	Theme	Frequency	Percentage
1	Motivated use	7	46.62%
2	Expansion of perception	5	33.30%
3	Experiential value	4	26.64%

Overall, the results of the current study corroborate the findings of previous investigations (e.g., Fahmi & Cahyono, 2021; ONeill & Russell, 2019; Thi et al., 2022) concerning learners' positive views toward AWE systems and the effectiveness of Grammarly for fostering language performance. Furthermore, the findings shed light on how AWE feedback can be related to EFL learners' everyday life experiences. Based on the findings, EFL teachers are encouraged to employ Grammarly feedback to improve EFL learners' speaking. Future research concerning the integration of Grammarly feedback with teachers' feedback on transcribed speech texts for improving speaking fluency, accuracy, and complexity is recommended.

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Investigate pre-service teachers' learning behaviors and their relationship with academic performance through LMS log data

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Learning Management Systems (LMS) have been widely used by many universities to support teaching and learning. Extensive research has shown that LMS usage patterns are associated with learners' outcomes, however, related studies from the pre-service teachers' perspective are limited. This paper aims to further explore the association between pre-service teachers' LMS patterns and their learning outcomes using a quantitative method. After examining 172 pre-service teachers' LMS log data and performance, the findings show that times participated and assignment on time percent are significant predictors of their grades. Moreover, pre-service teachers demonstrated distinct LMS behavioral patterns in LMS when engaging with the Virtual Field Experience theme. The findings provide insights into future curriculum and course designs to better support pre-service teachers.

Introduction

Learning Management Systems (LMS) have been widely adopted in higher education institutions to support teaching and learning practices (McGill & Klobas, 2009). Previous empirical studies have shown that learners' LMS usage patterns are associated with, and impact, their learning outcomes (Weaver et al., 2008). Furthermore, researchers have indicated that investigating the association between LMS usage patterns and learning outcomes offers practical implications for future LMS design (Washington, 2019).

Past studies on LMS have delved into the usage patterns among various learner groups across different disciplines (Demmans et al., 2020). These studies have provided valuable insights into refining LMS design to better meet learners' needs and preferences (Onodipe et al., 2020). However, a literature review conducted by the authors has revealed a lack of studies specifically focusing on pre-service teachers' LMS patterns and their association with learning outcomes. Given the extensive use of LMS in pre-service education, it is crucial to understand these perspectives to update and enhance course and lesson designs. To bridge this research gap, this study will examine pre-service teachers' LMS behavioral patterns and their correlation with learning outcomes. The aim is to furnish future instructors or instructional designers with valuable insights for designing and implementing pre-service courses in an LMS.

This study intends to probe into behavioral patterns and associations from both macroscopic and microscopic perspectives. From the macroscopic view, the researchers aim to investigate general usage patterns, such as total page views, on-time assignment percentages, and participation frequency, to discern their correlation with learning outcomes, leading to the following question:

1. How do pre-service teachers' overall course grades correlate with page views, on-time assignment percentages, and participation frequency on LMS?

From the microscopic lens, the research focuses on how pre-service teachers' usage patterns differ based on specific content themes and course design features, leading to the following question:

2. What patterns emerge in pre-service teachers' page views and participation times across various themes and course design elements?

Literature review

Researchers have identified and examined the value of LMS data in understanding students' learning behaviors and predicting their performance (e.g., Mozahem, 2020). Several studies have investigated students' behaviors using LMS by analyzing LMS data with various predictive approaches (e.g., Zhang et al., 2020). Haig et al. (2013) detected and visualized the frequency of students' access to resources and forum discussions in an undergraduate course using data generated from Moodle. Their results indicated students with higher grades accessed resources and forums more frequently. Similarly, Mandalapu et al. (2021) explored patterns in students' logins and time intervals to determine their influence on learning outcomes. These researchers observed the count and regularity of student logins positively correlated with performance improvement. Chen & Cui (2020) used a deep learning approach to analyze online temporal behaviors, such as daily click frequencies, to predict students' final grade performance. Unlike earlier research, they presented a trend in online student actions on Moodle for the course and concluded students' clicks on Moodle could predict their performance, but only during the early weeks of the course.

In conclusion, prior studies have examined the potential of LMS data in predicting students' performance and achievement. They explored factors like login frequencies and time spent on LMS as impacting course performance. However, more features and predictors within LMS should be evaluated to gain deeper insights into students' learning behaviors using LMS and their resultant performance.

Methods

Context and data sources

All data were retrieved from an undergraduate course conducted on the Canvas platform during the fall semester of 2021. This course aimed to equip pre-service teachers with the skills to integrate technology into their teaching. It was a blended course, lasting 16 weeks, with no exams scheduled for the final week of the semester.

The primary data sources were reports generated by the Canvas LMS. The access report data consist of 23,156 lines of LMS usage logs, produced by 172 pre-service teachers. Each line indicates the page accessed by a student and the number of times that student viewed and engaged with that page. The course grade report provides insights into students' overall course grades and their punctuality in submitting assignments. The LMS usage log data were analyzed in conjunction with their performance outcomes.

Analysis

Descriptive analysis displayed the overall learning behavior regarding times of page views, percentage of assignments submitted on time, and times participated on Canvas. Following this, a multiple regression analysis was conducted to explore the relationships between these three predicted variables and overall course grade as a dependent variable. Finally, content themes and course design features were coded and sorted based on the shared characteristics of the page content established for this course. Then, pre-service teachers' page views and participation times across themes and course design features were visualized to explore their usage pattern differences.

Results

Table 1 shows the descriptive statistics of behavioral variables available on the Canvas and the students' course grade. The overall mean course grade was 89.265. Students had chances to earn extra credit if they submitted the bonus assignments on Canvas. The highest final score was 104.5, and the lowest score was 8.8. The range of times the overall pages were viewed is from 176 times to 4206 times, and the average is 1031 times. In addition, the range of assignment on time percent was from 14.81% to 100 %, and the course had an average of 85.27% of on-time submission. As for times of participation on Canvas, the average number of times a student participated on Canvas was 34 times, ranging from 7 times to 57 times.

Table 1

Descriptive Statistics (n=172)

Variables	Mean	SD	Min	Max	SE
Overall course grade	89.26	19.97	8.8	104.5	1.52
Times viewed	1030.58	501.44	176	4606	38.23
Times Participated	34.07	6.22	7	57	0.47
Assignment on time percent (%)	85.27	16.65	14.81	100	1.27

Association among performance and usage patterns

A multiple regression model was conducted with course grade as the dependent variable, and times viewed, percentage of assignments submitted on time, and times participated as predictor variables. As shown in Table 2, times participated and the percentage of assignments submitted on time had statistically significant positive regression weights on course grade. This indicates that students who were more active on Canvas (t = 20.243, $p < 0.001$) and had a higher on-time submission rate for assignments (t = 2.516, $p = 0.013$) were expected to have higher final scores, after controlling for other variables in the model. However, page views did not contribute significantly to the multiple regression model, suggesting that the frequency of viewing Canvas pages did not significantly predict students' course grades.

Table 2

Summary of Regression Analysis for Variables Predicting Overall Course Grade (n=172)

Effect	Estimate	SE	95% CI		p
LL	UL				
Intercept	-14.906	4.707	-24.199	-5.612	0.002**
Times viewed	-0.003	0.002	-0.006	0	0.064
Times participated	2.868	0.142	2.589	3.148	<0.001***
Assignment on time percent	0.113	0.045	0.024	0.202	0.013*

*p <.05. **p<.01 ***p<0.001

Usage patterns across themes and course design features

To address the second research question, visualizations illustrating pre-service teachers' page views and participation times across various themes and course design features were crafted. Both the content themes and course design features were coded and sorted based on the shared characteristics of the page content established for this course. Figure 1 depicts the proportions of different course design features viewed by students within each theme. Notably, the theme "Virtual Field Experience" displayed a balanced and somewhat anticipated access pattern, with no particular feature standing out. However, the remaining themes revealed a consistent pattern: the features most frequently viewed by students were the Warm-up Quiz and Exit Ticket Quiz. Figure 2 demonstrates the distribution of different themes viewed by students for each feature. A key observation is that the bulk of the Content Materials accessed by students originated from the "Virtual Field Experience" theme. These results suggest that pre-service teachers accessed a greater volume of content materials during the virtual field experience phase.

Regarding participation frequency, Figure 3 showcases the distribution of different course design features in which students participated within each theme. Echoing Figure 1, all themes indicated the Warm-up and Exit Ticket quizzes were the primary features students engaged with. However, within the "Tech-Supported Educational Context" theme, student interaction was notably higher on Announcement pages. This observation is consistent with Figure 4. Concerning the proportion of times students engaged with the Announcement page, the dominant theme was "Tech-Supported Educational Context." Other features exhibited a more balanced and similar participation pattern across themes. These insights reveal that students were more inclined to review announcements when exploring technology-supported educational contexts.

Figure 1

Times Viewed for Theme and Course Design Features

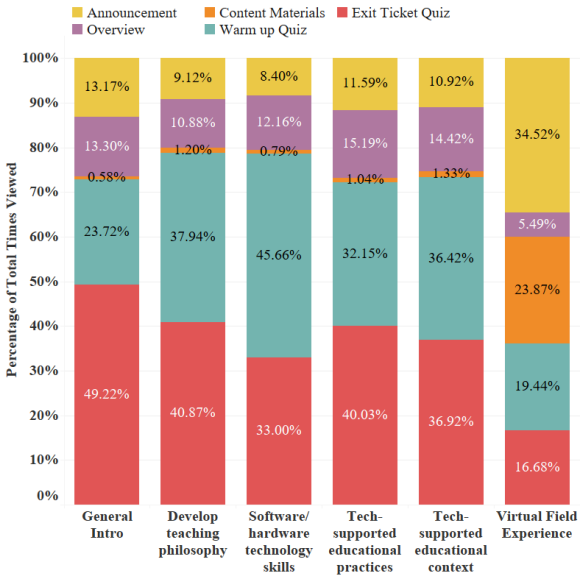


Figure 2

Times Viewed for Course Design Features and Theme

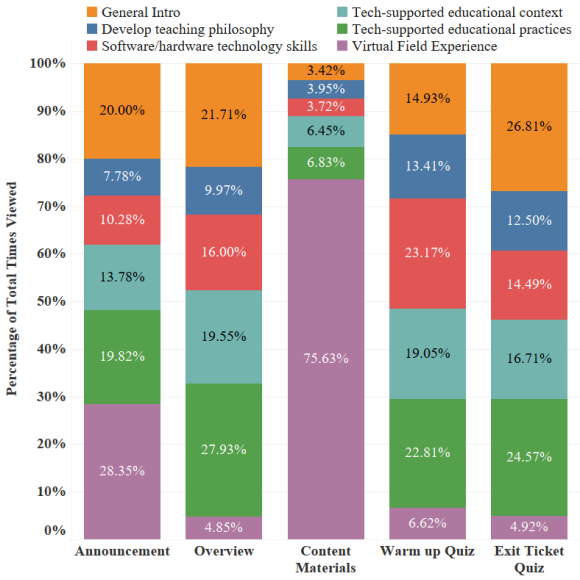


Figure 3

Times Participated for Theme and Course Design Features

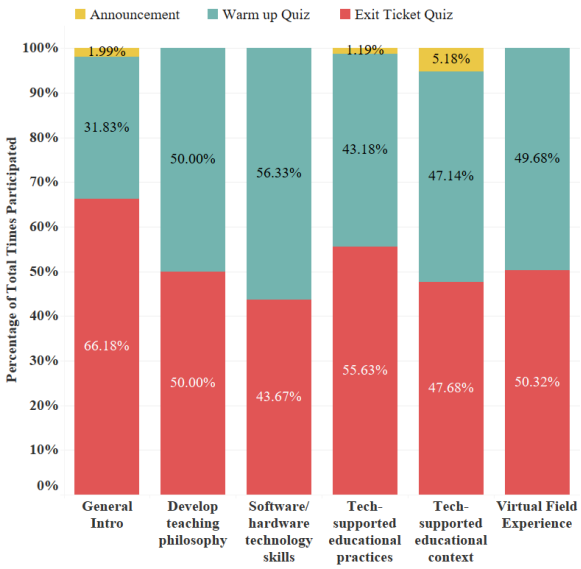
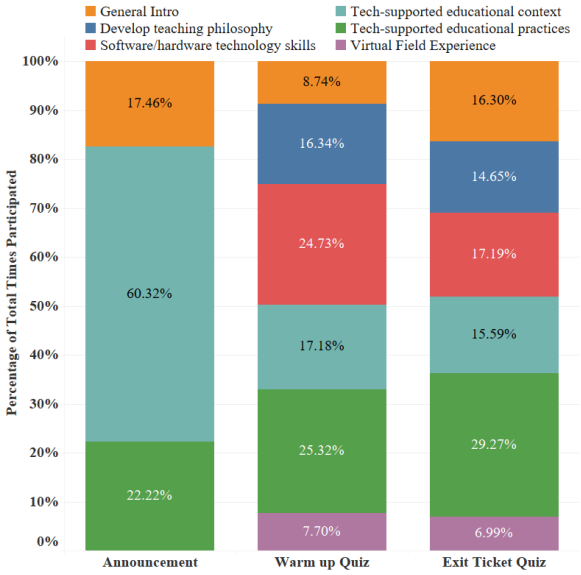


Figure 4

Times Participated for Course Design Features and Theme



Discussions

Statistical findings indicate a notable correlation between the number of page views and students' course grades, yet it wasn't a significant predictor. This contradicts Chen and Cui's (2020) findings regarding LMS click frequency predicting performance. Students' submission on time and participation on Canvas was significantly correlated with performance and predicted students' final course grades. Students' participation had the highest variable impact on their grades. The findings are consistent with the results in previous studies that late submissions and engagement were revealed to be significant indicators (You, 2016), which suggests the importance of increasing students' participation and assignment submissions to improve their performance. Therefore, in order to improve students' performance, instructors should monitor student activities, send reminders if necessary, and collaborate more often with them on Canvas.

Concerning the patterns of pre-service teachers' page views and participation times across themes and course design features, a salient finding is that pre-service teachers demonstrated completely different LMS behavioral patterns when engaging with the Virtual Field Experience theme. More specifically, pre-service teachers presented a more expected course feature access patterns (Figure 2), and most of the content materials they accessed were related to the Virtual Field Experience theme. These findings indicate that pre-service teachers treated the field experiences differently than the rest of the themes although the whole course is dedicated to preparing their teaching readiness. It is interesting to see pre-service teacher pay more attention to Announcements, especially the content materials, which present more expected learning strategies. However, it also reflects that they might have accessed the content materials in the other themes less than expected since all the content materials occupy a similar proportion in each theme. This result could shed some light on the future design of pre-service courses. Firstly, the learning materials about field experiences can be more integrated into other themes since pre-service teachers seemed interested in it, which might help cultivate a more balanced learning strategy on all the themes. Secondly, when teaching other themes, instructors can assist students in making content more relevant to the field experience since all the knowledge taught in the course will be helpful for their future teaching.

In all, by examining and analyzing learners' LMS usage patterns, the outcomes revealed significant yet nuanced learning behaviors which reflect pre-receive teachers' unique learning preferences and strategies. These findings could be applied to inform future course designs to better support pre-service teachers.

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Investigating Which Challenges Considered by Pre-service Teachers Are Reflected with Their Technology Integration Self-efficacy

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This study explored pre-service teachers' considered challenges regarding K-12 technology integration (TI) and their association with pre-service teachers' TI self-efficacy. Using the content analysis approaches, the research team identified five challenges perceived by 212 pre-service teachers, and further found four significant associations between the challenges and their TI self-efficacy. Pre-service teachers' considered challenges of differentiating students' needs and using technologies to facilitate learning are positively correlated with their TI self-efficacy, while their considered challenges of applying theories and preparing technologies are negatively correlated with their TI self-efficacy. The results suggest that additional instructional modules should be designed to help pre-service teachers in distinguishing K-12 students' needs and aligning TI with learning outcomes. Moreover, future TI instruction should incorporate practical TI cases, lesson plans, and technology evaluation training.

Introduction

In higher education, teaching technology integration (TI) in educator preparation programs (EPPs) has become essential (Gomez et al., 2022; Rizk, 2020). Many TI courses are designed to promote students' TI self-efficacy as an important learning outcome, which influences pre-service teachers' willingness to implement TI in their future classrooms (Kwon et al., 2019; Roblin et al., 2018). Previous researchers have explored the factors that are associated with TI self-efficacy (Lee & Lee, 2014; Şen & Durak, 2022; Yunkul & Gunes, 2022). These factors (e.g., competencies, sentiments) help researchers or instructors have a better understanding of how to achieve pre-service teachers' higher levels of TI self-efficacy (Bakar et al., 2020; Barton & Dexter, 2020; Birisci & Emin, 2019).

Pre-service teachers' considered challenges about TI were rarely noticed as possible factors that are associated with their TI self-efficacy. It is possible that pre-service teachers' considered challenges about TI are associated with their TI self-efficacy because pre-service teachers can be inspired or depressed by the low or high difficulty level of overcoming their considered challenges (Durak, 2021; Farjon et al., 2019; Njiku et al., 2019). Therefore, identifying the associations would provide new directions for promoting pre-service teachers' TI self-efficacy in TI courses. To address the research gap, this study delves into two research questions.

1. What are K-12 pre-service teachers' considered challenges about technology integration?
2. Which challenges are associated with K-12 pre-service teachers' self-efficacy in technology integration?

Literature Review

Previous researchers were exploring the factors that are associated with TI self-efficacy. Baker et al. (2020) considered technological pedagogical content knowledge (TPACK) as a factor that could be associated with TI self-efficacy. Their study indicated that TPACK with all its subordinate knowledge types are significantly correlated with TI self-efficacy. The study of Birisci & Emin (2019) demonstrated similar results. Durak (2021) further found TI Sel-efficacy was also significantly associated with teachers or pre-service teachers' technology literacy, social interaction, and educational background. Among these studies, the TI challenges considered by pre-service teachers were rarely seen as the target factors. Such challenges can be primarily considered either easy or difficult to be overcame, which can correspondingly inspire or depress the pre-service teachers (Roblin et al., 2018). Therefore, it is worth investigating what these challenges are and if they are reflected with TI self-efficacy.

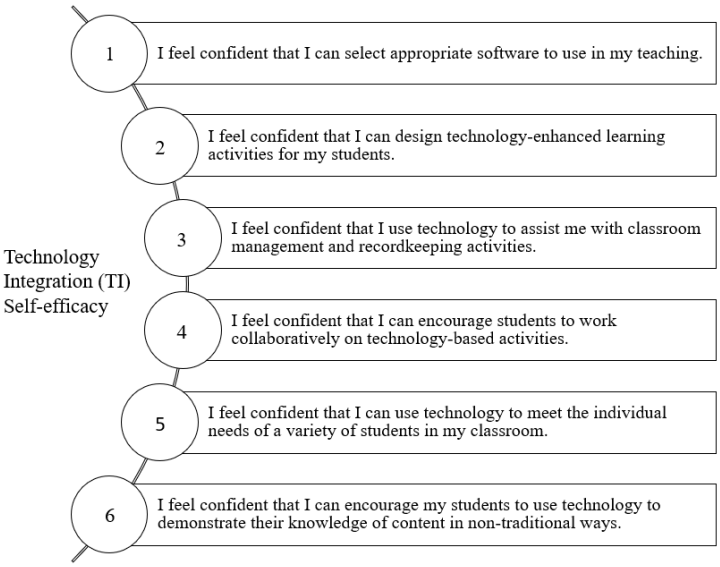
Methods

Data Collection

The participants were 212 K-12 pre-service teachers (196 females, 16 males) from an online course at a large public Southwestern university. An online survey consisted of six items of a 5-point Likert scale (see figure 1) and an open-ended question ("what would be the most important consideration when integrating technology?") and was distributed to the participants at the end of the semester. More than 97.6 % of students (n = 207) claimed they were moderate to highly proficient in computer skills.

Figure 1

TI Self-efficacy 5-Likert Scale Items (5-Strongly Agree, 1-Strongly Disagree)



Data Analysis

An exploratory mixed method research design was employed. Both qualitative and quantitative content analysis approaches were used to achieve the research purpose. The qualitative content analysis was applied for inducing the themes in the pre-service teachers' responses to the open-ended item. This study employed an open coding technique (Hsieh & Shannon, 2005). After coding 100 responses out of the 212 responses and revising the codes in multiple rounds, the research team confirmed the detected themes and sub-themes (see table 1). A double-coding protocol (Neuendorf, 2017) was implemented during the coding process. The interrater reliability was 0.91 before reaching the full agreement for each code.

Quantitative content analysis was applied for the rest of the 112 responses according to the themes identified previously. The research team continued to code 112 responses until a full agreement for each code was reached. After the whole coding process of 212 responses, each theme was transferred to a two-level ordinal variable in which zero stands for the existence of the theme in a pre-service teacher's response and one stands for the non-existence of the theme. In the end, correlational statistics were run to examine the associations between the five challenge variables with the self-efficacy variable, which was the mean value of the six 5-point Likert scale items.

Table 1

The Coding Framework (TI Challenges Considered by Pre-service Teachers)

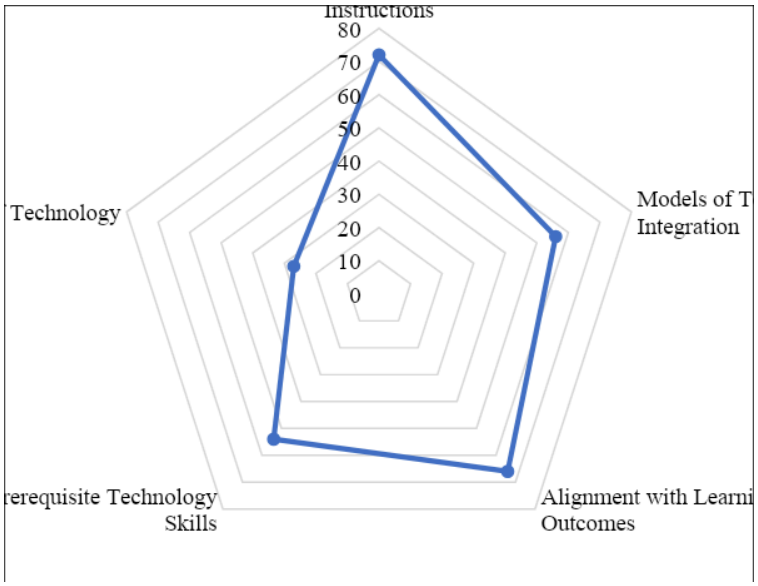
Theme	Definition	Example Meanings from Data
Differentiation of Instructions	Differentiating students' needs in instructions.	Is it appropriate for the student's age?
		… what your students comfort levels are…
		Not all students have access to technology…
		Is the way that it hits all learning types?
Models of Technology Integration	Appropriately integrating technologies into the classroom.	The most important consideration is SAMR.
		Classroom management is the challenge.
		How much technology is included?
		…know how to treat computers…
		The teacher must…monitor student behavior.
Alignment with Learning Outcomes	Using technologies to facilitate K-12 students' learning	…allows the student to learn content…
		… used to improve the learning outcomes…
		Are the children able to use it alone?
		…align its use to suit your objective…
		…aligned with the state standards…
Prerequisite Technology Skills	Equipping with technological skills	…teach our students how to use…
		You know exactly how to use the technology.
Management of Technology	Preparing high-quality and sufficient technologies for the classroom	The user friendliness of the technology.
		…engaging enough to help students…
		Not every school has the technology.
		… the technology is working appropriately…
		Allowing time to get familiarized with tech.

Results

There were five main themes suggesting pre-service teachers' primary considered challenges about TI. The first challenge refers to differentiating students' needs in instructions (i.e., Differentiation of Instructions, 34%). The second challenge referred to how to appropriately integrate technologies into the classroom (i.e., Models of Technology Integration, 26%). The third challenge referred to the use of technologies to facilitate K-12 students' learning (i.e., Alignment with Learning Outcomes, 31%). The fourth challenge is called Prerequisite Technology Skills (25%) which refers to equipping students with the required technological skills. The last challenge refers to preparing high-quality and sufficient technologies for the classroom (i.e., Management of Technology, 13%). Figure 2 shows the visualized distribution of the five themes as challenges. Regarding the distributions of the 5-likert TI self-efficacy items, the mean values of all the six multiple-choice items are four.

Figure 2

The Distribution of the Five Themes/Challenges



Spearman-rho was used to examine associations between the five main considered challenges and the mean score of pre-service teachers' self-efficacy. Among the detected significant associations, both the challenge about the differentiation of instructions ($r = 0.199$, $p < 0.001$) and the challenge about the alignment with learning outcomes ($r = 0.234$, $p < 0.001$) were positively correlated with pre-service teachers' TI self. The pre-service teachers who held the two challenges had a higher self-efficacy. On the other hand, the challenge about models of technology integration ($r = -0.256$, $p < 0.001$) and the considered challenge about the management of technology ($r = -0.195$, $p < 0.001$) were negatively correlated with pre-service teachers' TI self-efficacy at a significant level.

Discussion

The significant positive associations indicate that pre-service teachers have confidence in overcoming the relevant challenges and can be inspired by the low difficulty of meeting the conditions implied by these challenges. Considering such challenges results in correspondingly higher TI self-efficacy (Farjon et al., 2019; Njiku et al., 2019) in terms of differentiating instruction with technology and aligning learning outcomes with technology. To further enhance TI self-efficacy, TI instructors could offer data-driven instructional strategies in TI courses (Anderson et al., 2001; CAST, 2018) to emphasize the importance of differentiating K-12 students' needs and aligning TI with learning outcomes.

The significant negative associations indicate that the pre-service teachers have no confidence in overcoming the challenges and are consequently depressed by the high difficulty of meeting the conditions implied by these challenges. Thus, when they considered such challenges, their TI self-efficacy was correspondingly lower (Durak, 2021). To improve the TI self-efficacy regarding the two factors, TI instructors need to provide different TI models with more practical and authentic lesson plans. Also, pre-service teachers should have more opportunities to evaluate different technology tools and select the most relevant tool for given instructional context.

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It's All in the Design - the Learning Design: Comparing Active Learning Affordances within VLEs

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Using a cross-case thematic comparison of Virtual Learning Environment (VLE) studies we focused on distinctions among student reactions to validate the design of a browser-based virtual field experience. Results show that addressing higher-order learning through a given technology in the learning design creates comparable student responses to those received from more immersive experiences. This suggests that more democratized

Introduction

The pandemic had historic impacts in the context of shifting learning online. Since this transition to online learning, there has been an increased exploration of virtual learning experiences across various disciplines. However, in the spatial disciplines, particularly in the geosciences, fieldwork continues to experience challenges with facilitating trips (e.g., large classes, weather, etc.) which existed long before the onset of COVID-19. Before COVID, various solutions, including immersive options, were growing in popularity. To address the issue of transitioning from actual to virtual fieldwork, we need to understand how learning is being modeled across different modalities. Actual field trips are considered active learning experiences and how we address active learning in virtual counterparts is important to the success of a virtual field trip.

The pandemic introduced additional challenges in conducting virtual versions of field trips. Immersive technology, often hailed as a solution, leverages virtual reality (VR) headsets to create an embodied sense of space and enable interactions not possible within the real world (Zhao et al., 2020). However, immersive experiences come with inherent limitations for students with disabilities. The onset of the pandemic exacerbated the disparity in utilizing VR headsets, restricting access to such technology. Unfortunately, not all students were able to secure access to VR headsets and university resources were unavailable.

The benefits of immersive virtual experiences are hard to compare to non-immersive experiences for learning. We know immersing learners in the context of an experience can greatly increase knowledge attainment and retention (Dolphin et al., 2019), but does it account for learning designs which are more passive? The affordances of immersive virtual learning are highly dependent on the experience of the technology to elevate the learning. In comparing non-immersive learning experiences, however, good active learning design may present a way to validate the potential to meet student needs without the need for immersive technology.

Background

VLEs are gaining popularity with universities among students and instructors (Annansingh, 2019). VLEs can be valuable learning spaces as they provide a range of educational opportunities, serving as virtual field trips (VFTs), experiences, and tours which enable place-based learning. In addition to increasing the flexibility of accessing different sites for all learners more equitably, VLEs also promote independent learning through active exploration. Active learning has several positive effects on students, including improved learning outcomes, enhanced critical thinking and problem-solving skills, greater engagement and motivation, improved attitudes toward learning, and increased student participation (Cooper et al., 2018; Markant et al., 2016).

As a potential alternative to an actual trip, VLEs provide a real solution to the issues of conducting an actual field trip, a learning experience considered a core element within geoscience education (Lenkeit & Cuffey, 2012). However, vast resources are needed to invest in immersive VLE solutions. Thus, understanding if a non-immersive solution focused on a learning design which considers the affordances of the technology is comparable would make this core element of geoscience more accessible. VFTs offer place-based alternatives for learning with the promise of mimicking the active learning

experienced on an actual field trip, particularly in the field of geoscience. This place-based experience acts as a type of VLE which spans both immersive and non-immersive technology. Our topic focuses on the state of existing comparisons within VLEs used in geoscience which found immersive and non immersive experiences differ in many regards but not necessarily in learning outcomes (Zhao et al., 2020). This suggests there is a need to examine how learning is designed within immersive and non-immersive VLEs to better assist with the decision to invest in immersive or non-immersive solutions.

A key factor leading this topic on the learning design comparison of immersive and non-immersive VLE centers on how instruction is designed for an actual field trip. In the replication of an actual trip, Dolphin et al. (2019) indicated the need to further examine the learning design of the actual trip to compare it with its virtual counterpart. This suggests while many benefits exist from using immersive technology including presence, increased engagement, and enjoyment (Zhao et al., 2020), learning which replicates the actual field experience may also not have a strong learning design. Therefore, we designed our VLE to validate the ways we can involve geoscience students in active learning without the need for immersive equipment.

Problem Statement

We explored multiple forms of browser-based VFTs unsuitable for our direct needs. This resulted in our browser-based VLE to engage in active learning. The design focused on connecting with the actual field trip experience while adding higher-order learning through gamified activity. While our effort presented a design based on active learning principles, we aimed to understand if students could identify the value compared to students who had experienced an immersive field trip.

Methods

To validate our browser-based VLE (n= 91), we conducted a cross-case thematic comparison with a previous study (n= 19) used in a similar large undergraduate general education geoscience course (Figure 1). The validation study (Cook & Hatala, 2016) focused on how the immersive virtual field trip (iVFT) utilized immersive technology. This allowed us to identify how our interpretations in designing a browser-based VLE were similar based on student responses. Efforts focused on distinctions among student reactions to being involved through the different systems supplementing a full class field trip experience. This data came from the first year of each project and utilized open ended questions asking about likes and dislikes as well as the potential of these types of VLEs.

Figure 1

Two VLEs with the first Case on the Left and the second Case on the Right.

Browser-Based VFE HTC Vive iVFT

Our primary case was a Virtual Field Experience (VFE) offered as a browser-based implementation which virtualized a learning experience in a local state park located in the midwestern United States. A VFE focuses on having more active engagement in the experience compared to the more passive VFT experience. The experience included various programs such as Storyline and Thinglink's ability to navigate 360 images, apply sounds, and embed videos and images. We also connected learners with 3D models of rocks and fossils found on the site through Sketchfab, and narration. The point-and-click interaction allowed us to gamify the interface, incorporating collecting activities to earn points and learn facts while built-in assessment encouraged learners. Particular care was taken to form the experience around learning during COVID-19 when field trips were less frequent. The Canvas learning management system provided access to the VFE.

The second case focuses on data collected pre-COVID from an iVFT which incorporated an HTC Vive headset to experience an outcrop located in the northeastern United States. The virtual experience similarly included 360 images, diagrams and images from the accompanying textbook, text descriptions, and 3D rocks derived from photogrammetry all presented within Unity3D. Learners could stand and look around, navigating with the two controllers to teleport from point to point along the outcrop. The interactive activity provided further engagement with an active measurement of the 3D rocks. Students would measure, confirm their measurements, and enter their school email address to have the results sent to them to fill in their field trip reports. Additionally, the experience engaged learners in a unique feature of virtual experiences, to view a bird's eye perspective of the outcrop. This provided insights not possible from the actual field trip. The focus of the iVFT was to engage learners in an immersive experience of the outcrop without having to travel there. Students participated one at a time by scheduling to use the VR lab on campus.

Results

Using an interpretivist approach to parse and compare the student feedback, we found two primary themes: technocentric comments and content involvement. As the first year for each of these cases, we expected many comments to focus on technology issues, taking on a similar technocentric lens to the use of technology. These further aligned with expectations of how the technology should or could perform. However, comments began to differ when examining the experience of content involvement where issues of repetitive acts versus guidance were seen as helpful or boring. Content involvement through the activities within the experience evoked perceptions towards the nature of the educational experience and engagement.

Discussion

The notion that learners perceive involvement in an active learning experience differently based on the modality holds implications for examining the design of learning through technology. Comments which considered the experience as a whole versus individual elements present insights into how perceptions towards involvement were considered. For the iVFT one student wrote, "I liked measuring the layers of rocks." This differed from comments towards the VFE where another student wrote "I thought it was really well thought out and also executed well." As such, there was a notable distinction between the perception of involvement where the iVFT was described more by the active parts and the VFE was described more as an experience. In investigating the design based on the level of activity presented by the technology, comments within the iVFT fixated on looking around and feeling present while in the VFE, collective activities were described. This concurs with Webster's (2015) findings that engagement and interaction increased within the VLE but that active learning is what ultimately increased learning outcomes. While we did not compare learning outcomes, we examined the differences among student comments. Students from both studies recognized the nature of activity and their comments reflected on what interactions were more active and experiential.

Conclusion

The challenges associated with creating VLEs for undergraduate geoscience education stem from how we design learning experiences. While recent research indicates a need to examine how in-person pedagogical practices are conducted, there remains a need to examine how we can use technology to improve these experiences. While our findings note the obvious distinctions between the technology mediums, we also identified students were aware of how they were being involved in the learning process by the different activities they were engaged in. Different media embedded into our browser-based approach signaled a more involved experience engaging the learning as opposed to being present in the space and translating information into an externally submitted form.

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L-WI : Digital Innovation for Incubating Local Wisdom Innovators in Creative and Innovation Skills

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Local Wisdom Incubator is a professional web application that uses a seamless learning model to enhance creativity and innovation skills by using wisdom knowledge and five design thinking processes. Local entrepreneurs were encouraged to invent innovation and create new products to meet the needs of customers. The web application allows local entrepreneurs to study and research data in real life that can practice creating innovative works based on the design thinking concept in order to innovate and create new products.

Introduction

In Thailand's local communities, villages, and community collectives are being helped by the government-supported OTOP program. OTOP is short for 'One Tambon One Product' (Community Development Department, 2020). Artisans in different regions of the country produce an array of unique handmade products that showcase the traditions of that particular area. The research problem is local entrepreneurs lack the skills to create new unique products and the knowledge to create innovation for product development to meet the needs of customers. Thus, the solution is to develop digital innovation for incubating local wisdom innovators in the creative and innovation skills of local entrepreneurs. The web application allows local entrepreneurs to study and research data in real life while also storing, sharing, and disseminating knowledge digitally anytime and anywhere. Local entrepreneurs can practice creating innovative works based on the design thinking concept in order to innovate and create new products. The research participants were 32 OTOP manufacturers and entrepreneurs in Nonthaburi Province, Thailand.

Literature Review

Organizations in a wide array of fields and disciplines are increasingly using design thinking as an innovative process to create products or services that address wicked problems in their industries. (Bender-Salazar, 2023) Design thinking has undergone constant change; from being used for activities aimed at creating new products to being implemented as a solution in managerial practices that face strategic challenges (Dell'Era et al., 2020; Carella et al., 2023) A series of studies have defined design thinking as a powerful practice: a set of techniques, methods and tools that can support managers to face and overcome difficult and multifaceted challenges. (Brown, 2008, Carella et al., 2023). By embedding learning and reflective practices into the structure of design thinking, a web application that uses a seamless learning model of design thinking emerges that is a more effective tool for framing, setting in context, and solving these types of problems within teams to innovate and create new products.

Development Process of the Local Wisdom Incubator

Local Wisdom Incubator (L-WI) was created as a digital platform for local entrepreneurs to learn new skills (Reskill). The design of the web application consists of (1) web app structure or site map, (2) screen design, data input, and user interface, (3) web application components, (4) interaction parts, and (5) seamless learning model. The developed web application consists of 4 main menus: 1) Guide, 2) Media, 3) Workshop, and 4) Account. The development language is PHP, displayed in HTML5 format, and the web application is structured with CSS bootstrap5.

Digital media used to develop wisdom-based creativity and innovation is in the form of video clips (visual and audio) with expert lecturers delivering the content. The media consists of four categories: 1) Creation of innovation wisdom knowledge, 2) Design thinking for creating innovation, 3) Creation of innovation by applying business concepts, and 4) Creation of media to stimulate sales and meet customers' needs creatively

The design thinking workshop process in L-WI has 5 steps as follows.

Step 1: Empathize. Understand the problem or needs of the target group by observing behavior, interviewing, and listening to fully comprehend the needs of the target group without the interviewer's attitude. This is done by using an Empathy Map.

Step 2: Define. Define the problem and identify and analyze the cause of the problem (Pains) thoroughly to find a way to solve the problem directly (Gains). The crucial aspect is that it is a problem from the user's point of view, not a business problem. This is done by using a Define Map.

Step 3: Ideate. To brainstorm new ideas to find solutions to the target group's problems and to create new things. At this point, there is no need to be concerned about any boundaries or limitations. Any idea can be fully presented. There is no right or wrong. The emphasis is on developing new and innovative ideas that meet the needs of customers, focusing on creating a variety of alternative ideas and prioritizing ideas to develop prototypes. This is done by using Ideate Map.

Step 4: Prototype. To take the best idea to create a prototype by drawing a structure or creating a digital model. All information is input to test the idea to see if it can solve problems and meet the needs of the target group or not. This is done by using the Business Model Canvas.

Step 5: Test. To test efficiency, the prototype is tested for actual use with a target group that has attributes similar to the consumer group. Evaluation is conducted. Then, before releasing products and services to the market, the difficulties, barriers, advantages, and disadvantages that arise are used to improve and fix them. This is done by using a Test Map.

Roadmap for Using Local Wisdom Incubator

A seamless learning process map to promote wisdom-based creativity and innovation skills for local innovators consists of the physical dimension (F2F/Onsite) and the digital dimension (Online). Learning in the digital dimension can be divided into synchronous and asynchronous learning with a learning period of 4 weeks. Learning can be divided into 6 steps: (1) Pretest for evaluating creative and innovation skills in three areas including thinking creatively, working creatively with others, and implementing innovation; (2) F2F workshop included empathizing, defining, and ideating; (3) Self-learning via L-WI application by studying learning materials and resources; (4) Online workshop involved listen to lectures, practice, and create a prototype; (5) Pitching comprised present, pilot test, and receive feedback; and (6) Posttest for evaluating skills and work of innovation

Figure 1

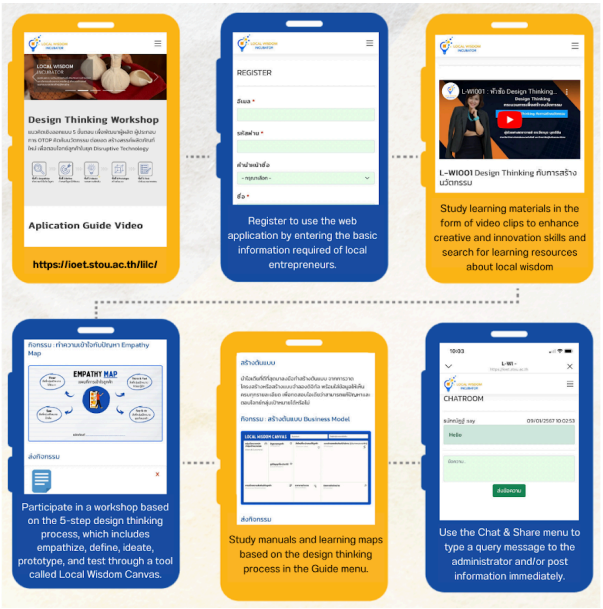
The Roadmap of Local Wisdom Incubator

How to Use Local Wisdom Incubator

1. Register to use the web application by entering the basic information required of local entrepreneurs. (https://ioet.stou.ac.th/lilc/)
2. Study learning materials in the form of video clips to enhance creative and innovation skills and search for learning resources about local wisdom.
3. Participate in a workshop based on the 5-step design thinking process, which includes empathizing, delineating, ideating, prototyping, and testing through a tool called Local Wisdom Canvas.
4. Study manuals and learning maps based on the design thinking process in the Guide menu.
5. Use the Chat & Share menu to type a query message to the administrator and/or post information immediately.

Figure 2

The Steps How to Use Local Wisdom Incubator



Results

This research question is whether the Local Wisdom Incubator enhances local entrepreneurs' creativity and innovation skills. The research methodology is experimental research (the one-group pretest-posttest design). The data were analyzed by mean, standard deviation and t-test. The results of using the Local Wisdom Incubator to enhance creativity and innovation skills by using wisdom knowledge for local innovators found that the participants had a score of self-efficacy perception on creativity and innovation skills after the experiment significantly higher than before the experiment at the .05 level (see Table 1). There were 20 works of innovation creation using wisdom knowledge (n = 32). The evaluation topics were divided into five areas. (1) The process of creating innovations, (2) the application of knowledge and creativity in the development of works, (3) the integration and collaboration, (4) the application of wisdom in the creation of innovations to create added value, and (5) the value resulting from innovation creation (see Figure 3).

Table 1

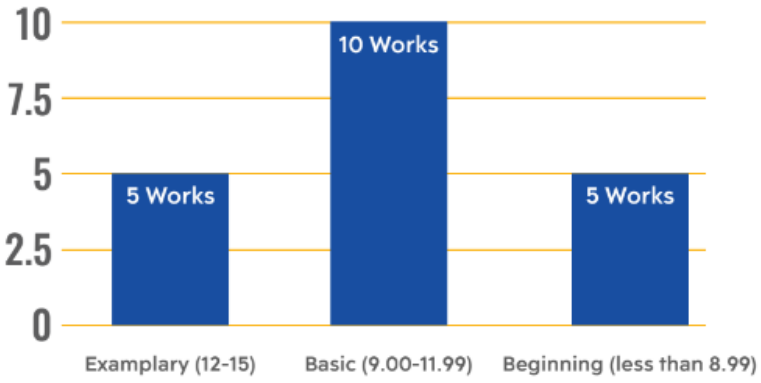
A Pretest and Posttest Score of Self-Efficacy Perception on Creativity and Innovation Skills

	N	Mean	SD	SD	t	sig
Pretest	32	3.92	0.19	0.64	-9.24*	0.000
Posttest	32	4.57	0.34			

*The mean difference is significant at the 0.05 level.

Figure 3

The 20 Works of Innovation Creation Using Wisdom Knowledge



Discussion

This study's findings suggest that the web application that uses a seamless learning model by using wisdom knowledge and five design thinking processes is an effective framework for addressing creativity and innovation skills. Namely, participants were able to recall various terms, such as "ideation" and "prototyping" when defining this web application. The design of the web application to serve as a digital tool to cultivate local innovators emphasizes a user-friendly design to facilitate easy learning and use. It also focuses on simplicity, consistency, and uniqueness. The application provides useful content and has a navigation system for users. The system supports responsive access and display (IxDF, 2022). This is in accordance with the research of Xin et al. (2018), in which a seamless learning platform model can effectively integrate the learning resources and teachers of the open education system and social individual education system and provide high-quality shared learning resources and diverse stratification teachers to students and social workers. The results of the study found that the implementation of seamless learning strategies through mobile phones was an important factor in promoting students' ability to learn concepts. The advantages of seamless learning through mobile phones are 1) Learners can learn unlimitedly both in the classroom and outside the classroom; 2) Learners can learn anywhere, anytime; 3) It combines formal education and non-formal education; 4) Learners are digital natives. Therefore, they are familiar with mobile phones; 5) Learners can learn both personally and socially; and 6) Learners can learn both physically and digitally.

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Liberatory Design Thinking for Equity-Centered Instructional Design: A Systems Thinking Analysis

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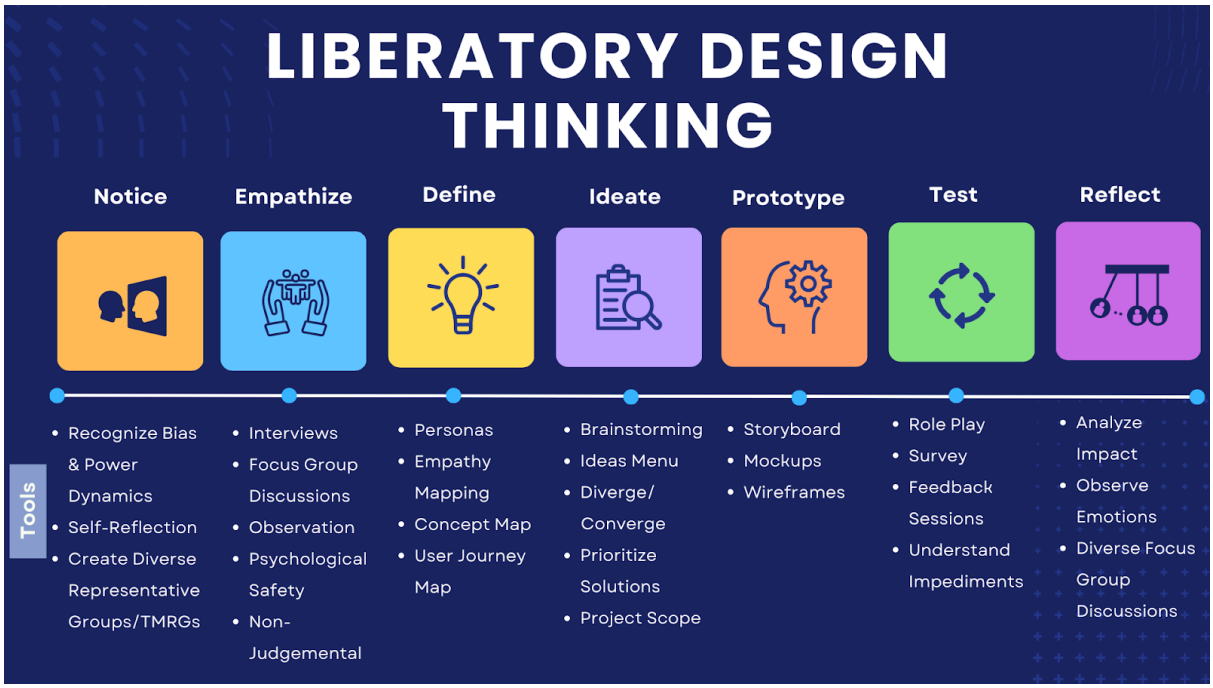
As per the National Equity Project, any system that produces inequities, injustices, and inequalities is often a product of design. Research has shown that systemic inequity often results from the design process and can rupture the power balance, producing inequitable relationships in the social justice arena (NEP, n.d.). Equity-centered systems design is pivotal in dismantling systems of oppression and empowering people of color, people with disabilities, the LGBTQ+ community, the indigenous, and other marginalized communities. An equity-centered liberatory design thinking approach can support instructional designers in identifying and addressing the problems of inequities in an existing system. By considering the ethos and strategies necessary to center equity by design, instructional designers can provide a platform and opportunity for all stakeholders to practice converging and divergent thinking.

Introduction

Liberatory design thinking is an equity-centered design framework that was co-created by Tania Anaissie, Victor Cary, David Clifford, Tom Malarkey, and Susie Wise during a collaboration in the year 2016 and 2017 with the National Equity Project and Stanford d.school's K12 Lab expanding the familial design thinking process (Anaissie et al., 2017). While design thinking has five phases —Empathize, Define, Ideate, Prototype, and Test (The Interaction Design Foundation, n.d), liberatory design thinking has two added phases: Notice and Reflect, as shown in Figure 1. These phases in the context of learning experience design focus on what instructional designers can do to add equity to designing and developing learning experiences. In the liberatory context, systems thinking can identify, analyze, and challenge the systems of power and design interventions and strategies for promoting social justice and liberation. It involves identifying the root causes of inequities and analyzing how different systems and structures contribute to or reinforce those inequities.

Figure 1

Liberatory Design Thinking Framework (Anaissie et al., 2017)



Design Challenge

The nonprofit in this design case experienced high turnover during COVID-19. The exit survey revealed that a lack of a sense of belonging, resource availability, and team member inclusion were major concerns leading to high exit rates. To improve team member experience, the organization prioritized hiring diverse employees along with DEI initiatives. And the L&D team was asked to redesign the onboarding learning experience. The author who was the sole instructional designer on this project, introduced the 'liberatory design thinking' framework for redesigning the onboarding learning program and inquired two significant questions:

1. How do instructional designers implement an equity-centered framework to design learning experiences that disassemble structural inequities?
2. Second, how might instructional designers promote effective instructions and learning strategies within the constraints and interdependencies in an existing system?

Design Decision and Outcome

The liberatory design thinking framework is non-linear and agile, allowing for simultaneous generation, presentation, and evaluation of design directions and alternatives. For this project, the tools were tailored and customized to fit the requirements and system constraints. The project started with creating a plan, keeping the liberatory design thinking framework as its core philosophy.

Figure 2

Project plan for liberatory designing thinking phases (Self-Design)

PROJECT PLAN - MANAGER TOOLKIT

PROJECT TITLE		PROJECT ROLES
Onboarding and Orientation	START DATE	Individual Names and their roles
PROJECT TEAM	02/01/23	
Core and Reflection Design Team	END DATE	
	12/15/23	

*WBS NO.	TASK NAME	MILESTONE STATUS	Assigned To	DUE DATE	COMMENTS
1	PHASE I - NOTICE AND EMPATHIZE				
1.1	– Project Conception, and Kickstart	Done			
1.2	– Notice Exercise	Done			
1.3	– Empathy based Research	Done			
2	PHASE II - DEFINE AND IDEATE				
2.1	– Create Personas	Done			
2.2	– Synthesize Data	Done			
2.3	– Learner Personas	Done			
2.4	– Ideate Solutions/Project Scope	Done			
3	PHASE III - PROTOTYPE				
3.1	– Program Goals and Learning Objectives	Done			
3.2	– Content Breakdown	Done			
3.3	– Task Analysis, High Level Course Design	Done			
3.4	– Opening Module (Pre-Arrival)	Done			
3.5	– Module 1 (First 2 Weeks)	Done			
3.6	– Module 2 (First 30 Days)	Done			
3.7	– Module 3 (First 60 Days)	Done			
3.8	– Module 4 (First 90 Days)	Done			
3.9	– Module 5 (First 90 - 180 Days & Closing)	Done			
4	PHASE IV - TEST AND REFLECT	Done			
4.1	– Pilot Release Focus Group Feedback - Opening (Pre-Arrival) and Module 1 (First-Two Weeks)	Done			
4.2	– Pilot Release Focus Group Feedback - Module 2 (30 Days) and Module 3 (60 Days)	Done			
4.3	– Pilot Release Focus Group Feedback - Module 4 (90 Days) and Module 5 (90-180 Days)	Done			
4.4	– Communication Strategy & Email Templates	Done			
4.5	– Final Course Launch	Done			

The Notice Phase

The first initiative taken before moving on with the project was to create a design team. Traditionally, people who participated in the design team were from the learning and development department consisting of instructional designers, training facilitators, learning administrators, content writers, project managers, leaders, and subject matter experts. In order to bring a liberatory mindset, multiple stakeholders were invited who were impacted by learning designs, i.e., the team member representatives. These representatives were from the 'team member resource groups' with shared characteristics or life experiences. The objective was to amplify the voices of traditionally under-represented people and marginalized communities by providing them a platform for the members of these communities and their allies to connect in the organization. When the author introduced the 'liberatory design thinking' framework, the senior leadership provided excellent support as it aligned with the organization's inclusion mandate. However, the thought of inviting external team members to the design team created tension in the existing team. The tensions were due to insecurities about giving up the power of design decisions and overlapping team member roles and responsibilities. In order to address these concerns, it was decided that the design team would be divided into two sub-teams: the 'core' team and the 'reflection' team. The 'core' team consisted of members from the learning and development department, with clearly defined roles for each member. The reflection team consisted of the TMRG representatives and subject matter experts to provide crucial feedback at each iteration and have a final voice for a more inclusive learning design.

Second, to notice with empathy, both the core team and the reflection team started a self-reflection exercise to notice shared values, identities, and biases. The reflection exercise helped to notice constraints and opportunities and negotiate with key stakeholders and people in power to influence the overall design. The self-reflection exercise consisted of questions, as shown in Table 1.

Table 1

Liberatory questions for the Notice Phase (Self-Design)

Liberatory Questions for the Notice Phase
1. Who am I/we? Who are our learners? What do I/we know about our learners? 2. How does my identity or job title position me in improving the learning experience? 3. Do I have privileges enjoyed by others? How does it impact the learning design to improve learning experiences? 4. Do I see patterns in the previous learning designs that might be biased and affect the learning experience? 5. Have I/we designed learning programs using inclusive language? Have I/we included examples and language that was culturally sensitive? Were the learning programs accessible to people with disabilities?

The Empathy Phase

The Empathy phase is core to understanding the people for whom the learning experience is designed. During this phase, the 'core' team collected data through ethnographic methods, including observations, interviews, and focus group discussions from both the 'reflection' team and with team members who joined the organization in the past 12 months and were impacted by the current onboarding and orientation learning program. The core team focused on liberatory questions that opened the door for more profound and meaningful data collection, as shown in Table 2.

Table 2

Liberatory questions for the Empathy phase (Self-Design)

Liberatory Questions for the Empathy Phase
1. How does my identity and role in this project affect how and what people share with me about their lived experiences? Do the learners feel safe to share their experiences? 2. What are the core needs of the learners? What are their struggles and aspirations regarding the onboarding and orientation program? When and where do their struggles occur? How often does this happen? Are there any additional data available? 3. Are the learners clear about their job expectations? Do they have any inequities in resource availability? Do the learners feel included? Do they feel their opinions and viewpoints are given a platform to be heard? What do my learners hear, think, and feel about the onboarding and orientation learning program? What do they see in their environment that affects their learning experiences?

Another critical aspect that followed throughout the empathy phase was creating an environment of psychological safety. In a systems approach, it is a shared expectation that leaders or people with power to influence will not embarrass, reject, or punish each other for sharing ideas, taking risks, or soliciting feedback (Staff, 2022). Hence, the ‘core’ team took the following steps to provide a platform that promotes safety:

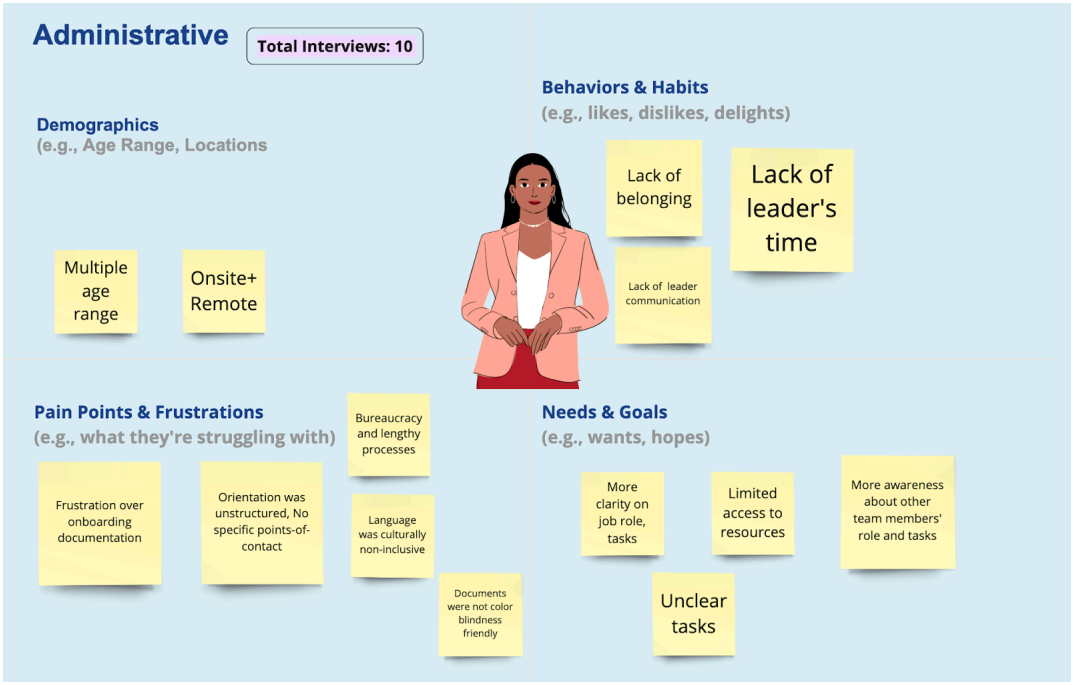
- Anonymous feedback forum if team members are unwilling to disclose their identity.
- Multiple options to collect data using personal interviews, anonymous surveys, and focus group discussions. Hence, the team members can share their experiences in whichever format they prefer to feel safe.
- Encouraging open and non-judgemental communication and active listening with no interruptions when someone shares their opinions, ideas, frustrations, or pain points.
- No personal remarks and respect for diverse perspectives and lived experiences.
- Focus and prioritize the well-being and safety of all.

The Define Phase

In the Define phase, the design team, including the ‘core’ and the ‘reflection’ teams, collaborated to synthesize the findings and articulated the insights by creating learner personas and empathy maps, as shown in Figure 3. The learner personas helped to visualize the target learner or group of learners for whom the learning programs were designed. On the other hand, the empathy maps helped to understand what the end users, i.e., the learners, felt, thought, saw, and heard, what pains and gains they experienced, and what were their own biases. During this phase, the team used whiteboards and visualization tools like the Miro to brainstorm and narrow down the key learner personas, their characteristics, behaviors, likes, pain points, and needs, as shown in Figure 3.

Figure 3

An empathy map showing a learner's persona and needs (Self-Design).

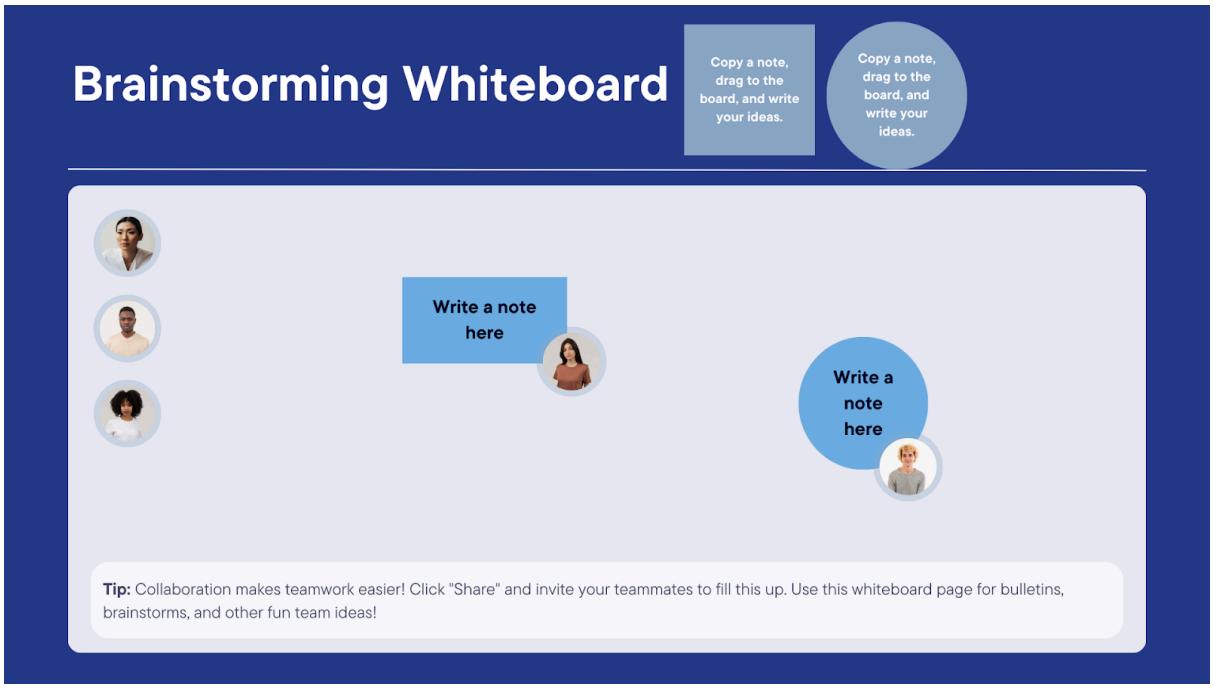


The Ideate Phase

The 'reflection' team played a crucial role in offering insights into the solutions. The TMRGs were also involved in the co-design processes to co-create solutions that met their needs and aligned with their values. The Ideate phase also overlapped with other phases, especially the 'Reflect' phase. Taking feedback from multiple stakeholders, including the TMRG group members, helped to understand the impact of the learning solutions. Furthermore, to make adjustments as needed to ensure that it genuinely empowers marginalized individuals and communities, as shown in Figure 4.

Figure 4

A virtual whiteboard for a brainstorming session for the Ideate phase (Self-Design).



The Prototype Phase

During the Prototype phase, the ‘core’ team designed prototypes incorporating learning principles like the backward design model and adult learning principles and created storyboards and wireframes. The ‘reflection’ team, which included the TMRG representatives, played a crucial role in providing feedback to co-design the learning solution at each iteration.

The design team at the nonprofit organization followed a few criteria to prototype the learning solutions:

- The solution must address the problems within the larger systems in which it operates.
- The solution must address and ensure that it aligns with the needs and values of diverse learners, especially marginalized and underrepresented learners.
- Use systems mapping techniques to visually represent the current systems and identify key stakeholders, feedback loops, and leverage areas.
- Use co-design techniques to involve multiple stakeholders, including representatives from the TMRG groups, in the prototyping process.
- Use inclusive and accessible design principles when creating the prototype. For example, ensuring closed captioning, good color contrast, culturally relevant images and language, and other WCAG (Web Content Accessibility Guidelines) protocols.

The Test and Reflect Phase

The Test phase focuses on getting specific feedback about how ideas and solutions can improve. The Reflect phase is ongoing and transparent throughout the liberatory design thinking phases. The design team made a questionnaire, as shown in Table 3, to make testing and reflection a continuous process.

Table 3

Reflection questions in a 'liberatory design thinking' framework (Self-Design)

Liberatory Questions for the Reflection Phase
1. As a team, does the learning experience feel equitable and inclusive? If not, why? What and how should we adjust? 2. How might cultural norms trigger unconscious biases that impede our relationships and work? What are the suggestions to improve the learning program? 3. What emotional state affects representative groups after experiencing the learning program? 4. How can we share or release distressful emotions to move through the Liberatory Design process with care for each other?

Conclusion

To summarize, a few critical observations in the design case that were observed while implementing the 'liberatory design thinking' framework were:

- Create a diverse design team, including multiple team members from diverse backgrounds, especially underrepresented and marginalized members.
- Promote psychological safety to get honest and diverse feedback (anonymous feedback/ no repercussions for providing feedback).
- The political will of senior leadership
- Appoint moderators who can serve as facilitators, mediators, and champions of inclusion.
- And design solutions with a systems thinking lens.

Finally, it is vital to remember that liberatory design thinking is an ongoing process that requires continuous reflection, adaptation, and monitoring to ensure that the solution effectively addresses the complex issues within the system.

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Online Learning Issues, Challenges, and Trends in Higher Education: An Instructional Design Perspective Beyond Pandemic

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Previous literature indicates that online learning has three issues and challenges - technological, pedagogical, and affective. Those issues and challenges are reflected in the following aspects: learning engagement, learning diversity, learning resources, learning assessment/feedback and learning environment. Among these, learning engagement is the most historical and central issue for online learning. This paper will share the vision for online learning trends beyond the Pandemic in Higher Education from an instructional design perspective by reviewing its potential issues and challenges. However, this study is more focused on discussing pedagogical and affective issues and challenges and how technological advancement potentially transforms students' learning experience pedagogically and effectively.

Introduction

Due to the impacts of the pandemic, there is an increasing demand for online learning. Meanwhile, there are challenges and concerns for online learning, including pedagogical, technological, and affective (Ferri et al., 2020; Yeung & Yau, 2022). This paper aims to reflect on the challenges above and issues with online learning faced during and beyond the pandemic. It delves into five critical aspects from instructional design perspectives:

1) learning engagement, 2) learning diversity, 3) learning resources, 4) learning assessment/feedback, and 5) learning environment. Additionally, this paper discusses the potential technology-driven solutions and trends in addressing online learning concerns, primarily focusing on emerging technologies such as extended reality (XR), simulation, artificial intelligence (AI), and learning analytics.

Issues and challenges

Learning engagement: Social connection

The online learning engagement issue is historically rooted in the absence or limitation of social connection (Ragusa & Crampton, 2018). The physical distance between learners and instructors separates individual learners from each other geologically and emotionally. During the pandemic, an increasing number of students enrolled in online learning, but the portion of students who were engaged with online learning decreased over time (Spitzer et al., 2021). To achieve a similar learning engagement and social connection as learners and instructors expected for formal face-to-face instruction, efforts should also be made in various aspects, such as learning environment, learning resources, learning assessment, and learning community/diversity.

Learning diversity: Tolerance of diversity

Online learners' cultural and linguistic backgrounds contribute to their online learning challenges, and hence a one-size-fits-all approach no longer serves the success of online learning. (Kerr et al., 2018). Although the call for designing for diversity within online learning has been discussed previously, the need for tolerance of diversity expects online learning to effectively engage each learner and provide a learning environment where learners can seamlessly switch between a universal learning environment and a personalized one. This "paradoxical" expectation is challenging the current online learning mode.

Learning resources: Interactive and engaging

Multimedia learning resources are pedagogically equivalent in helping learners acquire theoretical knowledge and even more effective in practical skills (Syed et al., 2019). To enhance students' learning effect and expand online learning into different learning domains, there is a need for teaching materials in the form of interactive multimedia, including images, animations,gamification, simulation, or even immersive or conversational learning resources (Ferri et al., 2020; Thomas & Rogers, 2020).

Learning assessment and feedback: In-time and intelligent

In online education, there is frustration about the lack of immediacy in responses and the feedback latency and quality concerns (Yeung & Yau, 2022), while instructors reported time commitment and workload issues.

Especially during the pandemic, well-being concerns with faculty arose as faculty reported burnout (Ardito et al., 2022). Besides, there is limited viability for measuring different types of learning; those learning goals of affective and psychomotor domains are difficult to reckon with the current mainstream online learning system (e.g.,

synchronous virtual meeting and LMS). The conflict between students' expectations and instructors' limits suggests adapting assessments to the new learning requirements and calls for a new solutionthat provides students with in-time and personalized responses or feedback (Rapanta et al., 2020).

Learning environment: Engaging and powerful

Previous studies have indicated that the home environment, while comfortable, maybe non-conducive to online learning (Ferri et al., 2020; Yeung & Yau, 2022). Students often struggle with noise, distractions, and small spaces while studying at home (Bringula et al., 2021). They also had difficulty maintaining attention in purely online contexts, reporting boredom, isolation, time management challenges, and a lack of self-organizing capabilities (Carolan et al., 2020). In response to those issues, it calls for an engaging and powerful learning environment (Thomas & Rogers, 2020).

Technologies-driven solutions

Addressing the challenges above will require massive work, energy, and time from different online learning stakeholders. It is unrealistic to address either of them without the support of technological advancement at a large scale because of practical challenges in real life, including funding limits, personal life commitments and other responsibilities, time constraints, and mental health concerns. Therefore, we will discuss how technological advancement could address the concerns on social and affective dimensions of online learning.

Extended reality

XR is an umbrella term encapsulating Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), and everything in between (Milgram & Kishino, 1994). Incorporating XR-based learning in online learning will primarily address concerns related to learning engagement, complex learning, assessment of learning in psychomotor and affective domains, and promoting learning diversity. For example, 1) Learning resources:

XR-based learning resources can be visual, immersive, and interactive (Donkor, 2010). AR technology can overlay the objects over reality, MR or VR students in a virtual world that simulates reality. 2) Learning assessment: XR-based learning, especially VR, can expand online learning to domains such as affective and psychomotor rather than just focusing on cognitive domains. 3) Learning environment: XR-based learning could provide an experiential, engaging, personalizable, and interactive learning environment. 4) Learning Community: Students can virtually meet and build a social connection; as it is experiential learning, the learning itself could be customized by students to match their needs, in which case the diversity of students could be accommodated and embraced.

Simulation

Simulation is a concept related to the delivery format. Some low-cost simulation products could be easily created and applied in online learning. Simulation is an alternative option to XR-based learning resources that can contribute to engaging and interactive learning experiences. Compared to XR-based learning resources, it is more cost-effective.

Artificial intelligence

AI-enabled online learning features, such as automatic feedback, could alleviate students' concerns about the lack of response immediacy and learning feedback latency (Georgia Tech, 2020). Emerging AI technologies could improve online learning for personalized and adaptive learning experiences (Peng, Ma, & Spector, 2019). AI-enabled learning management systems could identify students' learning gaps, provide personalized learning paths, and recommend learning content (Tapalova & Zhiyenbayeva, 2022; Raj & Renumol, 2022); this will

benefit students of diverse backgrounds with different learning needs, create a learning community that embraces the difference and diversity. Generative AI can customize learning resources and generate unique materials and assessments for different subjects/courses (van den Berg & du Plessis, 2023; Saunders, 2023), helping instructors cope with time constraint concerns and expanding the online learning assessment limit.

Learning analytics

Using learning analytics in online learning will monitor and regulate online students' learning behaviors, increase learners' interaction and learning engagement, predict online students' learning performance, personalize learners' learning experiences and feedback, increase learners' retention rates, and help improve future online learning courses (Kew & Tasir, 2022; Ramaswami et al., 2023). A learning analytics dashboard is a typical application in online learning whereby instructors can visualize learning data and provide actional feedback (Susnjak, Ramaswami, & Mathrani, 2022). The learning analytics dashboard often functions as a centralized hub through which you can identify at-risk students, help with real-time learning progress tracking, develop data-informed teaching strategies, and provide personalized learning experiences.

Conclusions and discussion

These technologies-driven solutions above will redefine the online learning future. It might be a new form of blended learning in which AI-enabled online learning combines with VR-supported virtual learning, offering self-paced, adaptive, personalized learning experiences. Learning resources will become more interactive through simulation and XR technologies. Students could receive personalized assessments and instant feedback with the support of learning analytics and AI technologies. These learning tools will better prepare future generations for unexpected crises.

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Personalizing Feedback and Developing Learner Agency Using Kami

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This paper presents the schoolwide implementation and evaluation of an online social annotation tool (SA), Kami, used to provide personalized feedback to deepen learning and develop learner agency. Through a mixed-methods study, providing personalized video feedback using Kami could enhance learners' perceived individual learning, collaborative learning, learner agency, and deep learning. A strong correlation existed between learner agency and collaborative learning using Kami. Teachers' overall adoption rate and perceptions about using Kami provided evidence for the success of the implementation and professional development strategies based on the diffusion of innovation theory. The paper offers a glimpse of effective pedagogy using SA tools in a blended learning environment, strategies for technology professional development for large-scale implementation, and an evidence-based approach to evaluating an implementation outcome

Introduction

The COVID-19 pandemic exacerbated the need to strengthen online pedagogies and interactivity. The School of Science and Technology, Singapore (SST) has actively implemented the use of an online social annotation (SA) tool, Kami, and piloted various professional development (PD) and instructional initiatives. This paper presents the schoolwide implementation strategies and the outcome evaluation findings.

Social Annotation Tools

SA tools allow users to comment, highlight, collaborate online, and receive notifications. Novak et al. (2011) found that SA tools enhanced learning outcomes, critical thinking, metacognition, comprehension, communications, collaborations, and learner emotions. The authors recommended providing adequate training, instructional support, and small groupings for learning activities. Glover and colleagues (2007) generated a list of essential and desirable features for SA tools, such as commenting, private annotations, browser compatibility, drawing, and collaborations. Chen and colleagues (2012) highlighted interactivity and intuitive notetaking as key factors fostering student-content interaction and predicting sustained use of SA tools. Kami has most of the desired features mentioned by the studies and unique features, such as video commenting, allowing users to provide personal and in-depth feedback more effortlessly. Thus, SST chose Kami as an SA tool for online

instructional innovations and contributed to the literature by evaluating the impact of using SA tools within the K-12 context rarely examined.

Technology Implementation

The implementation of Kami within SST followed an ABCD framework that addresses various key concepts of the diffusion of innovation theory (DTI, Rogers, 2003). According to Rogers, an innovation-decision process involves knowledge (information about the innovation), persuasion (formation of an attitude toward the innovation), decision (adoption or rejection), implementation (innovation in practice), and confirmation (affirmation for decision) stages. Opinion leaders and change agents play pivotal roles in influencing innovation decisions. The rate of adoption depends on perceived innovativeness, or how early one is ready to adopt new technology and the innovation attributes (relative advantage, compatibility, ease of use, trialability, and observability) of the technology. The ABCD framework stands for advocacy by change agents, backing with support, capacity building for teachers, and demonstration by champions. SST completed the four-year implementation and evaluation cycle for Kami, from schoolwide subscription, department-based trials, subject-based instructional modeling, level-wide integration for learners, one-to-one coaching, and sharing at cluster and national levels. In 2023, the Physics team implemented an instructional intervention among two 9th-grade Physics classes using Kami to provide personalized video feedback for daily homework for a year and evaluated the impact of learning using Kami.

The purpose of the study was to understand the perceptions of students and teachers regarding the use of Kami and provide insights into effective instructional strategies using SA tools. The following research questions guided the study:

1. What are students' perceptions about the impact of learning using Kami in terms of individual learning, collaborative learning, learner agency, and deep learning?
2. What are students' perceptions of teachers' feedback using Kami?
3. What are teachers' perceptions about using Kami in terms of their adoption decision stage, perceived innovativeness, and perceived innovation attributes of Kami?

Methodology

The evaluation study embraced a pragmatic lens, using multiple data sources (Mertens, 2018) and a matching comparison group design (Henry, 2010) to estimate the intervention's effect. This section summarizes the key elements of the research design and methodology.

Context and Research Design

The study occurred in an independent Singapore school that actively pioneers technology integration initiatives. We employed a sequential mixed-methods approach (Creswell & Plano Clark, 2011), using quantitative survey data to understand students' and teachers' perceptions of the impact of learning using Kami, qualitative feedback to understand students' experiences with teacher feedback, and student work samples to corroborate the results.

Sampling and Participants

We followed the purposive sampling strategy (Kerrigan, 2014) to select two 9th-grade Physics classes (n= 47) for the instructional intervention and the remaining 141 students as the control group for the evaluation. All students used Kami in regular ways, such as digital annotations and commenting. The intervention group received personalized video feedback using Kami for daily homework. Overall, 120 students and 17 Science teachers completed the evaluation surveys after the intervention.

Instrumentation

We adapted the student survey items from various validated scales. The items for individual and collaborative learning originated from Zhao et al. (2018). Individual learning refers to how learners interact with the content, whereas collaborative learning is how they interact with others and the content. Perceived learner agency was measured in terms of self-regulated learning (Greene, 2015; Jiang et al., 2023) defined as an "active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior" (Pintrich, 2000). Deep learning involves integrating prior and new knowledge to refine understanding or create more complex knowledge, according

to Greene (2015) whose items for self-regulation and deep learning strategies were adapted. We constructed the qualitative questions based on Lim and colleagues' study (2020) on perceptions of teacher feedback. The student survey consisted of 18 items on a Likert scale of 1 (strongly disagree) to 7 (strongly agree) and four open-ended questions such as "What did you like/dislike about this method of providing feedback using Kami?" For teachers' perceptions, we adapted 18 items on a similar scale from Celik et al. (2012) to evaluate their adoption decision stage, perceived innovativeness, and innovation attributes of Kami based on DTI.

Data Collection and Analysis

Participants received the online surveys as part of school surveys after an instructional intervention. For the qualitative data, we followed systematic steps (Braun & Clarke, 2006) to conduct a priori and thematic coding independently before merging the findings. Further, we examined student work samples for evidence confirming or counteracting our conclusions.

Trustworthiness

To ensure trustworthiness, we checked the reliability of the subscales, which achieved a Cronbach Alpha value of more than 0.90 for all constructs. The credibility of qualitative findings was supported by 95% congruence in the codes generated by the researchers. We also engaged several reviewers to critique the evaluation and findings.

Findings and Discussion

The following sections show the descriptive and influential statistics from the data analyses and discuss the combined findings.

Students' Perceptions of the Impact of Learning Using Kami

Table 1 shows an average score of 4.3 out of 7 regarding 9th-grade Physics students' perceptions of the impact of learning using Kami. The intervention group had a significantly higher average score for each construct (t> 3 andp< 0.01). Therefore, providing personalized video feedback using Kami potentially enhances students' perceived individual learning, collaborative learning, learner agency, and experience of deep learning. Learner agency correlated strongly (R2 = 0.69 andp < 0.01) with collaborative learning using Kami, reaffirming the importance of incorporating group work in helping students acquire self-regulation skills.

Table 1

Summary of Descriptive and Independent Samples T-test Statistics

Constructs	Control Group	Intervention Group	All	Cronbach Alpha	*t* value	*p* value
Ave Individual Learning	3.7	5.1	4.2	0.96	3.32	*0.0014
Stdev Individual Learning	1.95	1.49	1.91			
Ave Collaborative Learning	3.8	5.1	4.2	0.91	3.22	*0.002
Stdev Collaborative Learning	2.18	1.42	2.02			
Ave Overall Learning	3.8	5.5	4.5	0.97	3.26	*0.0017
Stdev Overall Learning	2.37	1.53	2.23			
Ave Learner Agency	3.6	5.1	4.2	0.97	3.22	*0.0019
Stdev Learner Agency	2.13	1.45	2.03			
Ave Deep Learning	3.7	5.1	4.2	0.98	3.23	*0.0019
Stdev Deep Learning	2.06	1.38	1.95			

Students' Perceptions of Personalized Feedback Using Kami

The qualitative student feedback confirmed the positive impact of personalized feedback on student learning, particularly in terms of facilitating detailed feedback, revisions, and understanding of complex concepts. As one learner shared, "I think the videos are very useful in my understanding. Outside of going through the questions during class, this allows me to revise and look back at the mistakes I have made, especially after a long time of no revision." Table 2 illustrates the distribution of qualitative codes by the number of participants who minimally mentioned the code once. Overall, 87.5% of the students perceived a positive impact of teachers' feedback using Kami in at least one aspect, 77.8% perceived deep learning, 56.9% suggested increased learner agency, and 50.0% found learning more efficient with Kami feedback. One student explained that he appreciated the opportunity to review targeted feedback with Kami videos without having to go through every question slowly. Collectively, the results affirmed the positive impact of learning using Kami and explained why there was a difference in the perceptions of the students between the control and intervention groups. Nonetheless, one-third of the students mentioned some drawbacks of Kami, primarily related to difficulties typing equations and drawing without a stylus.

Table 2

Distribution of Qualitative Codes by Participants

Qualitative Codes \ # of Participants	Personalised Learning	Learner Agency	Deep Learning	Efficiency	Likes Video Comments	>= 1 Aspect
#	33	41	56	36	36	63
%	45.8%	56.9%	77.8%	50.0%	50.0%	87.5%

Teachers' Perceptions About the Use of Kami

The teacher survey results provided further evidence for the implementation's success. Kami reports that 59.3% of teachers schoolwide use Kami actively. At least 94.1% of science teachers decided to adopt Kami and 76.5% implemented it. For perceived innovativeness, 53.0% of the science teachers are innovators, early adopters, or early majority adopting Kami, suggesting they are relatively early in embracing new technology. Table 3 shows the average innovation attribute scores by teachers' decision stages, indicating a higher average score for teachers in the implementation or confirmation stage. Observability had the highest average score, showing the effectiveness of PD strategies. The findings confirmed the applicability of Rogers' (2003) DTI in guiding new technology implementation and evaluation of technology, reiterating the criticality of sustained support throughout the implementation.

Table 3

Summary of Average Innovation Attribute Scores by Adoption Decision Stage

Decision Stage	Relative Advantage	Compatibility	Trialability	Ease of Use	Observability	n
Knowledge	4.0	3.5	3.7	3.0	4.5	1
Decision (Adoption)	4.8	4.5	4.4	3.8	4.8	3
Implementation	4.9	5.0	5.0	4.6	5.3	12
Confirmation	4.3	5.0	5.0	5.7	5.0	1
Overall	4.8	4.8	4.8	4.4	5.2	17

Conclusion

The present study suggested that providing personalized video feedback potentially enhances perceived learning, learner agency, deep learning, and efficiency for learners. The correlation between learner agency and collaborative learning reinforces the importance of group activities in developing self-regulation. The high adoption rates of Kami provided evidence for the success of the implementation strategies based on DTI in the K-12 setting. We used multiple strategies aforementioned to ensure the trustworthiness of the findings, but limitations of the study exist, including the small sample size of teacher participants, lack of qualitative insights from teachers, and using self-reports instead of actual classroom practices. Future studies using larger teacher sample sizes from different subject teams and qualitative feedback will help validate the impact of learning using Kami and understand the challenges for teachers during implementation.

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Perspectives About the State of Undergraduate Computing Education in Nigeria

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In this preliminary research, qualitative research was conducted through interviews with employers of computing talent, recent computing graduates, and undergraduate computing professors. The findings indicate a concerning trend of decline in the quality of undergraduate computing programs in Nigeria, primarily due to graduates' dissatisfaction with the outcome of computing education. University professors and recent graduates have offered recommendations to enhance the quality of computing education in the country.

Introduction

Computing education, part of STEM, has witnessed a decline in quality in Nigerian universities, leading to a diminished reputation of higher education in the country, as many independent learning hubs have recorded more success in their computing education efforts (Chiemeke et al., 2009; Atiase et al., 2020).

This study examines the state and perceived value of computing education in Nigeria from stakeholders' perspectives. These stakeholders within the computing education community include the employers of computing talent; the computing graduates themselves, and their professors. These stakeholders shared their perspectives and experiences with regard to computing education in Nigeria, and data were gathered through online interviews with these different stakeholders.

This research employs the phenomenology qualitative research theory and as seen in the Stanford Encyclopedia of Philosophy, "Phenomenology is the study of structures of consciousness as experienced from the first-person point of view" (Smith, 2018). In this research, we investigate the experiences of people in the computing education context, and we seek to answer the following research questions:

1. What do computing graduates (early career professionals), professors, and recruiters think about the quality and effectiveness of undergraduate computing education in Nigeria?
2. Are there common perspectives among graduates, professors, and recruiters?
3. How do these perspectives influence the present and future of undergraduate computing education in Nigeria?

Literature review

Computing education in Nigeria began in 1963 with the establishment of a training center by the IBM World Trade Corporation at the University of Ibadan, leading to bachelor's degree programs in Computer Science in several Nigerian universities (Anyanwu, 1978). Computing education in Nigeria has grown in popularity, as Computer Science is currently one of the most sought-after programs by

prospective undergraduates. Presently, over 114 universities in Nigeria offer Computer Science programs (DrugSavant, 2023; Nigerian Scholars, 2019).

Historical research indicates that early computing programs designed their curricula in alignment with the national needs of their time, ensuring that graduates were equipped with skills that met the nation's requirements (Anyanwu, 1978). However, the current situation in most universities reveals static and outdated computing curricula that do not address the current needs of Nigeria. As a result, independent learning hubs have emerged as more successful in providing relevant computing education and contributing to national innovation and development (Atiase, 2020).

Existing research on undergraduate computing education in Nigeria has primarily focused on elementary and secondary education (Basson, 2021; Dlamini & Dewa, 2021; Tshukudu et al., 2023), cultural relationships and methods (Arawjo & Mogos, 2021; López-Quiñones et al., 2023), and technology's role in improving learning experiences (Agbo et al., 2021; Bukar et al., 2016; Olutola et al., 2021; Thomas et al., 2020; Uzorka & Olaniyan, 2023). Some research has explored the relationship between undergraduate education and graduate employability, emphasizing the importance of practical skills and real-world examples (Chukwuedo & Ementa, 2022). Few studies have specifically examined computing education a concentration on individual aspects of the curriculum. One research paper focused on Deep Learning (Artificial Intelligence) education (Yong, 2022), and another focused on Object-oriented programming education (Sunday, 2022).

Methodology

This preliminary research focuses on the perceived value of undergraduate computing education programs and curricula from the perspectives of technology recruiters, recent graduates, and university professors, which is a gap that has been identified in the literature. The objective is to gain insight into the current state of undergraduate computing education and its value as perceived by key stakeholders, with the aim of identifying areas for improvement.

Research design

Data sampling

This preliminary research included a total of 14 participants: 5 recruiters, 6 graduates, and 3 professors. The recruiters were responsible for recruiting computing professionals for prominent industries in Nigeria.

The computing professionals graduated from various universities across Nigeria between 2014 and 2019. Their academic backgrounds primarily comprised STEM-related fields, particularly in computing, technology, and engineering. These universities were in different regions of Nigeria, including the South-West, North Central, and South-East.

The university professors chosen for this study were specifically Computer Science educators instructing computing and technology courses at a university in the Southwestern region of Nigeria.

Purposive sampling was employed to select these participants due to their expertise in computing education, either as educators, professionals, or talent recruiters.

Data collection instrument and procedure

Interviews were used as the data collection method. Recruiters answered 12 questions, professionals answered 16, and professors answered 7.

Recruiters' interviews focused on the quality of undergraduates' skills. Professionals were asked how well their university education prepared them for employment, and professors were queried about the effectiveness of the computing curriculum in equipping students with the necessary skills.

Participants were primarily found on LinkedIn and contacted through messaging platforms such as LinkedIn, WhatsApp, and Facebook. The interviews were conducted via Zoom, and responses were recorded in text format.

Data analysis

Thematic analysis was used to identify the most prominent themes within the responses.

Results and discussion

Hiring fresh graduates: Recruiters’ perspectives

Recruiters were asked about their hiring practices. 75% of them confirmed hiring recent graduates, typically placing them into graduate trainee roles.

When discussing the desired skills in recruits, recruiters noted that both technical and non-technical skills are important. Notably, a recruiter from a Fortune 500 company highlighted that a university degree is not the primary consideration for entry-level recruits; instead, they value hands-on skills relevant to the role.

These findings suggest that employers in the computing and technology sector expect a certain level of expertise in fresh graduates but are also open to providing training, recognizing that some graduates acquire the necessary skills through non-traditional means.

Universities' approach to computing education: Graduates' perspective

When asked if their university education adequately prepared them for the industry, 65% of early career professionals responded negatively. Some who felt prepared credited assignments and projects, while others relied on independent learning. Those who felt unprepared cited outdated curriculum, lack of hands-on experience, inclusion of irrelevant courses, insufficient guidance on real-world knowledge application, and a generally uninspiring learning experience.

Notably, 100% of early career professionals pursued additional training post-graduation, with half choosing self-study and the other half opting for external educational programs. This supplementary training equipped them with the practical skills required for employment in their industry.

These professionals offered recommendations to enhance undergraduate computing/technology education including:

- updating the course curriculum,
- reducing non-computing coursework,
- investing more in internship placements for students,
- fostering academia-industry relationships,
- providing hands-on practical with real-world relevance,
- improving teacher/professor training and professor-student relationships,
- creating distraction-free learning environments for students, and
- establishing a robust alumni network of industry professionals.

Universities' approach to computing education: Professors' perspective

The majority of professors, around 65%, believed that providing additional experiential learning opportunities would benefit students. Professors acknowledged the value of industry internship opportunities for providing some real-world experience for students. However, all professors indicated that they currently do not offer real-world projects for students to apply their course content experientially, for these reasons:

- Lack of synergy between academia and industry.
- The necessity to adhere to an outdated curriculum to maintain accreditation by the National Universities Commission (NUC)
- Insufficient funding and infrastructure.
- Heavy workloads for professors, which impede innovation.

Despite these challenges, all interviewed professors expressed their willingness to integrate real-world projects into their courses if such opportunities were made available.

Implication of results and conclusion

This study suggests several implications for the future of computing education in Nigeria. It emphasizes the need for programs to better equip students with essential skills. It also stresses the importance of collaboration among universities, industry, and the Nigerian government, for the purpose of creating an effective curriculum.

In conclusion, the research reveals that undergraduate computing programs in Nigeria are at risk of decline due to dissatisfaction among graduates. The paper suggests recommendations from professors and recent graduates to improve the quality of computing education, emphasizing the need for a collaborative effort among various stakeholders to enhance undergraduate computing education in Nigeria.

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Pre-Algebra Student Negative Sign Computer-based Learning

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Middle school students who struggle with manipulating math expressions involving the negative sign have demonstrated difficulty learning pre-algebra content that prepares them for higher-level math courses. This study involved a multimedia intervention to improve middle school students' negative sign proficiency and math self-efficacy. A mixed-methods action research study was implemented involving 28 middle school students who participated in an intervention three days a week, working on 12 computer-based math learning modules. The module's learning goals focused on students evaluating negative sign expressions supported by Realistic Mathematics Education learning theory, cognitive theory of multimedia learning, and multimedia self-efficacy instructional strategies. The results showed a statistically significant improvement in negative sign math proficiency, a non-significant improvement in math self-efficacy, and that student perceptions of learning through the modules were favorable. This research contributes to understanding technology intervention learning environments that include middle school math self-efficacy instructional strategies.

Introduction

Since the publication of A Nation at Risk: The Imperative for Educational Reform (National Commission on Excellence in Education, 1983), the United States educational school systems have been vigilantly working to improve mathematics achievement for K-12 students. Despite the increased national focus, many students still have difficulty learning algebra concepts because they cannot perform operations with negative numbers (Vlassis, 2004). More recent research on Algebra I students shows that students are making more errors when working with a negative sign, exceeding errors in arithmetic and fraction operations (Young & Booth, 2020). The difficulties are further exacerbated because being able to work with negative numbers and the negative sign is critical to students being able to learn higher-level math concepts.

Negative sign knowledge

In the United States education system, students are typically first taught integer operations in middle school. During their previous years in elementary school, students are taught extensively positive number mathematics, which may provide obstacles when they are exposed to working with negative numbers (Bruno & Martinon, 1999). With a backdrop of the earlier rules learned for positive numbers, negative numbers present counterintuitive concepts, such as -5 being greater than -1 (Whitacre et al., 2017). Developing knowledge of a learner's conceptual understanding of the negative sign has been accomplished through historical concept development comparisons, dissecting the various applications of the negative sign in mathematics, and research on instructional approaches (Bishop et al., 2014). The cognitive role of learning through contextualization approaches to math learning through a focused instructional model that uses hypothetical learning trajectories has been empirically demonstrated to be an effective strategy for mathematical learning environments (Simon, 2018).

Math self-efficacy

A learner's mathematical self-efficacy has been shown to have implications for learning but also shows there are opportunities to develop it through instructional strategies (Huang et al., 2020). Bandura (1997) identified four sources of self-efficacy: physiological state, vicarious experience, social persuasion, and mastery experience. Employing a vicarious experience source of self-efficacy, Knapp (2020) used teacher-made screencasts of geometry lessons which led to the students reporting higher self-efficacy after watching them. Improved math proficiency and positive self-efficacy effects may be achieved through strong teacher-student and peer relationships that impact student social persuasion while providing multiple opportunities to observe the modeling of peers provide positive vicarious and social persuasion experiences (Townsend, 2016). Math instruction should maximize mastery experience opportunities for a student as it is the most potent source of math self-efficacy (Usher & Pajares, 2009).

Multimedia learning

The cognitive theory of multimedia learning and its associated principles provide a framework for developing educational multimedia presentations. To promote cognitive information processes for knowledge construction, an instructional design incorporating computer technology should consider research-based principles that provide insight into the influences of learner cognitive load on information gathering and integration (Mayer, 2019). Supporting the development of instructional products, cognitive load theory provides a foundation for product design that enhances learning through the way information is exhibited and interacted with (Mayer, 2019). Information a learner is given to process should be minimized if it has no value to the learning objective, and depending on the complexity of the material, the information should be appropriately scaffolded based on the ability of the learner to optimize the demand to their working memory (Clark & Mayer, 2016). Consistent with the constructivist view of learning, Mayer (2019) encompasses multimedia platforms used for knowledge construction supported by twelve multimedia learning principles. Six multimedia learning principles were incorporated into the intervention instructional design for this research project: Coherence, Spatial Contiguity, Segmenting, Personalization, Voice, and Image principles. This approach provided opportunities for the computer modules to optimize student negative sign knowledge construction while working within the computer-based learning environment.

Purpose

When students struggle with math expressions involving negatives, their proficiency and self-efficacy are negatively impacted. An intervention that provides a directed approach was needed to improve students' math proficiency and self-efficacy. The following research questions were explored:

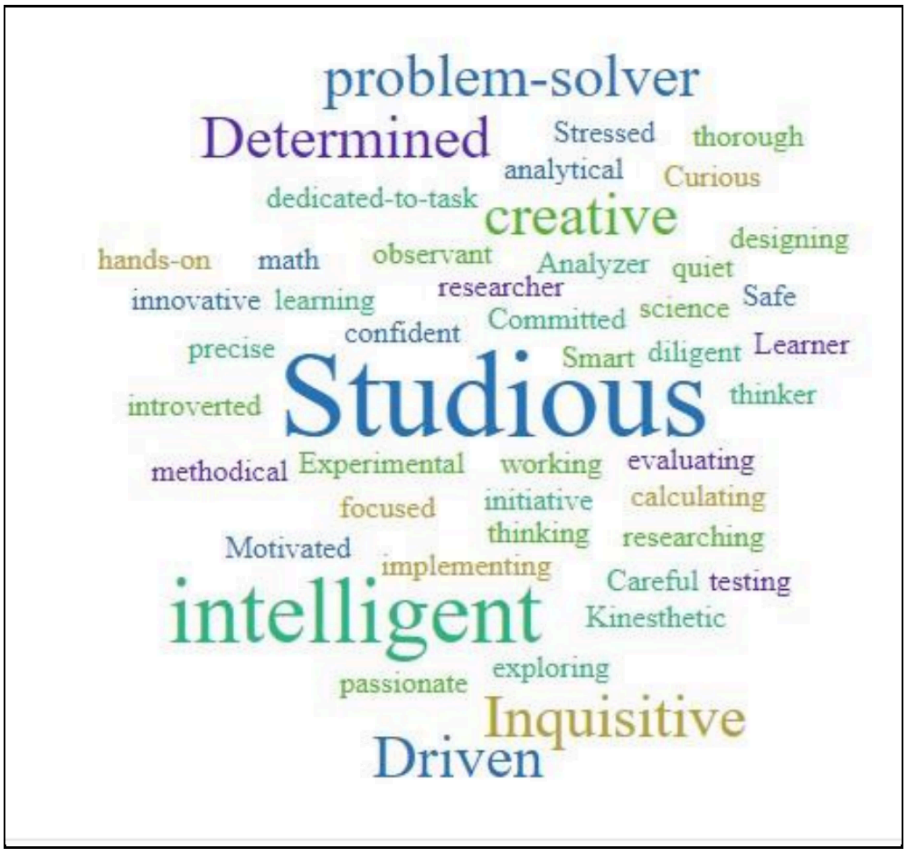
1. How and to what extent did the computer-based intervention influence students' negative sign math proficiency?
2. How and to what extent did the computer-based intervention influence students' math self-efficacy?
3. What were students' perceptions about the computer-based intervention on their learning experience?

Intervention components

The computer-based mathematics learning modules (CMLM) were developed using the topics of negative sign math expressions, Realistic Mathematics Education learning theory, hypothetical learning trajectories, self-efficacy instructional strategies, and the cognitive theory of multimedia learning. The participants in this study included 28 middle school students enrolled in a pre-algebra course. Written, parental consent was obtained for each participant. The students engaged in the intervention three days a week for four weeks completing 12 CMLM which included computer-assisted instruction features for math proficiency strategies focused on student conceptual understanding and procedural fluency. The CMLM included interactive digital slideshows created using PowerPoint that the student could complete without teacher assistance. Use of the PowerPoint presentations allowed for self-efficacy instructional strategies to be incorporated through physiological state growth mindset videos, teacher-created lecture screencasts for vicarious experiences, mastery experience practice problems, and social persuasion feedback that included middle school student images and caption bubbles (see Figure 1).

Figure 1

Example of feedback following a correct response. Picture from Pexels.com, (Taylor, 2020). All rights reserved. Used with permission.



Method and Results

This was a mixed-methods action research study. Quantitative data was collected using four instruments: Pre/Post Mathematics Proficiency Assessment, Pre/Post Sources of Middle School Mathematics Self-Efficacy Scale (Usher & Pajares, 2009), Post Student Perception Survey (Bryant et al., 2020), and Lesson Exit Tickets. Qualitative data were collected from participant think-aloud activities and individual student interviews. The Mathematics Proficiency Assessment consisted of sixteen questions that had three multiple-choice answers. These results support that students scored statistically significantly higher on the post-assessment, $t(27) = -4.50$, $p < .001$. The Sources of Middle School Mathematics Self-Efficacy Scale consisted of four subscales, totaling 24 statements, each with a four-point Likert rating scale. An analysis of the data indicated that students showed a non-significant difference from the

pre-survey (Mdn = 2.50) to the post-survey (Mdn = 2.46; W = 140.50, p = .80). The Student Perceptions Survey consisted of 22 Likert-rating scale statements divided into two subscales: Math Activities (8 statements) and Computer Modules (14 statements). Using descriptive statistics to identify quantitative trends (Creswell & Creswell, 2018), the results support student perspectives about using the CMLM in their learning to have been positive overall. Students were given Likert-rating scale lesson exit tickets covering student math proficiency, student self-efficacy, and student perceptions. The student's perceptions of the intervention helping them improve their understanding of math expressions involving negative signs were positive (in agreement) to the questions offered regarding their math proficiency (M=3.84, SD=0.73), student self-efficacy (M=3.81, SD=0.74), and student perceptions (M=3.92, SD=0.78).

Three themes emerged from the qualitative data: CMLM's provided a productive learning environment for reviewing math concepts and skill mastery, feedback supported students' mathematical proficiency and self-efficacy mastery experiences, and conceptualized learning fostered student's persistence in working through their struggles with mathematical language. Theme one was supported by quantitative data through the Student Perception survey. Interview comments included "Computer modules help me understand what I need to work on" and "Computer modules help me to learn from my mistakes. Theme two was supported by the self-efficacy scale outcomes, which indicated positive increases between the pre/post-survey means related to mastery experience, physiological state, and social persuasion. Supporting comments included "it really helps to know how I did in a problem", "modules made me think", and "math can be boring, but I need to learn it." Theme three was supported by quantitative data through the proficiency assessment, showing a statistically significant increase in pre/post-test means. Student comments also reflected this finding, for example, "Some videos were good, like the ones that talked about money" or "Three is bigger than the one, and three is negative, so it should be negative two dollars."

Discussion

The present research contributes to understanding a technology instruction intervention for negative sign math proficiency and student self-efficacy in a traditional classroom learning environment. The pedagogical implications for teachers include implementing technology interventions for math content review and using think-aloud activities for instructional formative feedback on student understanding. This research replicated aspects of previous work in showing evidence that middle school students see CMLM as beneficial (Aytekin & Isiksal-Bostan, 2019), that contextualizing negative sign applications assists student understanding (Clarke & Roche, 2018), and that self-efficacy instructional strategies can influence math self-efficacy (Huang et al., 2020).

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Promoting Multidisciplinary Digital Learning: A Design-Based Approach to Creating Teacher and Student Support Materials

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Digital learning environments are used frequently in K-12 classrooms. Such use can require skillful orchestration as teachers need to understand the affordances of the learning environment, sequence of activities, and when and how to intervene with students. Using a digital learning environment in a multidisciplinary classroom context makes the design of support materials for teachers and students even more essential. To design for effective teacher orchestration in the classroom, we created a comprehensive set of materials for our multidisciplinary digital learning environment. We employ the design-based intervention research framework to trace the contextual and practical iterations these materials underwent. Additionally, we provide next steps for our work and considerations for the broader community.

Introduction

The use of digital learning environments in classrooms to supplement or reinforce traditional curricula can require adept teacher orchestration. Teachers should have a solid understanding of the affordances of the learning environment, the ordering of activities, and when and how to intervene with students. This may occur with ease in single-subject classrooms where the teacher has specialized pedagogical practices for the discipline. However, in a multidisciplinary context, teachers may need additional pedagogical support such as physical resources (i.e., documents) and substantial professional development (PD) that provides not only content background but emphasizes the use of the digital learning environment and strategies to support teacher confidence for presenting and troubleshooting (Zimmer & Matthews, 2022).

We used a design-based approach to create teacher and student materials for our multidisciplinary digital learning environment to support computational thinking, science, and language arts learning. This approach is predicated on an iterative, open-ended design process that uses stakeholder input and outcomes from stakeholder use of materials (Brown, 1992). The classroom technology and computer science education research communities have utilized this approach for curriculum design (Hansen et al., 2016), teaching (Koehler & Mishra, 2005), and technology-based activity development (Comber et al., 2019). Below, we illustrate our process for designing support materials for teachers using our InfuseCS digital learning environment.

Framework

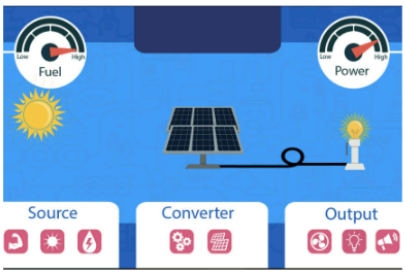
Design-based research (DBR; Brown, 1992) methodologies are powerful approaches for studying, understanding, and theorizing about real-world learning. When using DBR, research modifications occur systematically; changes that are made allow for testing, evaluation, and theory-building (Brown, 1992). Design-based intervention research (DBIR; Fishman et al., 2013) emphasizes the mutual and necessary relationship between research and practice and underscores the role of iterative refinement. We acknowledge the importance of practitioner needs and input as the driver behind refinement.

Method

InfuseCS—designed for upper elementary students (age 9 to 11)—utilizes a problem-based learning scenario to drive student interest. In the storyline, scientists with a well-stocked ship have found themselves marooned on a deserted island and they must use their salvaged materials to power their village. Pedagogically, InfuseCS has three complementary and overlapping components: (1) a Science Explorer where students engage with multimedia content and simulation activities to learn about energy transformation (Figure 1a), (2) a Narrative Designer that uses a block-based programming language for students to create an interactive science narrative (Figure 1b), and (3) Makerspace-type activities that reinforce science content and bolster student narratives (Figure 1c). Our team has designed a set of support materials for each of these components.

Figure 1

The three InfuseCS complementary and overlapping components: (a) Science Explorer; (b) Narrative Designer; (c) Makerspace activities.




Focus groups, pilot studies, teacher PD, and classroom implementations with students (n=106) and teachers (n=8) were conducted across two states in the United States. The research team—comprising experts in computer science, computer science education, education, and science as well as current and former K-12 teachers—made initial design decisions for the support materials based on literature, findings from related projects, and in-class teaching experiences. The support materials we present underwent a series of refinements, informed by teacher and student stakeholders and our observations of the materials in use.

Support material design and redesign

Using a DBIR approach to developing InfuseCS materials has meant the integration of different disciplines (science, making, narrative writing, computational thinking, and coding) and perspectives (student, teacher, and developer). InfuseCS materials have undergone a series of iterations based on feedback, observations, and continued research. The testing and iteration process for materials for the three main components of the learning environment (Science Explorer, Narrative Designer, and Makerspace) are explained in the next sections.

Science Explorer

The Science Explorer (Figure 1a) introduces students to science concepts (energy types and conversion) related to the overarching learning scenario. Building on initial feedback from both teachers and students, we implemented several improvements to the Science Explorer materials. In particular, in PD sessions, teachers expressed some concern over their own perceived science content competence and their efficacy in being able to support student learning. The team then created content "cheat sheets" that included infographics, Frayer models, and factoids, exposing students and teachers to relevant terminology and helping correct misconceptions.

Narrative Designer

The Narrative Designer (Figure 1b) assists students with creating their interactive science narratives using a block-based programming interface. A narrative planning worksheet, designed as an external tool to guide students' narrative construction after they completed the science investigation portion of the intervention, was intended to support the transition from planned narratives, or narrative notes, to block-based narrative programs using story blocks (e.g., character, locations on the island, and dialogue). Initial observations during school visits, along with feedback from students and teachers, led to several iterations of the narrative planning worksheet. However, teacher input and researcher observation indicated the students lacked interest in using the worksheet in the narrative planning process. This information supports removing the worksheet and encapsulating the narrative planning into the learning environment itself.

Makerspace Activities

Maker activities (Figure 1c) were developed and piloted in two categories: storyline cutout kits and energy source and receiver conversion kits. These are outlined below.

Energy Conversion Kits

Energy conversion kits that align with the virtual components seen by students in the simulation portion of the science investigation included both energy sources, or inputs (battery packs, solar panels, windmills, and hand cranks), and energy receivers, or outputs (fans, sirens, lights), along with wires to make connections. Although these kits are considered external elements, they directly align with the circuit-building activities in the simulation activity, and they align conceptually with the different forms of content delivery (text-based and audiovisual). The first energy conversion kit maker activity developed was titled: Reinforcing Physical Science Concepts through Play. A teacher guide and a paper-based student worksheet document were produced for this activity. A separate document was also created to assist teachers in setting up an energy conversion station in the classroom. The student worksheet included gamified checklists to guide the students through the building of simple and complex circuits using the components in the kits. Due to time constraints typical of classrooms, we opted to use a structured approach, rather than unstructured exploration.

The original energy conversion kits utilized a full set of energy sources, receivers, and wires, allowing the students to assemble various types of circuits similar to the ones that the scientists on the island would use. After iterative testing, the flow of the program was divided such that the students would have a set amount of maker time using the conversion kits and exploring the science content, followed by an equal amount of time to draft their written narratives and convert them into block-based narrative programs.

Storyline Cutouts

The storyline cutout maker activities utilized characters and prop assets built into InfuseCS, such as generators and solar panels. The purpose of this activity is for students to construct a story set and prepare to tell their story to peers via a physical manifestation of their story, similar to a puppet show. As part of the storytelling, the students also have access to the physical science materials from the energy conversion kits (e.g., battery pack, motor, fan). In the piloted version of this activity, as a student's animated story plays on the screen within the InfuseCS software, the student would simultaneously act out the story using the physical characters, props, and materials.

Although some students enjoyed the process of setting up the characters and props to act out their stories, there was concern that the cutout kits may not provide enough added value towards achieving the overall learning goals to justify the time required for their inclusion. Research team meetings, teacher feedback, and observations of students interacting with the hands-on materials also placed the circuit building with the energy conversion kits (rather than the storyline cutout kits) right at the center of the intersection of the science content, problem-solving, and narrative expectations of the program. In line with the findings from the analysis and testing of the narrative planning worksheets, it appears that minimizing assets external to the digital learning environment may be beneficial.

Conclusion

Teachers have extensive knowledge of their students, their interests, and the practicality of an activity (Gomez et al., 2018). Likewise, students are experts in their own knowledge and comfort with using novel materials in classrooms. As such, involving stakeholders in the iterative design process is essential. By way of focus group and

teacher PD feedback, as well as observations during classroom implementations, the research team made several significant changes to the materials that teachers and students use in InfuseCS. To support teachers, we created science content cheat sheets. Narrative Designer changes centered around developing a paper worksheet to support students' ability to write from a character's perspective; this will soon be tested as a system-embedded component. Changes within the Makerspace component emphasize students' use of hands-on energy conversion kits that mirror the needs within the problem scenario. These DBIR-inspired changes are slated for classroom testing.

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Prototype Design of XR technology for psychomotor skill learning (PSL): Layering content focus and feedback to prompt deep PSL

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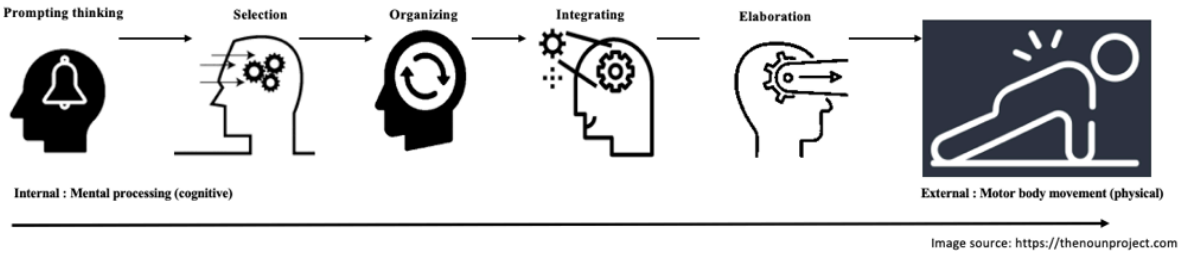
Contemporary research in the realm of psychomotor skill learning uses sophisticated features of Extended reality (XR) technologies (VR/AR/MR), with promising implications towards accelerating learning process and enhancing learning outcome. A functional prototype is presented that replicates the potential representation of underlying PSL mechanism including both mental processing and motor movements. Rather than focusing on immersing learners in the virtual environment, this prototype aims at reversely immersing them in the intricate mechanisms of psychomotor skill to achieve deeper levels of PSL. The proposed prototype challenges the traditional emphasis on observable behaviors, informing the significant role of mental processing. The integration of mental and motor processing enables learners to completely immerse themselves in the psychomotor task leading to more effective and efficient PSL. Learners engaged in psychomotor tasks use external sensory stimuli to promptly refine their body movements for optimal performance. This paper contributes to PSL discourse offering practical insights and implications.

Psychomotor skills learning

Psychomotor skills learning (PSL), gross and fine physical behaviors with or without tools, involves the hierarchical development of skills through mental and motor processing (Miller et al., 1960), indicative of the path towards mastery (Romiszowski, 1999). Dave (1970) proposed that skills are developed in progressive levels encompassing imitation, manipulation, precision, articulation, and naturalization. Although skill development has been studied from multiple perspectives, the underlying mechanisms of PSL phenomenon remain not entirely comprehended. Additionally, the rapid rise of emerging technologies has led to the expansive uses of Virtual, Augmented, and other forms of Extended Reality for simulating skills training. Many examples can be found in sports (Pagé et al., 2019), healthcare (Stanney et al., 2022), and music education (Chen, 2022). Given the complexity of underlying PSL mechanisms and the rapid development of XR technologies, it is questionable as to whether features of emerging technologies have been used most effectively to support PSL - has the use of emerging technologies gone beyond the traditional skills training methods of modeling and practice? While researchers have focused on overt behaviors (physical body movement), they have often provided less emphasis on the mental processing necessary to achieve deeper levels of PSL (Singer, 1978).

Figure 1

Four Elements of Generative Learning (Selecting, Organizing, Integrating and Elaboration)



A prototype XR instructional intervention aims to enhance PSL process by completely immersing learners in both mental and motor processing during PSL. This prototype conveys central tenets that learners are not focused on the immersive virtual environment - learning from the technology; rather, learners are immersed in the PSL task while using technology features to scaffold their PSL processes - learning with the technology (Jonassen, 2013). Despite numerous empirical studies on PSL with XR technology, several instructional interventions are observed to lack features that prompt thinking while providing consistent feedback on the accuracy or correctness of the skill during the learning process. These studies often produced learning outcomes at a surface level, lacking the mental skills necessary to achieve higher efficiency. Seamlessly integrating both mental and motor processing into PSL facilitates the progression of skills from imitation to naturalization, incorporating layers of feedback in instruction. The prototype design developed incorporating three theoretical frameworks, generative learning, cognitive flexibility, and reflection principles (Figure 1), illustrates how sophisticated features of XR technology can prompt thinking while reinforcing the hierarchical development of skills. Issues concerning learner focus on psychomotor tasks, technology, environment, and implications of the proposed prototype are discussed.

Psychomotor skill learning with XR technology

Has the focus of PSL with emerging technologies been effective in immersing learners in progressive PSL? For several decades, one prominent aspect studied in PSL has centered on investigating the influence of intervention on both efficacy denoting the "ability to bring about some end result with maximum certainty" (Guthrie 1952, p. 136) and efficiency, characterized as the "minimum outlay of energy or of time and energy" (Guthrie, 1952, p. 136). Little has been studied on how to prompt the mental processes involved in PSL. Psychomotor skills are developed with physical movement connected to conscious mental processing (Oermann, 1990). Previous studies focused on providing models of expected behaviors to encourage PSL and failed to engage learners in associated mental processes. It was assumed that simply supporting learners with models encouraged them to engage in multimodal processing that helped them create awareness of knowledge gaps and correct misconceptions about their physical behaviors (Sigrist et al., 2013).

Unpacking these underlying mechanisms of how psychomotor skills are learned may help influence learning and performance during instruction (Wulf, 2013). Duffy and Jonassen (1992) suggested that technology may aid knowledge construction by helping learners interpret, integrate, and organize the new information and episodes encountered through experiences into existing mental structures by employing essential cognitive prompts. These tenets are mirrored in principles of generative learning (GLT) and cognitive flexibility (CFT) theories (Koszalka et al., 2019). Best practices in PSL suggest that sequence - simple-to-complex and order - most essential information in detail prior to complex information is warranted (Jonassen et al., 2013). GLT advocates that learners be physically active and aware of their internal mental process in its entirety (Wittrock, 1992) during PSL processes (Ainsworth & Loizou, 2003). Cratty (1967) also suggested the need to prompt learners to think about the skill task, performance, environment, and other internal factors associated with PSL. Without fully immersing learners in PSL tasks, the learner does not begin to construct meaning of new incoming information about the skill (Wittrock, 1992). The quality of mental processing and motor movement impacts the ultimate level of learning, performance, and proficiency of the skill (Singer, 2002). As learners immerse in the PSL task and use emerging technologies, they begin to learn with technological support rather than just how to replicate movements (Jonassen et al., 2013).

Rapid advancements in emerging technologies are impacting PSL training. Although a plethora of technology tools (VR/AR/MR) are available in the market to guide PSL training, these tools do not take advantage of existing features that can deeply engage learners in PSL mental processing, nor do they always offer scaffolding to provide consistent feedback that may aid in progressively developing specific skills. How can these emerging technologies and their sophisticated features be designed into instructional tools (Gagne & Briggs, 1974) that do not merely immerse learners in a virtual environment (i.e., immersive VR/AR/MR), but rather, become scaffolds to immerse the learner in the PSL task via mental and motor processing (i.e., reverse-immersive VR/AR/MR)? In other words, as suggested by Jonassen et al. (2013), how can we envision learning skills with technology as opposed to learning from technology? The proposed XR technology prototype design takes steps toward learning with a technology philosophy to demonstrate how features can be used to prompt thinking and reinforce hierarchical development of deeper levels of PSL while learners are fully focused on the PSL tasks. See Table 1 for the proposed design of XR technology for psychomotor skill learning.

Table 1

Proposed Design of XR Technology for Psychomotor Skill Learning

Levels of mental processing	Learner	Generative activities for PSL / Dave's domain of psychomotor skill	Mental prompt: self-explanation, self-monitoring, self-testing, imagining, enacting
Selecting	generate meaning of new information by accessing and applying existing knowledge.	repetition, rehearsal, and review/ Imitation	Visual display of process or sequential steps/pattern with respect to psychomotor skill learning.
Organizing	organizes the information into a relevant structure by visually developing an association between actual movements and desired body movement.	modifying and creating new schemes/Articulation	Mental prompt guides learners to organize, monitor, and evaluate their own mental processes while learning.
Integrating	connects information with prior knowledge.	outlining and categorizing /Manipulation or Precision	Mental prompting stimulates ongoing appraisal, incorporation, and modification of body movements.
Elaboration	thinks of precise or accurate body movement and makes inferences about the information from existing knowledge.	mental images and creating physical diagrams / Precision or Naturalization	Mental prompting learner's attention to specific aspect of PSL process while learning in action.

Conclusion

This concept paper has explored a significant research gap in the domain of Psychomotor skill learning (PSL): the omission of mental processing and the lack of structured hierarchical skill development. Through a comprehensive examination of this performance gap, the multifaceted challenges that are associated with PSL are presented for learners, educators, instructional designers, and practitioners across various fields. Learners can attain a deeper level of engagement in psychomotor tasks through the integration of mental and motor processing. During PSL, the learners are deeply immersed in the psychomotor task purposefully interacting with the content (Jonassen et al., 1994) that leads to construction and generation of meaning being prompted by features of XR technology. This prototype challenges the conventional understanding of immersion, suggesting that the learners are neither immersed in the virtual world nor immersive environment; rather, they are reversely immersed in the psychomotor task through both mental and physical involvement. Finally, this prototype design suggests a transformative shift in how we perceive psychomotor skill learning. It emphasizes that true immersion in the content (i.e., psychomotor task) arises from actively, both mentally and physically, engaging in the task facilitated by the XR technology.

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Redesigning Learning Space for Teacher Professional Development: From Traditional PD to Metaverse-based PD

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To address the evolving demand for modern-day classrooms and skills, there is a need to redesign the approach used for teacher training and professional development. This proposed research project aims to explore how teachers perceive the implementation of metaverse-based professional development, using qualitative research methods. The study's findings may provide insights for the redesign of teacher professional development practices, aiming to enhance their effectiveness in the classroom.

Introduction

Teacher professional development (PD) has been implemented as a policy solution to improve teacher quality and help students achieve academic success (Colbert et al., 2008), leading many school districts across the United States to make it mandatory for teachers to engage in PD. Teachers' professional development has in recent times transitioned to online platforms. Teachers now attend professional development entirely online without the need to travel to a physical location. Online professional development is provided through synchronous or asynchronous learning or a blend of the two. Synchronous PD is carried out through webinars or video conferences, while asynchronous learning takes place through Learning Management Systems or by watching assigned videos or lectures. As education evolves, the methods used to provide teacher training and professional development must also evolve.

One emerging approach to preparing teachers for the 21st century is the use of virtual learning spaces, such as metaverse-based PD, which offers new opportunities for immersive and interactive learning experiences (Mo & Mo, 2023). According to Lee (2022), Metaverse is a fully immersive virtual world that is persistent and allows users to interact with each other using digital objects in real time. It is a virtual world where users interact with the real world (Mo & Mo, 2023), and a type of virtual learning space that provides a new way of learning and engaging with information. Recent studies suggest that Metaverse is not a new entity in the domains of Virtual Reality (VR) or Artificial Reality (AR), but rather an integration of emerging technologies, including 5G, Artificial Intelligence (AI), VR, AR, digital twins, blockchain, holography, and IoT (Internet of Things) (Mo & Mo, 2023; Park & Kim, 2022). As a result of the emergence of Metaverse and the 21st-century classroom, it is important to consider the design and implementation of teacher training or PD. Hence, this study will investigate how the use of Metaverse as a type of professional development, specifically known as metaverse-based PD, is perceived by teachers.

Literature Review

Teacher Professional Development

Mitchell (2013) identifies professional development as the process through which teachers acquire or enhance their skills, knowledge, and/or attitudes for improved practice. Teacher PD refers to formal and informal training designed to support teachers' professional growth (Coldwell, 2017). It is considered one of the most effective methods of improving teachers' effectiveness in the classroom (Dash et al., 2012). PD can take various forms, such as workshops, seminars, online (via video conferencing), or in-person conferences.

Metaverse

One of the popular definitions of Metaverse is "the post-reality universe, a perpetual and persistent multiuser environment merging physical reality with digital virtuality" (Mystakidis, 2022, p. 486). It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects, and people, such as virtual reality (VR) and augmented reality (AR) (Mystakidis, 2022). Ng. (2022) also defines metaverse as "a 3D digital virtual world that enables people to "live " and "learn " through their avatars in immersive learning environments" (p. 195).

Metaverse has changed the trajectory of online learning in recent years by providing learners with a more interactive, immersive, and engaging learning experience (Mo & Mo, 2023; Calisir et al., 2022; Zhang et al., 2022). Kye et al. (2021) reviewed four categories of metaverse (i.e., augmented reality, lifelogging, mirror world, and virtual reality) that have been applied in education for years. The authors recommended examining how to teach and learn using the metaverse. In educational settings, metaverse activities have been applied, such as game-based collaboration (Jovanović & Milosavljević, 2022) and problem-solving (Park & Kim, 2022).

Engage VR (https://engagevr.io) and Oculus Quest 2 VR Headset were used for participants to engage with the metaverse experience. Engage is a spatial computing platform designed for educational and professional development purposes. Users can attend classes, events, or training in the virtual worlds that organizations or event organizers created. In order to participate in the Engage VR, participants will wear Oculus Quest 2 and interact with virtual content (Meta, 2023).

Theoretical Framework

Immersive technology is becoming widely adopted in education. However, the theory related to immersive technology that shapes this study is learner engagement. When learners experience an immersive environment like in Metaverse, they engage in the learning content. Meaningful engagement occurs when learners become active learners. Research shows that learner engagement increases the chances of improved learning outcomes (Oprean & Balakrishnan, 2020). Nevertheless, learner engagement does not isolatedly impact learning outcomes because there are other factors involved that increase learning outcomes such as teaching method, implementation, individual learner, and learning content (Oprean & Balakrishnan, 2020).

Learner engagement consists of four elements based on the learner experience's quality including (1) affective states, (2) behavioral states, (3) cognitive engagement, and (4) agentic states (Han et al., 2023). In the affective states, a learner is interested in and enjoys the lesson. In the behavioral states, a learner engages in a task. In cognitive engagement, a learner concentrates on the lesson. In the agentic states, a learner contributes to his/her learning. Han et al. (2023) claim that Metaverse practices could impact learners' experience and improve their learning skills.

Purpose

This research aims to explore how teachers perceive the use of metaverse as a type of professional development, which is referred to as metaverse-based PD. Through examining teachers' perspectives, the study aims to offer valuable understanding to school administrators to aid them in redesigning and implementing teacher professional development. This study will find answers to the following research questions:

1. What are teachers' perceptions of a metaverse-based PD?
2. Do teachers perceive the metaverse-based PD to be engaging in learning?
3. Do teachers perceive the metaverse-based PD to be collaborating with other colleagues?
4. Do teachers perceive that metaverse-based PD enhances their instructional practices?

Method

To address the research questions, a qualitative research design is proposed to provide an understanding of the meaning of respondents' experiences and lifeworlds (Warren, 2011). Researchers will collect data from participants to explore how they perceive the use of metaverse as a type of professional development to have a better understanding of redesigning and implementing a PD that meets technology advancement. Proposed participants will be ten or more certified middle and high school teachers in the Southern region of the United States of America, randomly selected regardless of gender or subject background. Participants will complete a 30-minute metaverse-based PD session using Engage VR (https://engagevr.io) and Oculus Quest 2 VR Headset to enhance their teaching efficacy in the classroom. Engage VR was selected for this proposal because the platform supports different devices, which makes it easily accessible to the participants. During the data collection, participants will be required to participate in pre-intervention, intervention (the PD session), and post-intervention activities. After the PD experience, researchers will interview each of the participants to obtain their views on the application of metaverse as a new approach to conducting teachers' PD. Then, the researchers will analyze the collected data following the thematic analysis technique (Guest et al., 2011).

Figure 1

Pre-Interview Questionnaire

Demographic questions

- What gender do you identify as?
  - Male
  - Female
  - Other:
  - Prefer not to say.
- What is your age?
  - 18 - 24 years old
  - 25 - 34 years old
  - 35 - 44 years old
  - 45+
- What is the highest degree or level of education you have completed?
  - High School
  - Bachelor's Degree
  - Master's Degree
  - Ph.D. or higher

Questions related to metaverse experience.

- Have you ever used Metaverse before?
  - yes
  - no
- If YES, what was your experience with using the metaverse?
- If NO, what is your expectation if you have an opportunity to use a metaverse?

Figure 2

Interview Questions

- How was your experience of using a metaverse-based Professional Development?
    - How was your interaction while using a metaverse-based PD?
- Can you describe the challenges you experience while using a metaverse-based PD?
- How would you expect to use a metaverse application in your professional life?
- How would you describe your overall perception of participating in a metaverse-based professional development (PD) compared to traditional PD formats?
- In your experience with metaverse-based PD, how would you describe the level of engagement and collaboration among teachers?
- Can you provide specific examples that illustrate the collaborative aspects?
- Explain what influence metaverse-based PD would have in your future PD plans.

Timeline of Proposed Study

This proposal is based on an ongoing study where data will be collected in the summer of 2024 due to the teachers' busy schedules and the ongoing IRB application process. The findings of this study may support efforts to improve the design and implementation of teachers' professional development across the globe.

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Reflections and Transformations in an Open University

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Although Anadolu University is a dual mode higher education institution, it has been acting as an open university since 1982 and offering quality undergraduate education to millions in Turkiye. In 2023-2024 Fall semester, over a million students registered to its traditional distance education programs. Over four decades many changes and advances have happened nationwide and globally. Anadolu has been in a constant transformation mode since the beginning. This paper aims to summarize the major transformations the institution experienced as well as reflections of the stakeholders concerning these transformations.

Introduction

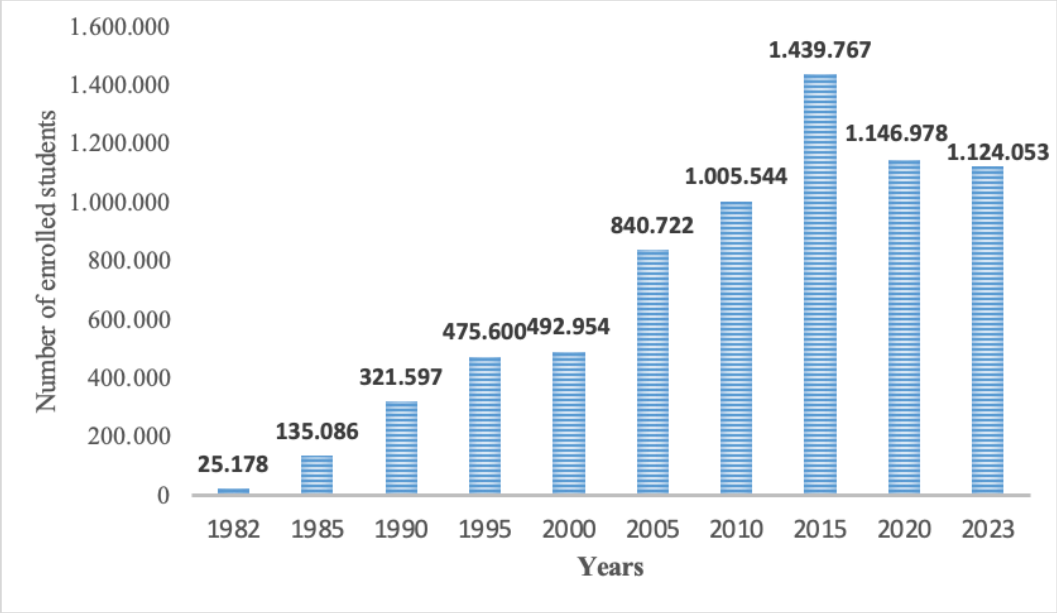
Anadolu University's open education system stands as a pioneering and innovative approach to higher education in Turkiye. With a rich history dating back to 1982, this system has been a trailblazer in providing accessible and flexible learning opportunities to a diverse range of students. Anadolu University has consistently adapted to the changing educational landscape by leveraging technology to deliver high-quality courses and programs, ensuring that education knows no boundaries. This system epitomizes the university's commitment to democratizing education and fostering lifelong learning. The following sections of the paper report the transformations in its learners, learner support systems, assessment strategies, human resources development, research and development, and informal and non-formal learning opportunities.

Learner Demographics

Open and distance learning in Turkiye dates back to the early years of the nation, but no initiative has been sustainable until the establishment of Anadolu University’s open education system in 1982. It was initiated to meet the increasing demand for higher education (HE). During the 1970s and early 1980s, there was a big shortage of seats in higher education institutions while the demand was skyrocketing. So, it was a “necessity” during the early years, and mainly traditional students (high school graduates) were enrolling in the programs.

Figure 1

Number of student enrollment between 1982-2023 at Anadolu University Open Education System



Over time, the number of HE institutions has increased rapidly, and so many traditional students have had changes to enroll in traditional face-to-face degree programs. While the number of traditional students in Anadolu's open education system has started to drop, the number of non-traditional students (aged 24 and more years) increased substantially. The rise of reskilling and upskilling needs fostered this change. So, open education has transformed into a "convenience" from a "necessity" in the country. To date, nearly 4.1 million students have graduated from the open education system. Figure 1 reveals the changes in enrollment at Anadolu University.

In terms of gender, the percentage of female students was quite low during the first years but boosted especially during the mid-2000s. Although this increase in female student numbers has been constant, the percentage of male students (approximately 5.1%) is still slightly higher than that of females (approximately 4.9%).

Learner Support

Learner support systems are vital for the success of open and distance learning institutions (Moore & Kearsley, 2012). These systems encompass pedagogical, administrative, technical, and social aspects (Berge, 1995). Services related to course content fall under pedagogical support; services concerning registration processes, administrative tasks, study schedules, and organization pertain to administrative support; services aimed at resolving learners' issues with software and hardware constitute technical support; and services related to enhancing interpersonal relationships, group dynamics, and non-academic interactions among learners and between learners and educators can be considered within the scope of social support. The digital transformation of the learner support systems within the Anadolu University Open Education System provides pedagogical, social, administrative, and technical support for its learners.

Traditional support tools like SMS messages are still widely used to keep learners updated on important developments and deadlines. Radio A programs continue to provide information about the Open Education System. Official social media accounts on platforms like Facebook, Instagram, and others have become common tools for administrative and technical support. Students receive information through posts and can seek answers to related questions. The latest innovation is the introduction of chatbot technology, launched on the website in November 2022. The chatbot has significantly reduced the volume of telephone calls and the use of the Question Tracking System, demonstrating its effectiveness in support services.

Assessment

In 1982, Anadolu University decided to use centralized exams for assessing the students' learning, or achievement. Until 2010, the system had only one semester, lasting 28 weeks. So, in each semester, two mid-term exams and a final exam were organized throughout the country as well as in Europe. After 2010, Anadolu adopted a two- semester structure, like traditional HE institutions, and since then, has been organizing only one mid-term and one final exam in each semester. Over the last five years, Anadolu has also started to offer short-term summer semesters. The same exam organization (one mid-term and one final) is also adapted for the summer semester, too.

Due to the large scale, multiple-choice questions had to be used in the exams. Beginning in 2018, in some of the courses in which there are fewer students enrolled, open-ended questions were added to exams. However, due to the scale, the number of courses that included open-ended questions for assessment could not be increased.

Until the late 1990s, Anadolu collaborated with the national testing agency (Student Selection and Placement Centre, OSYM) to organize the exams. Later, the university established its own testing center and specialized in administering large-scale national and international exams. Today, Anadolu uses approximately 3000 buildings (usually lecture halls in local HE institutions and schools) and 300000 staff (academics, teachers, safeguards, transporters, etc.) in 111 centers (cities) to administer one of its centralized exams for nearly 700 courses. Each exam is organized in three sessions during a weekend (Saturday morning afternoon, and Sunday morning), and nearly 2 million question booklets and answer sheets are used.

During the pandemic period, Anadolu had to transform all of its exams into online exams. One of the major steps of this transformation was to develop an exam software that could handle 1 million students. It was created and used in different ways. Early implementations were a bit problematic in terms of student misbehavior (cheating) but agile decisions taken and a series of security measures, such as water marks, screen lacks, etc. adapted solve this problem in a large extent. This period has been very informative about organizing online exams. As a result, Anadolu has transformed its in-person exams for international students into online proctoring exams. Today, the university organizes synchronous online exams for its students who live in 6 different time zones. An AI-based proctoring exam system was adopted in collaboration with a private local company for these exams. During the COVID-10 pandemic, Anadolu also provided exam services to those who could not come to exam centers.

Human Resources Development

Every organization should consider skilling, reskilling, and upskilling their human resources. Skilling is, in general, different than others more related to pre-recruitment. However, Anadolu, right after establishing its open education system in 1982, has built a system to train its current and future human resources. Four academic departments were founded under the Open Education Faculty to offer face-to-face 4 years long degree programs based on the contemporary needs of the system. The Radio and Television Department focused on training staff and academicians for education radio and television, the Educational Communications and Planning Department to train instructional designers, the Publishing Department targeted to train staff for the publishing house of the university, and the Communication Arts Department intended to train people who will work on public relations concerning the open and distance learning. Many staff currently working in Anadolu's open educational system graduated from these undergraduate programs.

Until 2006, no formal human resources implementation was initiated, but only informal (on-the-job) training was provided to newcomer staff. In 2006 a master's program on distance education was established under the Social Sciences Institute of Anadolu for mainly train quality academicians in the field of open and distance learning. Later in 2010, a PhD program on distance education was also built to serve the same purpose. And finally in 2014, a completely online master's level program on distance education was established to train practitioners in the field. Mainly this program accepts students from other institutions.

Research Tendencies

Anadolu University in Turkey has played a central role in shaping the research agenda for ODL within the Turkish context. There are some earlier attempts to understand and gain more insights regarding the research tendencies in distance education and open and distance learning in Turkish Higher education. Nevertheless, these previous investigations (Aydin et al., 2020; Bozkurt et al., 2019) provide only a partial perspective. In a study by Bozkurt et al. (2015b), an uneven distribution of research areas was observed in doctoral theses spanning the years 1986 to 2014. Predominantly, research areas like instructional design, distance education systems and institutions, education technology, and learner characteristics received most of the attention.

More recently, Bozkurt et al. (2022) examined doctoral dissertations in the Turkish higher education context with a specific focus on distance education. The findings of Bozkurt et al.'s study can be concentrated into three meta-themes. Accordingly, these are:

- The use of (online) technologies and implementation of educational technologies,
- Increasing efforts on learning processes as a focal point on learners,
- The pursuit of methodological perfection rather than exploring the field with a critical perspective and theoretically forged practices.

Non-formal and Informal Learning

The open education system of Anadolu does not only provide formal education but also many non-formal and informal learning opportunities to millions. Starting in 1982, Anadolu aired educational television and radio programs to all. Especially television programs via one of the Turkish Radio and Television Agency channels (TRT4) were reached all around the country. This channel was not targeting solely education, but Anadolu's success in its educational programs fostered a transformation, and the channel was changed to an education channel, later entitled TRTOkul (TRT School). Those broadcast TV programs helped many people learn different topics. So, it was a non-formal learning opportunity provided by Anadolu. Unfortunately, later in 2014 Anadolu stopped airing its programs due to financial reasons. In terms of informal learning, Anadolu has initiated a number of projects, including YunusEmre OpenCourseware, AnaPOD Open Podcasting, AKADEMA MOOCs, Digital Course Platform, OpenScience, OpenLibrary, and similar projects. Among these, the AKADEMA MOOCs platform continues to offer open courses (currently 135) to thousands of people, and the Digital Course Platform still receives millions of hits every year.

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Reflections on how M. David Merrill's First Principles of Instruction (FPI) Can Transform Student Learning

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Three previous action research studies illustrated the transformative power Merrill's First Principles of Instruction (FPI) had on three graduate-level Instructional Design and Technology courses. Data collected indicated statistical increases in overall student mastery, student course satisfaction, and student perception of course tasks. These studies included courses dealing with an introduction to audio, video, and interactivity, learning management systems and organization, as well as instructional design and evaluation. Encouraged by these results, the researchers desired to know if Merrill's FPI could be applied to a master's capstone project course (Media Asset Creation). Upon completion of this stage in the study, results indicated that Merrill's FPI had a transformative positive influence on the Media Asset Creation course, although not as strong as the findings from the previous courses, due to the small numbers of students in the study. Indicators show that any course may benefit from the application of Merrill's FPI.

Introduction

Merrill's First Principles of Instruction (FPI) were applied to three Instructional Design and Technology courses at a private university located in the southeast area of the United States. Based on the findings from these previously FPI-transformed courses, the researchers replicated the study with a follow-on graduate course called IDT680 - Media Asset Creation, in which students completed their Master's Capstone Project. In the spirit of action research and reflection on the success of the previous course re-designs, this study also included qualitative student reflections on their development processes using FPI.

IDT680 – Media Asset Creation, the course where students develop their Master's Capstone Project, is four weeks long. As part of the action research, every part of Merrill's FPI was applied. Data collected came from six months prior to the re-design using Merrill's FPI to six months after the application of Merrill's FPI was applied. One may wonder what Merrill's First Principles of Instruction are. They are noted as follows:

Task-centered: Learning is promoted when learners acquire skill in the context of real-world problems; Activation: Learning is promoted when learners activate existing knowledge and skills as a foundation for new skills; Demonstration: Learning is promoted when learners observe a demonstration of the skill to be learned; Application: Learning is promoted when learners apply their newly acquired skill to solve problems; Integration: Learning is promoted when learners reflect on, discuss and defend their newly acquired skills (Merrill, 2018; 2020).

Results of Applying Merrill's FPI

As in previous courses Merrill's FPI was applied in re-designing them (McBride et al., 2020; 2022; Cropper et al., 2021); for IDT680 the researchers gathered data from the following areas:

1. Overall student mastery of content (MoC);
2. Positive instructor experience (PiE);
3. Positive overall experience (PoE);
4. Perception of Merrill's FPI being applied to the course (FPI effect).

Prior to the application of Merrill's FPI, IDT680's MoC was 94.16 percent. After the implementation of Merrill's FPI, the MoC rose to 94.46 percent. The PiE stayed about the same, with the previous six months at 4.95 (on a scale of 1 to 5, with 1 as "strongly disagree" and 5 as "strongly agree), with the PiE dropping slightly to 4.94. However, the PoE went from 4.89 for the previous six months to 5.0 for the six months after the implementation of Merrill's FPI. The "FPI effect," however, was a solid score of 5. It is important to note that despite the scores not being as high as the researchers had hoped for, the re-designed IDT680 course was more rigorous and robust as compared to the older version of the course, indicating the positive effect Merrill's FPI has on student retention and engagement. It is important to note further that the "N" was small, consisting of only 22 students. As the action research continues, and as the "N" increases, the researchers expect an increase in the aforementioned areas.

Before the application of Merrill's FPI, IDT680 was originally put together based on outcomes and objectives, not task-centered. It consisted of learning activities, but no conscious decision in using any particular instructional design model was followed. In other words, it consisted of good ideas and activities but did not follow a conscious instructional design model. Merrill's FPI changed all that, and the results, as discussed above, indicate that.

Literature Review

A literature review also encourages further exploration of the "FPI effect." A review of instructional theories and models revealed that FPI was represented in many of them (Merrill, 2002). Studies researching the effectiveness of FPI revealed renewed confidence in Merrill's FPI and task-centered approach (Merrill, 2018; 2020).

In recent studies, Frick et al. (2022a; 2022b), and Frick and Dagli (2022) provide evidence of the transformative effectiveness of FPI through analysis of student performance on an Indiana University Plagiarism Tutorials and Tests (IPTAT) Massive Open Online Course (MOOC). The latest study (Frick & Dagli, 2022), included 131,000+ learning journeys with adult students participating from 169 countries worldwide from August 21, 2022 to October 18, 2022. Using Google Analytics for tracking student use of the IPTAT website – a new version of Google Analytics (GA4) was leveraged to do an Analysis of Patterns in Time (APT) along with Excel spreadsheets (Frick & Dagli, 2022). The main APT findings showed that students who tried any part of an IPTAT designed with FPI (Merrill, 2020) were two times more likely to pass a certification test. Further, students who tried all parts of the IPTAT designed with FPI were four times more likely to pass a certification test. By the same token, students who tried no parts designed with FPI were 1.2 times more likely to fail a certification test.

Discussion

Merrill (2018; 2020) contends, and research confirms, transformative student learning takes place when learners are engaged in solving real-world problems; existing knowledge is activated as a foundation for new knowledge; new knowledge is demonstrated to the learner, applied by the learner, and finally, integrated into the learner's world. In previous courses, as discussed earlier, the researchers noted positive results in the Action Research items/indicators listed above, where Merrill's FPI was implemented, as compared to the earlier versions of the courses prior to such implementation. They expected to find similar results in the IDT680 - Media Asset Creation course, the course that was redesigned during this study. Further, the researchers evaluated how well and to what extent Merrill's FPI impacted students' learning in the development and quality of their individual capstone projects, which was the purpose of the redesigned course. What is significant is students experienced the transformative effect of Merrill's FPI in a course directly dedicated to reflection on skills learned in past courses, and in the development of a capstone project.

But aside from the statistics, what did students feel or perceive about the "FPI effect," and how did it influence the development of their capstone projects? The following is taken from qualitative student reflections regarding their experience in IDT680 – Media Asset Creation:

"Merrill's First Principles of Instruction (FPI) is an organized yet straightforward framework to ensure task-centered training. Each of the five phases included in the diagram combines to create a solid design foundation. Instructional designers begin by determining a learning outcome. Next, they activate prior knowledge and follow with a demonstration. Once learners have new knowledge, they apply it in the application phase. Finally, designers assess learning in the integration phase. The framework is easy to follow, making it an excellent choice to help develop a capstone project."

"By incorporating activation, demonstration, application, and integration, I ensured that students were actively engaged, gained a thorough understanding of the material, and had ample opportunities to apply their knowledge and skills in authentic situations."

"My successes amount to feeling empowered by producing a project I feel proud of, and I haven't been able to say that in a long time with my coursework because of the bumps in the road along the way. I also love building eLearning content that was fleshed out with my online learning with Articulate. My most important success has been the absence of feeling overwhelmed or stressed with this project, and I feel like that goes back to the IDD Blueprint and Merrill's FPI."

"These would serve not only as road maps for the path ahead but repeatedly going over the plans for the project helped me to quickly identify potential issues and mitigate those issues. Eventually, during this course and the execution phase of the project, those plans became a checklist that I was able to follow to verify that each task was being completed. If you fail to plan, [you] then plan to fail."

Conclusion

Students who have experienced FPI and who have had the opportunity to reflect upon past course experiences that have been transformed by applying FPI expect the same quality of course, especially in their capstone project course. For many, the capstone project becomes the centerpiece of their professional portfolios, which often leads to greater opportunities in the field of Instructional Design. Having experienced the transformative power of FPI in this course will allow students to further hone and sharpen fundamental skills, knowledge, or perspectives that should be pursued to ensure they can contribute meaningfully and responsibly to the effective and impactful design of learning experiences.

For-profit universities, like the one involved in this research, are uniquely motivated by what provides the best results with the highest return on design time invested—their existence depends on it! Having reflected on data indicators collected from previous studies and from the findings in this redesigned course, the researchers suggest that Merrill's FPI can be generalized as transformative design guidelines.

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Revealing the Hidden Processes of Making - A Case Study in a Pop-Up Makerspace STEAM Studio

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This study examines making and learning processes in Pop-Up STEAM Studios often overshadowed by the final product. Through a community-based STEAM solar lantern challenge, researchers revealed valuable and hidden processes of making through dynamic interaction between "episodes" (planning, making, redesigning, and testing), Learning Practices of Making, and timestamp moments of creating solar lantern using a convergent parallel mixed methods design and data from the digital story.

Introduction

Making refers to the active construction to create something shareable (Martinez & Stager, 2019). Our NSF-funded pop-up makerspaces focused on exploring community-based STEAM (Science, Technology, Engineering, Arts, and mathematics) challenges in a high-poverty rural county in the U.S. Midwest. Unlike permanent makerspaces that are restricted to a stationary location and limited audience, pop-ups are inexpensive and temporary setups open for wider participation (Pandey & Srivastava, 2016). In this case, residents engaged in a community-wide STEAM-making challenge of designing an artistic working solar lantern. This case study explored and showcased the making process, which is often overshadowed by the focus on presenting the final product (Alter et al., 2009). There is value in uncovering the learning that occurs in the messy and iterative processes of making (Blikstein, 2013; Garcia & Coneway, 2019; Maltese et al., 2018). This process-focused approach reflects design thinking and the development of learning processes happening in different "episodes" of our design framework: planning, making, redesigning, and testing. Design thinking is a crucial component in a makerspace setting, offering opportunities to uncover dynamic interactions between the episodes of the design framework and Wardrip and Brahms' (2015) Learning Practices of Making (LPM): Tinker, Inquire, Seek & Share Resources, Hack & Repurpose, Express Intention, Develop Fluency, and Simplify to Complexify within a pop-up STEAM studio. The research question guiding this study is: How did the deconstruction of a digital story reveal the design thinking process in a pop-up STEAM studio design challenge?

Papert's (1993) Theory of Constructionism and the practices of Reggio Emilia, Italy, frame this study and are often cited as influential to the maker movement (Martinez & Stager, 2019). Papert believed the learner keeps on constructing new knowledge internally based on prior experiences and that constructing shareable tangible artifacts supports the learner's conceptual understanding, facilitating knowledge development in a more concrete way (Papert, 1993). In Reggio's preschools, teachers practice a pedagogy of negotiated learning (Forman & Fyfe, 2012), carefully crafting provocations that captivate children's curiosity, stimulate their interests, ignite their imaginations, and foster inventiveness through the mediums of construction, exploration, and art, often sparked from questions and wonders of children as they explore the environment, engage in conversations, and express intentions. Students persist in exploring and testing theories of interest and record their process of learning in the form of diagrams and drawings. Teachers document the explorations and understandings using photos, observational notes, and video transcripts, creating visual displays, like digital stories, that document students' work-in-progress. These displays and artifacts provided students with additional opportunities for "reflecting on their design process and thinking process" (Resnick, 2007, p. 5). We deconstructed this method by taking apart the visual displays to reveal the making process.

Methods

Cross (2007) identifies design as an application of "the arts of planning, inventing, making, and doing" (p. 1). The deconstruction of the digital story revealed the "iterative and non-linear" design thinking process of this maker (Brown, 2009, p. 5). In our larger study, we found that participants engaged in iterative and non-linear episodes of planning, making, redesigning, and testing (Panwar & Vasinda, 2023). This study was conducted in six community-based Solar Lantern Making Challenge Popups, including three rural libraries, a county family resource center, a university-sponsored botanical garden, and a public park in a high-poverty rural county in the U.S. Midwest. Multigenerational community members engaged in making solar lanterns with materials provided in the pop-up studio, including solar path lights, various art supplies, and upcycled containers. Researchers observed, photographed, videotaped, questioned, and interviewed the participants about their processes, looking specifically for the LPM and in which episode of the design framework they were engaged. In this

case study, we purposefully selected a female participant (age 5-12 years) as an information-rich case because of her continuous engagement in designing and making the solar lantern (Wan, 2019). This allowed us to gain an in-depth understanding of the design thinking process in a pop-up makerspace and helped to uncover the hidden processes of making explicitly.

We used an episode-based design framework (Figure 1) for the units of analysis to analyze the LPM. Planning describes the decision-making involved in an intention or goal. Observations of planning episodes included participants' engagement as they entered the space and contemplated the challenge. They looked at the materials available and made decisions often while verbalizing their intentions (plan) and how they wanted to go about their making. Making episodes was their initial construction process, but it also overlapped with the redesign. The redesign might occur at any point in planning or making as changes were articulated or observed when participants made adjustments or changes to their project. Redesign often came as a result of testing. Testing involves evaluating the performance or quality of the creation. It might occur during the making episode after completion of the product, or at any stage of development along the way. The LPM communicates the making process and progress through seven actions: Inquire, Tinker, Seek & Share Resources, Hack & Repurpose, Express Intention, Develop Fluency, and Simplify to Complexify (Table 1).

Figure 1

Iterative Episodes of Design Framework

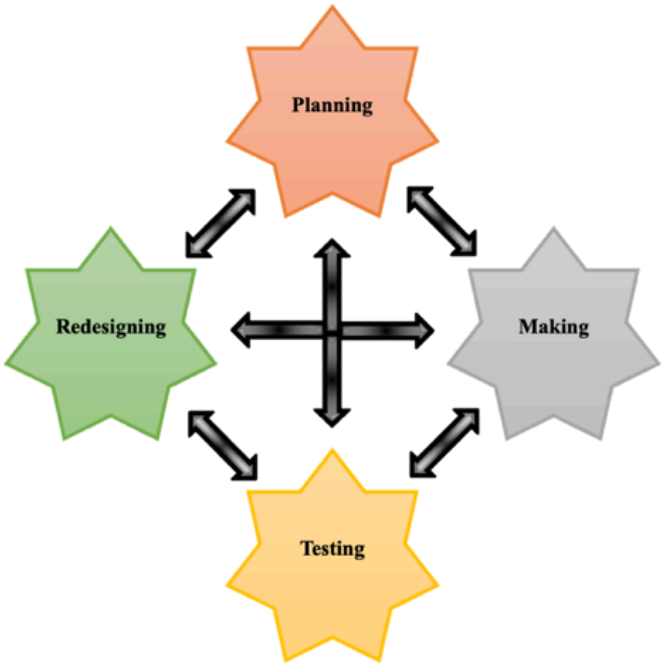


Table 1

Learning Practices of Making (Brahms & Wardrip, 2015, p. 376)

Learning Practice	Practice Description
Inquire	Openness and curious approach to possibilities of the context through exploration and questioning of its materials properties.
Tinker	Purposeful play, testing, risk-taking, and evaluation of properties of materials, tools, and processes.
Seek & Share Resources	Identification, pursuit/recruitment, and sharing of expertise with others; include collaboration and recognition of one's unfamiliarity and desire to learn.
Hack & Repurpose	Harnessing and salvaging of materials, tools, and processes to modify, enhance or create a new product or process; includes the dissociation of object property from familiar use.
Express Intention	Discovery, evolution, and refinement of personal identity and interest areas through the determination of short and long-term goals; includes responsive choice, negotiation, and pursuit of goals alone and with others.
Develop Fluency	Development of comfort and competence with diverse tools, materials, and processes; developing craft.
Simplify to Complexify	Demonstration of understanding of materials and processes by connecting and combining component elements to make new meanings.

Using a convergent parallel mixed methods design, data were collected simultaneously from survey and visuals, analyzed separately, then merged to support the study's findings (Creswell, 2017). We arranged the gathered visual data based on the video time stamps to showcase the development of the making process through digital stories. The analysis took place in two stages. First, we deconstructed the digital story into visuals and transcripts. Second, we uploaded each visual piece according to the time it occurred, along with the transcript, into QSR NVivo (Release 1.0) for coding. Time stamps of the visuals were crucial in the coding process. Two parent codes were generated:

2. LPM along with the child codes of Inquire, Tinker, Seek & Share Resources, Hack & Repurpose, Express Intention, Develop Fluency, and Simplify to Complexify.
3. Episodes of design framework with the child codes of planning, making, redesigning, and testing.

A sequential connection between the LPM and the episodes of the design framework was established as we moved from one timestamp visual to another. The resulting coded data from NVivo was transported to R studio to generate a graphical representation communicating the iterative nature of the design thinking process (Figure 3). We analyzed the digital story, graphical representation of the digital story and questionnaire data of the pilot case to establish the findings.

Findings

The deconstruction of the digital story and timestamp visuals revealed the dynamic iterative interaction between observable episodes of the design framework and the LPMs through the timestamp scatter plot (Figure 3). Learning practices such as Tinker and Hack & Repurpose were most evident, followed by Inquire and Develop Fluency. Next evident were Express Intention, then Seek & Share Resources, and finally, Simplify to Complexify. When the timestamp scatter plot of the deconstructed digital story and questionnaire data (Figure 4) were compared, interestingly, the participant didn't report on the LPM Simplify to Complexify, but the scatter plot (Figure 3) depicts acquiring a complex design during the end of the process, enacting Simplify to Complexify. We found a non-linear transition within different episodes of the design framework (Figure 5) from making (timestamp visuals numbering from 1-5) to testing (timestamp visual number 6), back to making (timestamp visual numbering from 7-9), then to redesigning (timestamp visual number 10), returning again to making and testing (timestamp visual numbering from 11-13), then redesigning (timestamp visual number 14), making again (timestamp visual number 15), redesigning again (timestamp visual numbers 16, 17), then redesigning and making (timestamp visual number 18). We were unable to observe episodes of planning, but making, redesigning, and testing were observable (Figure 5), but the participant reported episodes of planning were imperceptible to us.

Figure 3

Timestamp Scatter Plot of the Deconstructed Digital Story After Analysis

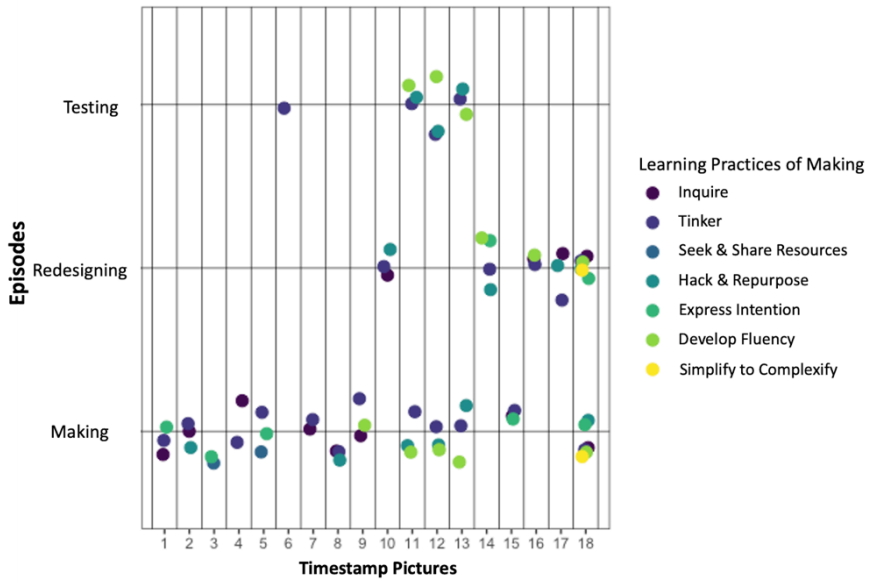


Figure 3. Timestamp Scatter Plot of the Deconstructed Digital Story After Analysis

Figure 4.

Questionnaire Data of the Participant

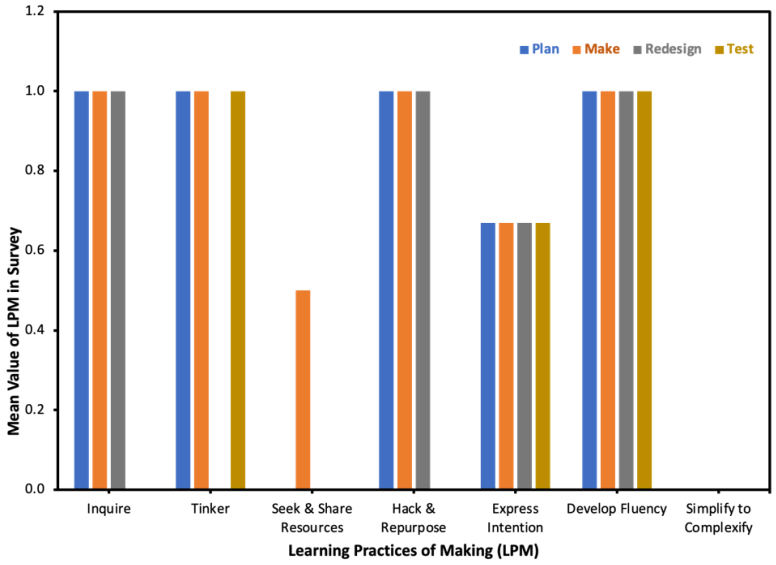
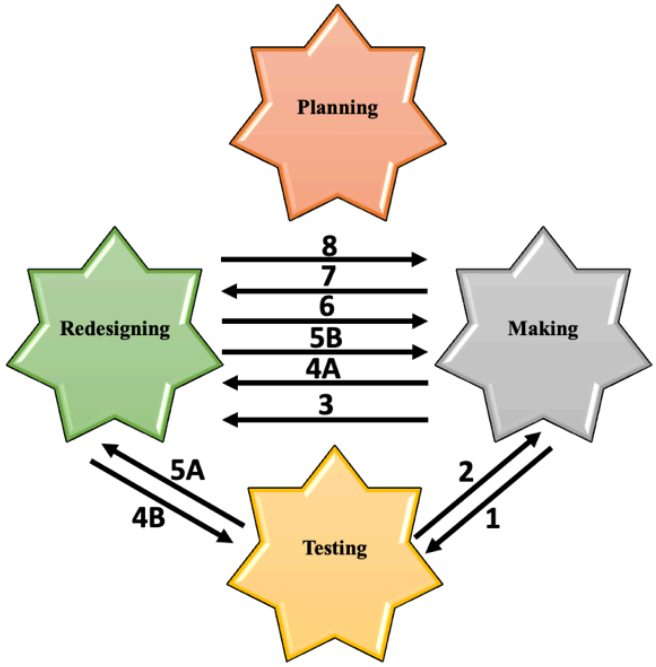


Figure 4. Questionnaire Data of the Participant

Figure 5

Iterative Episodes from the Scatter Plot



Conclusions

Representing the interactions between episodes of making and LPM reveals much more than the back-and-forth interactions. When the often invisible process of making is made visible, there are still hidden aspects that only the maker knows (planning and intent). Conversely, there may be some processes hidden to the maker (Simplify to Complexify) because they may be unaware of their growing expertise. Therefore, additional research is needed to understand the planning processes in making and helping makers understand the practice of Simplify to Complexify as part of their growing expertise.

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Second University Programs for Personal and Professional Development: Reflections from Anadolu University Open Education System

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In a world that is constantly changing, transforming, and growing, people's personal and professional development needs to be supported on an ongoing basis. The continuous updating of knowledge and the need for different qualifications have brought continuing education or lifelong learning to the agenda. In this context, Anadolu University Open Education System Second University Programs, an important indicator of openness in education, have been launched to meet these needs. This study aims to explore the reflections of the Second University programs of Anadolu University's open education system on the personal and professional development of learners. The data were collected from open and distance learners in Anadolu University Open Education System through an open-ended question. Content analysis was used to analyze the data. The results show that those enrolled in Second University programs benefit personally and professionally.

Introduction

Open and distance education has become increasingly popular in recent years, as it offers flexible learning opportunities for individuals who cannot attend traditional on-campus programs. Besides, open and distance education programs can be effective tools for personal and professional development, as they allow individuals to learn at their own pace and on their own schedule (Klein & Ware, 2003). Anadolu University's open education system, which is a pioneering and innovative institution in providing open and distance higher education in Türkiye and in the world, is an important institution in the context of open and distance education. Established in 1982, the open education system of Anadolu University has provided flexible and accessible learning opportunities to millions of students. It has also played a leading role in democratizing education and promoting lifelong learning (Bozkurt, 2017). This study examines the reflections of the Second University programs supporting lifelong learning in Anadolu University Open Education System on the personal and professional development of learners.

Anadolu University's Open Education System

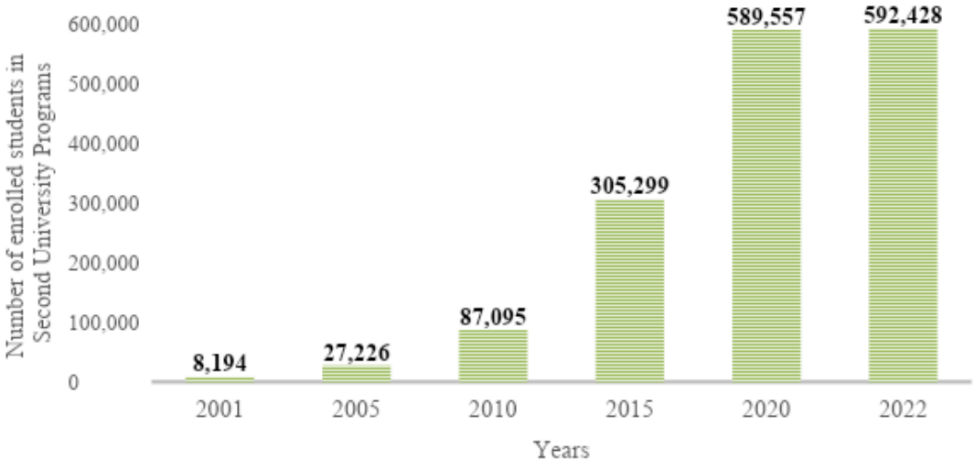
Anadolu University, which is celebrating its 41st anniversary as a provider of open and distance education in Türkiye, is one of the world's leading providers of open and distance education. In addition to Türkiye, there are students enrolled in the Open Education system in more than thirty different countries. With over four million graduates, the university currently provides higher education to over one million learners worldwide each academic year. Currently, Anadolu University's Open Education System offers 21 undergraduate and 39 associate degree programs. By law, students wishing to enroll in higher education in Türkiye for the first time must take a university entrance examination. However, those who are currently enrolled in or have completed a higher education program can enroll in Second University programs in Anadolu University's Open Education System without taking an entrance exam. Thus, Anadolu University's Second University programs offer learners the opportunity for personal and professional development.

Second University Programs: A Reflection of Openness in Education

Anadolu University Open Education System initially offered an opportunity for higher education to millions of people in Türkiye who were unable to access face-to-face education for the first time due to time and space constraints. Over time, changing needs and developing technologies, along with globalization, have revealed people's need for lifelong learning. As a result, it is accepted by everyone that education should be continuous. In this context, not only students seeking higher education for the first time but also people wishing to continue their lifelong learning have been given the right to enroll in Anadolu University's Open Education System since 2001. Thus, there have been significant changes over time in the numbers and profiles of those enrolled in this system. The number of students in this program has increased substantially in the last two decades, from 8,000 to approximately 600,000 (Figure 1).

Figure 1

Number of students enrolled in Second University programs between 2001-2022



Methodology

The purpose of this qualitative case study is to examine the reflections of the Second University programs of Anadolu University's open education system on the personal and professional development of open and distance learners. For this aim, a case study approach was adopted (Yin, 2003). The study's main aim is to discover the reflections of open and distance learners of Anadolu University's open education system who enrolled in Second University programs within the context of personal and professional development. The data were collected through an open-ended question. Content analysis was used to analyze the data.

Findings

To collect data in the context of the research, students in the Second University programs of the Open Education system were asked the question, "What does the Open Education system mean to you in terms of personal and professional development?" through the learning management system. Thousands of responses were received from students regarding this question, but 450 responses were analyzed in the context of the research after the review of four field experts. The experiences of four students in the open education system regarding their personal and professional development with the Second University are presented below. Akın (a pseudonym) stated:

> *I am 43 years old, and I work as an occupational safety specialist. After I started studying as a Second University in the health management department, I started to see and express the deficiencies in the health and safety units I work in more clearly. It is a great feeling to continue learning, to take exams, and to struggle.*

Burak (a pseudonym) predicated the following:

> *The Department of International Relations, which I studied as a Second University program, has changed my perspective on politics, the world and even myself. I see the change in myself in a way that is priceless in this regard. Thanks to the Second University, I have made incredible personal gains.*

Cansu (a pseudonym) stated:

> *I studied law at university and then started working as a lawyer. But for the legal issues I was working on, I decided to study sociology. Studying this department helped me to understand and interpret the society, sociological structure while doing my job. Thank you open education.*

Duru (a pseudonym) indicated the following:

> *I retired at an early age and now I am living in a place with a garden. I felt that I was having difficulties while gardening. I got help from YouTube etc. for many subjects, but then I enrolled in the agriculture program within the scope of the Second University program. While studying, I learned and applied very good things about agriculture and gardening. Having exams helped me to work harder and learn in detail.*

Results show that learners enrolled in a Second University benefit from these programs in the context of personal and professional development in their lives. Regarding personal development, through the Second University programs, the learners are making changes in their lives to boost their potential. These programs enable individuals to acquire new knowledge and skills and to improve existing knowledge and skills. This contributes to the personal development of individuals and the improvement of their quality of life. In terms of professional development, these programs enable individuals to develop their professional knowledge and skills. More student stories covering student experiences in the open education system are also included in the book published by Bozkurt et al. (2023).

Conclusion

In the past, students mostly enrolled in the Anadolu University Open Education system in Türkiye due to constraints such as time, space, and work life, while in recent years, it can be said that those who study at university or have a university diploma have enrolled in Second University programs for their personal and/or professional development. The Open education system of Anadolu does not only provide open and distance education but also learning opportunities that support the personal and/or professional development of thousands of learners. Through these programs, individuals can acquire new professional knowledge and skills and improve their existing professional knowledge and skills. This also contributes to the professional development and career advancement of individuals. In this context, Second University programs provide an important opportunity for personal and professional development.

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Shakespeare and Social Presence: The Power of Virtual Reality in Remote Education

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This mixed methods study focuses on a remote educational intervention using Quest 2 headsets to facilitate a virtual reality book club studying the works of William Shakespeare. Students engaged with one another, a teacher, and a live actor in virtual reality using VRChat and Bigscreen for this online learning experience. Social presence and academic growth were evaluated. Data was collected using a pre-post assessment test, writing prompts, multiple-choice questions, and student interviews to measure knowledge of Shakespearean works. Three quantitative measures, student interviews, and writing prompts were used to assess social presence. Results suggested that students can learn about Shakespeare while also building social presence in virtual reality. The majority of students interviewed stated it was easier to make friends in virtual reality than in an in-person setting. This study can serve as a model for future research on the social and academic elements of innovative educational technology.

Introduction

Social presence is an important element of online education. Social presence has been defined as a "sense of being with another in a mediated environment" (Biocca & Harms, 2002, p.10). The community of inquiry model's conception of social presence focuses on group cohesion, affective expression, and open communication (Garrison & Arbaugh, 2007). Research suggests achieving a sense of community can be a challenge in online learning (Sun & Chen, 2016). This study considered social presence regarding group cohesion and cognitive effect as well as interpersonal interactions in an online environment (Arbaugh et al., 2008). To what extent social presence should refer to factors besides the salience of another individual and their interaction in a mediated environment has been discussed in the literature (Kreijns et al., 2014). Previous scholarship has discussed virtual reality within the context of Shakespeare (Wittek & McInnis, 2021). Although past research has been conducted on virtual reality and education, there is a gap in the literature relating to virtual reality being used as the medium for students participating in online learning (Kavanagh et al., 2017). This study examines an intervention using virtual reality for remote education.

The purpose of this mixed methods study was to implement and evaluate the impact of a virtual reality book club on the social presence of students. This research examined participant responses using virtual reality headsets to study the works of William Shakespeare. Students participated in a virtual reality book club focused on four different plays. Social presence and academic growth were evaluated. This study examined two research questions: 1) How does the implementation of a virtual reality technological innovation affect students' knowledge of Shakespearean works? 2) How does the implementation of a virtual reality technological innovation affect social presence in students?

Methodology

Nine students used Quest 2 virtual reality headsets to participate in the virtual reality book club. Students came from a variety of educational backgrounds. Some students attended a traditional public school district in rural South Carolina while others had charter school backgrounds. Several were homeschooled. Four different plays by William Shakespeare were studied in the virtual reality book club: The Tragedy of Julius Caesar, Macbeth, Hamlet, and Richard III. VRChat was used to take students to various virtual worlds related to the content being studied?

Bigscreen was used to show students visual art based on the plays, Shakespearean passages, and animated scenes of the works. A live actor provided Shakespearean performances within virtual reality.

The virtual sessions were held during the evening hours for eight consecutive weeks. Students used VRChat to meet up on a farm for the first virtual reality session. The teacher put down a portal, and students walked through to visit the Pantheon. The teacher led a discussion on Julius and Augustus Caesar next to a statue in the virtual world. The students and the teacher walked to the amphitheater. The live actor joined and recited lines from the work. After the actor's performance, the teacher asked about the content of the Shakespearean performance. The next week students used Bigscreen to view animated scenes, watch the live actor perform, and engage in discussion. On the third week, the actor performed a portion of Macbeth while in a throne room in VRChat. In the fourth week, students used Bigscreen to watch animated scenes of Shakespeare and discuss the text. In order to study Hamlet, students visited the Temple of Herod, a cemetery, and a Victorian house. Students watched the actor recite portions of the work in both the cemetery and the Victorian house. The last two sessions focused on Richard III. Students learned about the era of the Renaissance by visiting a cathedral and examining various paintings. Students also visited the throne room and discussed a quote from the play. In the last session, students watched animated scenes of Richard III and discussed choice and destiny within the context of Shakespearean works.

Students were assessed on social presence using three different measures: the Social Presence measure on the Community of Inquiry Survey, the Adapted Networked Minds Social Presence Measure, and the Social Presence Survey. The Shakespeare Knowledge Assessment was used to assess student knowledge of the works. Students were provided with the Shakespeare Knowledge Assessment early in the intervention as well as after the final virtual reality session. The website myShakespeare.com was used by the researcher to create most of the Shakespeare Knowledge Assessment questions. Multiple-choice questions and writing prompts were also provided after each session to evaluate knowledge of Shakespeare. The Community of Inquiry survey (Stenbom, 2018), a social presence survey based on previous research (Nowak and Biocca, 2003), and an adapted version of the Networked Minds Measure of Social Presence (Harms & Biocca, 2004) were used to assess social presence. Modifications were made to various assessment questions. Interview questions were also used in this research.

Results

Descriptive statistics and nonparametric statistics were used to examine the results of the Shakespeare Knowledge Assessment. Students showed an average growth of 16.04% in their knowledge of Shakespeare. Though the average amount of student knowledge did increase, the results were not statistically significant ($p < .07$, $W = 4.50$). Numerous students also correctly answered multiple-choice questions about Shakespearean works. The Community of Inquiry survey showed that students tended to agree that they experienced social presence while participating in the virtual reality book club ($M = 4.12$ out of 5, $SD = 0.83$). Results from the Community of Inquiry survey showed that students tended to agree that they experienced a sense of belonging and felt other participants acknowledged their perspective. Students also tended to feel comfortable participating in conversation. The Adapted Networked Minds Social Presence Measure also provided evidence students experienced social presence ($M = 4.84$ out of 7, $SD = 1.55$). The Social Presence Survey showed that students tended to feel as if they were together with other virtual reality book club participants in the same room ($M = 0.32$, $SD = 0.31$). Students also tended to believe they could get to know an individual they met solely in the virtual reality book club ($M = 0.36$, $SD = 0.22$).

Five students participated in interviews about their experiences in the virtual reality book club. Structural Coding, Emotion Coding, In Vivo Coding, and Process Coding were used to analyze writing prompts and interview data. These methods of coding have been discussed in previous scholarship (Saldaña, 2021). Twelve categories were created which were used to support the emergence of three themes: 1. Students enjoyed sharing a common virtual reality experience while developing a sense of social cohesion, 2. Virtual reality played a powerful role in creating social connections among students, and 3. The immersive nature of virtual reality furthered students' knowledge about Shakespeare. Student interviews provided insight related to the use of virtual reality technological innovation. For example, one student noted that "it's very straightforward and to the point, how you're teaching." A student noted in their interview response, "I just...I feel like it helped in a lot of ways, including just making it easier to talk about how you felt and talk about your opinions." The majority of the students interviewed stated they found making friends in virtual reality to be easier than in an in-person setting.

The interview data of students demonstrated the power of using virtual reality to teach Shakespeare. One participant stated "It's kind of like a field trip at your house. And you don't have to, like, go anywhere.

And it's much easier than flying somewhere, which made it really fun and felt like real life." Another student noted that they "thought of Shakespeare as boring or reading books, but, like, when I can see everything…that made it much better." Both qualitative and quantitative data supported that virtual reality can be used to create an engaging experience for students learning about Shakespearean texts.

Discussion

This research has important implications for how virtual reality could be used to help introverted students participate in remote education. The findings of this study suggest virtual reality could help introverted students improve their social skills. As one student noted, "In real life, a lot of times people respond to you they, like, say, like, something, like, really jerky and mean. But, like, they would respond nicely in VR, and it made me feel happy and accepted." Another student noted "a change of confidence" in relation to a student who was shy in real life but outspoken in

virtual reality. The small sample size of this study is one limitation. Past scholarship has discussed how a limited sample size leads to a lack of validity (Faber & Fonseca, 2014). Future research could conduct similar research on virtual reality and education on a larger scale. Another limitation is that students who participated in the study might have had an interest in virtual reality before the research began. Additional research is recommended on both the social and academic elements of using virtual reality for online education.

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Shifts in Professional Development and PLNs Among Post-Remote Teaching Educators

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The pandemic greatly impacted education, including how educators approach professional development (PD) and the people, spaces, and tools they access for resources and support. Our survey study explored changes and continuity in PD and professional learning networks of education professionals from the school year 2019 to 2022. Our findings from the survey responses and interview data indicate that while some aspects have changed, others remain unchanged regardless of the impact of the pandemic.

Background

With numerous changes emerging for educators in the COVID-19 era, K-12 and higher education educators have faced and overcome professional challenges in the early, mid, and "post" stages of a novel (and often remote) learning situation. Formally organized professional development (PD) training is considered indispensable for teachers' professional growth. However, during the pandemic, teachers were reportedly relying on informal PD activities on social media to enhance needed skills for flexibility, availability of resources, and access to supporting networks just in time (Macià & García, 2016; Greenhalgh & Koehler, 2017).

Within the K-12 context, the PD of educators is typically focused on content-specific learning, classroom management techniques, and pedagogical practices. Increasing demand for technology in K-12 classrooms has shifted the focus of many PD goals toward technology integration (Liao et al., 2017). A comparative analysis study showed K-12 teachers' positive shifts in the perceived usefulness of online PD (Liao et al., 2017). Similarly, educators in higher education (HE) also seek PD through social media across many disciplines, most notably education and humanities (Singh, 2020). Although several social media platforms, including Facebook, Academic.edu, Google+, and Research Gate, are used by academics, Twitter (now rebranded as X) remains the predominant social media platform. The use of X has been mostly concentrated on academic activities such as conferences, networking, information, and resource sharing, staying updated, and engaging in social commentary.

Krutka et al. (2017) propose the professional learning networks (PLNs) framework to describe the people, places, and tools that support and tailor educators' PD beyond conventional training. The benefits of PLNs have been well documented; however, little is known about how educators' PLNs evolve. Carpenter et al. (2021) conducted a follow-up study of their prior study (Trust et al., 2016). They found that more than 90% of educators indicated changes occurred in their PLNs between 2014-2018. The contributing factors include shifts in jobs, people or organizations, technologies, and interests/goals. The global pandemic has greatly influenced policies and teaching practices, creating a 'new normal' in education. It is crucial to explore how such external conditions have affected educators' support systems and their approaches to PD.

We aim to explore how educators' approaches to both PD and PLNs change across time periods (pre-remote, early remote, present). We use Krutka et al.'s (2017) PLN framework to guide this exploration and answer the research question: How has the pandemic influenced education professionals' approach to PD and PLNs?

Method

We used mixed methods to investigate post-remote PD and PLNs via survey and interview. The study was approved by the Institutional Review Board, and participants provided informed consent for the interviews. Eligible participants included K-12 and higher education teaching

professionals who had experiences teaching from pre- and post-pandemic (2019-2022). Recruiting information was disseminated via email and social media posting. This paper focuses on the findings from survey data, with quantitative data analysis to compare the frequency of certain PD opportunities and PLN activities over periods (pre-remote, early remote, present).

Results

We received 70 valid responses, with 45 educators working in K-12 and 25 in higher education. The average years of teaching was 15.51 years. Of the 45 responses from educators in K-12 or higher education settings, 17 participants took a follow-up interview. Among the 70 respondents, none reported being a novice in educational technologies, with 24.29% indicating competence or expertise and 51.43% proficiency. A steady increase was observed in the comfortableness of using technology to support educational activities for both settings across time.

Influences on professional development

The survey results indicate a strong inclination towards new learning opportunities during the pandemic, with 88.58% of participants agreeing or strongly agreeing that they sought new learning resources online, 63% of participants expressing a desire to continue building their online networks, 54.29% joining new teaching-focused groups online during the pandemic. Educators also shifted their engagement in their learning communities. Compared to the pre-remote period (or before 2020), the results show a decrease in passive engagement in the post-remote period (or after 2021), such as lurkers, from 32.14% to 25.23%, while the number of community leaders increased from 7.14% to 13.51%. Similarly, the number of networkers rose from 24.11% to 29.71% and content creators from 14.29% to 17.12%. In sum, these results highlight a significant shift towards more active and participatory PD, with professionals seeking new learning resources and engaging more proactively with the online learning community.

Influences on professional learning networks

While the survey findings showed varying degrees of change or continuity in the components of educators' PLNs, there's a growing trend toward the use of digital technologies and virtual interactions for professional networking and development. Regarding the tools, 55.71% of educators reported an increase in the number of tools they are using compared to 2020, while 40% reported no change and 4.29% reported a decrease. While 51.45% reported no change in the number of blogs, sites, hashtags, and e-newsletters they follow or visit compared to 2020, 41.43% reported an increase and 7.14% reported a decrease.

For the number of educators and people they connect with, 51.43% reported an increase compared to 2020, 44.29% reported no change, and 3% reported a decrease. The same trend was observed for the number of online groups and communities they join: 52.86% of educators reported an increase in their membership, 42.86% reported no change, and 4.29% reported a decrease.

Finally, there is a shift towards space they engage in PD, with in-person modality becoming less popular and online synchronous and asynchronous modality becoming more preferred. Before 2020, in-person PD was the most popular form of PD (38.24%), but during 2020 and after 2021, online synchronous and asynchronous modes increased in popularity, accounting for 44.12% and 35.90%, respectively.

Discussion and implications

The research findings suggested that the pandemic impacted teaching professionals to varying degrees and in varying aspects, including increased engagement in pursuing PD and preference for online modality. Participants also reported positive changes in their approaches and attitudes towards self-directed PD, educational technologies, and teaching practices despite the challenging situation. Educators with strong and established professional networks and those having training in educational technologies before the pandemic reported a smoother transition.

Our findings have theoretical and practical implications. Theoretically, the research findings contribute to the literature on educators' PD and the PLNs amid challenges. This study highlights the impact of external and situational factors that compel educators to initiate self-driven PD, seek out ideas from their PLNs, or provide support to others within their PLNs. Building on Carpenter et al. (2021) regarding the evolution of educators' PLNs, our study provides unique insights into the impact of the pandemic on the change and continuity of educators' PLNs.

Practically, success stories revealed that educators are encouraged to draw on different PD opportunities and take active roles in developing and maintaining their professional networks to glean the benefits of participatory culture. Meanwhile, educators should also be mindful of the work required outside of the classroom for self-driven PD online; it may bring fulfillment in the short term but may create additional digital demands or even lead to burnout. Finally, institutions should consider ways to compensate for those professional activities if formally organized PD is not offered or does not meet educators' needs.

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Smart Campus Development: A Case Study of a Middle School in Wuhan

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This paper presents a case study of smart campus development in a middle school in Wuhan, China. A smart campus leverages digital technology and connectivity to enhance user experience and operational efficiency in educational institutions. The study aligns with the smart education initiatives of the Wuhan municipal, focusing on key evaluation criteria, and aims to understand the perspectives of administrative staff, teachers, and students regarding the evolution of the smart campus. The research involved questionnaires and interviews, providing insights into various aspects of smart campus development. Results indicate positive feedback in areas such as management and support, digital literacy, digital resource access, and classroom innovation. However, challenges in implementing data-driven evaluation are observed, requiring further refinement.

Introduction

The smart campus typically refers to an intelligently designed environment that leverages digital technology and connectivity to enhance both the user experience and operational efficiency (Dong et al., 2020; Roy & Tushar, 2019). Implementing a smart campus strategy can bring numerous benefits to educational institutions, including an improved student experience, enhanced campus safety and security, reduced operational costs, data-driven decision-making, improved efficiency, and a positive impact on the community (Abuarqoub et al., 2017; Dong et al., 2020; MacLeod et al., 2018; Muhamad, Kurniawan, & Yazid, 2017). Based on these benefits, an increasing number of countries and regions are prioritizing the construction and development of smart campuses.

In 2020, the Wuhan municipal government of China issued an implementation plan outlining six pivotal actions aimed at building a national smart education demonstration zone (General Office of the Wuhan Municipal People's Government, 2020). These actions are as follows:

1. Promotion of smart education environment to build a high-level smart education infrastructure encompassing the entire city;
2. Promotion of digital literacy among administrative staff, teachers and students;
3. Innovation in classroom practices to drive changes in teaching and learning methods across all primary and secondary schools;
4. Revamping resource supply models to achieve differentiated supply and intelligent service when it comes to digital instructional resources;
5. Data-driven evaluation to implement practical actions that leverage data analytics and stimulate the all-round development of students, including their morality, intelligence, physical fitness, aesthetics, and labor;
6. Optimizing basic education governance to promote the modernization of the primary and secondary school management system and capabilities.

Subsequently, the Wuhan Municipal Bureau of Education released the 2020 Evaluation Criteria for Smart Campuses in Primary and Secondary Schools (Wuhan Education Bureau, 2020). The evaluation standards consist of five primary indicators:

1. Infrastructure construction carries a weight of 25%, comprising various subentries such as the campus network, data center, smart classroom, artificial intelligence laboratory, smart library, campus security system;
2. Digital resources supply accounts for 10% of the evaluation, ensuring easy access to fundamental curriculum resources, an array of supplementary materials on various subjects, and an extensive collection of books and periodicals;
3. Digital literacy accounts for 10% of the evaluation, focusing on both teachers and students;
4. Support mechanism holds a 15%, mandating the appointment of a Chief Information Officer (CIO), the establishment of a dedicated leadership group, and the diligent execution of their duties. It also specifies that 20% of the school's budget should be used for smart campus development, alongside the formulation and implementation of comprehensive development plans;
5. Application services constitute the largest component at 40%, including three aspects: school governance, classroom innovation, data-driven evaluation, all aimed at fostering the holistic development of students.

As the evolution of smart campuses gains momentum, it becomes increasingly imperative to grasp how participants engage with and perceive the evolution of these intelligent educational environments. As highlighted in previous studies, understanding participants' perceptions and viewpoints of smart campus development is essential for ensuring the success and effectiveness of smart campus applications, promoting user adoption, and aligning smart campus development with user needs and expectations. This study contributes to the existing literature by scrutinizing the perspectives of administrative staff, teachers, and students in a selected middle school in Wuhan, shedding light on their perceptions and experiences.

Participants and Data Collection

The study involved participants from "M" Middle School in Wuhan, China, which had a population of 1,082 students, 85 teachers, and 15 administrative staff. This school was chosen as a representative model of a public secondary school. The diverse perspectives of its students, teachers, and administrative staff regarding smart campus development were sought to gain insights applicable to secondary schools on a broader scale.

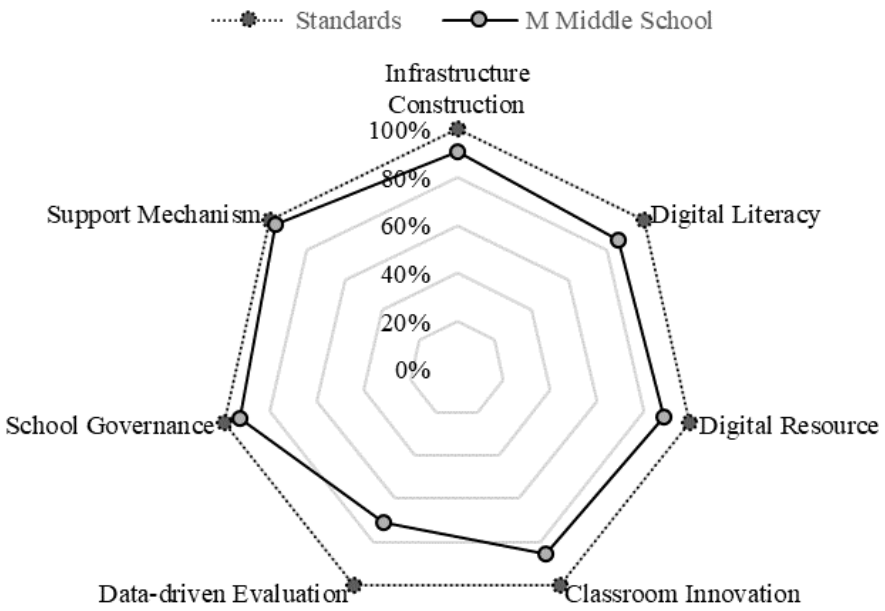
To align with Wuhan authorities' implementation plan and evaluation criteria for smart campus development, the research team of this study designed user experience-oriented questionnaires tailored to school administrative staff, teachers, and students at "M" Middle School. These questionnaires underwent reliability and validity verification, resulting in a Cronbach's alpha coefficient of 0.89 for the entire set. The questionnaires were disseminated to all members of "M" Middle School via the online platform wjx.cn, yielding a remarkable response rate of 91.50% and an effective rate of 96.36%. In addition to the questionnaire surveys, the research team developed semi-structured interview questions. Interviews were conducted with representatives from the school's administrative staff, teaching faculty, and student body, providing insights into the current state of smart campus development from the user's perspective.

Results and Discussion

As shown in Figure 1, the following are the results and discussion after analyzing the questionnaire and interview data.

Figure 1

Radar map of smart campus development status of M middle school



First, the results indicate that the school has received highest positive feedback in three key areas of management and support: the support mechanism, school governance, and infrastructure construction. In terms of the support mechanism, a dedicated leadership group has been established to drive the development of the smart campus, and a significant step has been taken by appointing one of the school headmasters as the Chief Information Officer (CIO). This move has enabled efficient digital management across various aspects of the institution, including teaching affairs, daily office operations, management of state-owned assets, and the oversight of research projects in the field of educational science. Regarding infrastructure construction, the school has made substantial progress. They have successfully completed the establishment of critical components, including the campus network, data center, information terminal, multimedia network classrooms, smart classrooms, digital laboratories, campus security systems, campus radio and television systems, facilities dedicated to innovation and creativity, an online teaching and learning platform, and a campus e-Card system. This comprehensive infrastructure development signifies a significant advancement in modernizing the school's facilities and technological capabilities. Overall, these positive developments reflect the school's commitment to improving its management and infrastructure, ultimately enhancing its ability to provide a modern and effective educational experience.

Second, the results of the analysis show that the school has received highly positive feedback in three critical areas: digital literacy, digital resource access, and classroom innovation. In terms of digital literacy, it's evident that the school's management team has embraced the concept, as all members can apply the school's digital governance platform. Notably, the feedback suggests that younger teachers tend to excel in digital literacy compared to their more senior colleagues. This generational difference is advantageous, as younger teachers are often more adept at handling digital resources, implementing smart instructional methods, and conducting educational research that aligns with the demands of the age of artificial intelligence. The digital resource aspect is also promising, with the school's digital library offering an extensive collection of electronic books, magazines, journals, newspapers, and courseware. This rich repository of digital resources ensures that both teachers and students have easy access to a wealth of educational materials. Furthermore, the school's commitment to classroom innovation is evident in the widespread adoption of smart education concepts, platforms, and facilities. This innovative approach is being integrated into the teaching and learning practices of M Middle School, fostering a dynamic and technology-enhanced educational environment. Overall, these positive developments indicate the school's dedication to fostering digital literacy, providing abundant digital resources, and promoting innovative teaching and learning methods, ultimately contributing to a more advanced and engaging educational experience.

Finally, the results suggest that the implementation of data-driven evaluation in M middle school for assessing the holistic development of all students has not fully met the requirements for widespread application. This is particularly evident in its effectiveness in identifying students with the potential to enter higher-grade schools. While the concept of data-driven evaluation holds promise for evaluating various aspects of a student's development, it appears that there are challenges or limitations in its current application. Further refinement or adjustments may be necessary to address these issues and fully realize the potential of data-driven evaluation in the educational context.

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STEM Educators' Perceptions of Gender Bias and the Contributing Factors that Persist for Women in STEM Education

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Gender bias is considered an influencing factor that affects the decisions of female high school students to participate in STEM education. This action research used a convergent mixed method design to investigate perceptions of high school STEM educators pertaining to gender bias in STEM education. This descriptive study also sought to identify and examine the key factors that STEM educators perceived as influential factors for female high school students' participation in STEM education. Three main factors of influence - behavioral, individual, and environmental - were used to categorize the perceived factors of influence from the STEM educators' perspectives. The perceptions of high school STEM educators regarding gender bias found biological influences, social norms, stereotypes of STEM students, and the underrepresentation of female students to be most significant.

Introduction

Female representation in Science, Technology, Engineering, and Mathematics (STEM) continues to decline even with the increase in educational programs and technological advancements in society demanding STEM professionals. In 2019, statistics from the National Center for Science and Engineering found that 38.9% of women graduated with a STEM undergraduate degree (Freyman & Rotermund, 2019). This phenomenon has called for researchers to explore the influential factors that contribute to the decline of women in STEM education and careers that have created a gender gap in STEM education (Card & Payne, 2021). The gender gap has called researchers to explore the key factors of behavioral, individual, and environmental influences that contribute to the decrease in females in STEM education and careers. In this descriptive action research study, the two research questions were: what are high school STEM educators' perceptions regarding gender bias in the STEM School of Study cluster at Skyler High School (pseudonym used)? and What factors do high school STEM educators perceive as contributing to low participation among female high school students within the STEM School of Study cluster at Skyler High School?

Literature review

The literature review provided an understanding of previous research on gender bias in STEM education and the previous studies conducted to determine factors that influence high school female students' STEM choice selection. The factors that were determined from past research included three main categories: behavioral, individual, and environmental (Bandura, 1997). The categories provided evidence that influencing factors are complex and that individual choice can be determined at an early age by societal and family beliefs (Hand et al., 2017). These beliefs are then carried throughout the educational process and have been described to be influential in the underrepresentation of females in STEM education (Kong et al., 2020). There exists a gap in the literature on the specific topic of gender bias, specifically in STEM education referring to gender. The two main theories that investigate the perceptions pertaining to gender bias in STEM education are the Social Cognitive Theory (Bandura, 1986) and Social Domain Theory (Yoo & Smetana, 2022).

Methodology

This study took place at a mid-size suburban high school in the southeastern United States. The Skyler High School student population in 2021 was approximately 2586, with 183 faculty/staff. This site was selected because Skyler High School offered six STEM programs for students to enroll in and receive Career and Technology Education, as well as 32 Advanced Placement or Dual-Enrollment courses. Both quantitative and qualitative data were collected and analyzed to provide a comprehensive understanding of the research questions related to gender bias in STEM education. Quantitative data was collected using the Perceptions of STEM Participation Survey, Sex Typing Occupation Survey, and DASS Instrument. The Perceptions of STE Participant Survey was a cross-sectional survey using a 5-point Likert scale response. The Sex Typing of Occupation Survey consisted of 27 items rated on a 7-point bipolar scale to assess the perception of occupations as "masculine" or "feminine" from the participant's perspective. The Draw a Scientist Instrument (DASS) was adapted from a previous instrument and aimed to produce both quantitative and qualitative data. This instrument assessed stereotypes related to STEM students. The surveys and the DAAS were distributed to participants digitally via email and Google Forms to ensure prompt and accurate data collection. Qualitative data was collected using one open-ended question from the Perceptions of STEM Participant Survey, two open -ended questions from the DASS Instrument, and semi-structured interviews. A standardized image was used to compare the DASS participant drawing.

Results

Descriptive statistics were calculated using Microsoft Excel to analyze the quantitative data from the surveys. The frequency of artifact indicators (e.g., lab coat, eyeglasses, and symbols of research) occurring on the DASS participant drawing was calculated. Qualitative data was analyzed using an inductive approach. The data was transcribed, reviewed for accuracy, and analyzed to identify recurring themes about the participant's perceptions.

The Perceptions of STEM Participation Survey assessed high school STEM teachers' perceptions regarding female students' involvement in STEM courses and the presence of gender bias. The mean score of responses was 2.75 out of 5 (SD = 1.03), suggesting that high school STEM educators were between slightly disagreement

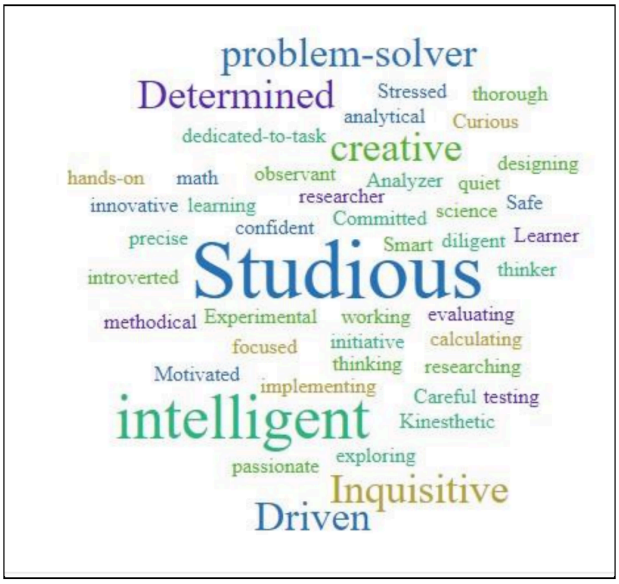
and neutral about the statements presented concerning female high school students' participation in STEM courses.

The top four occupations, as identified in the outcomes of the Sex Typing Occupation Survey, where the mean scores were found to represent a feminine occupation, were Dental Hygienist, Certified Nursing Assistant, Registered Nurse, and Physician Assistant. The top four occupations where the mean scores were found to represent a masculine occupation were Waste Management, Land Surveyor, Air Traffic Controller, and IT Manager. The top four occupations where the mean scores were found to represent a gender-neutral occupation were Computer Support Specialist, Chemist, Statistician, and Architect.

The DASS Instrument asked the participant to "List three words that come to mind when you think of this STEM student." A frequency count was used to analyze the words provided, and a word cloud was generated to display the findings (see Figure 1). Of the 45 unique words collected, "studious" was reported the most. More than one participant used seven words: studious, intelligent, creative, determined, drive, inquisitive, and problem solver. Words that were synonymous were combined into one dominant word where ten overarching word categories used to describe a STEM Student prevailed: academic subject analyzer, creative, dedicated, intelligent, introverted, kinesthetic learner, problem solver, researching, and stressed.

Figure 1

Word Cloud of DASS Instrument List of Three Words



In summary, the quantitative findings of this study showed that the teachers at Skyler High School perceived certain careers as more feminine or masculine and that female students are more successful in interactive science fields, such as behavioral or medical fields. The faculty participants perceived STEM students as intelligent and dedicated, with math and science students being kinesthetic learners and creative problem solvers. The educators perceived STEM students as smart students taking more rigorous hard science courses, working on computers, and being inquisitive and critical thinkers. Specific to female STEM students, the educators' perceptions of female STEM students were the opposite of the stereotypical perception of a STEM student found in the existing research (Kong et al., 2020; Moss-Racusin et al., 2015). Stereotypical perceptions of female STEM students included traits like emotional, sensitive and nurturing. Teachers of this study perceived female STEM students as having a caring and quiet demeanor, choosing easier academic paths, and fearing failure. Lastly, the findings of the study indicated that STEM educators do not see a significant gender bias in STEM education at Skyler High School but identify a continued overall gender bias by societal norms that are seen through the underrepresentation of women in STEM careers.

The combined qualitative data sources were analyzed using Delve software themes emerged: (1) Teachers perceived the female students fear of failure to influence why they take STEM classes, (2) Teachers perceive cultural influences to impact the choices female students make, and (3) Teachers perceive slight growth away from the traditional school aura that female students are not capable of succeeding in STEM course.

Teachers perceived female students' fear of failure to be a major factor that contributes to low participation from high school female students in STEM education. Also, teachers perceived female students' personal life choices, combined with being afraid of failure and not being shown they could be successful in STEM areas, as factors for low STEM enrollment. The findings showed that Skylar High School teachers perceived female students to assume STEM areas are too hard and that female students tend to stray away from the STEM curriculums that are perceived by society as masculine. Self-determination was also perceived by the teachers to be a barrier for female high school students in pursuing STEM courses.

STEM education enrollment can be influenced by parental and environmental factors that are placed on female students, either in the classroom or at home (Pinquart & Ebeling, 2020). One cultural influence identified in the qualitative outcomes of this study was educational opportunities and the parent's ability to provide supplemental education or continuing education for their child. A student's access to technology also influences how females' behavior and attitudes relate to STEM education. The Skyler High School teachers agreed there are social norms that create a larger cultural holdover when referring to STEM careers and education. Lastly, the STEM educators perceived a push from middle school guidance counselors to enroll female high school students in humanitarian courses, such as nursing; which is also tied to societal norms that are placed on STEM careers as either masculine or feminine.

The findings of this study were interpreted in comparison to what past research has determined about gender bias in STEM education; teachers have a stereotypical view of STEM students and STEM careers (Kong et al., 2020). The data was converged and considered through a lens of conceptual understanding about gender bias pertaining to female high school students and the research-based literature. This study found several key findings related to gender bias in the perceptions of high school STEM educators at Skyler High School: biological influences, social norms, stereotypes of STEM students, and the underrepresentation of female students in STEM education. The converged data supported these teachers' views on certain career choices to weigh heavily on one's gender in STEM areas. Additionally, acknowledges that gender development starts at an early age through childhood experiences that influence female students in decision-making skills.

Conclusion

The study emphasized the importance of early intervention in recruiting and promoting females toward STEM education. Teachers believe that exposing female students to STEM from a young age is essential to influence their decisions and increase their participation in STEM courses. While recruitment efforts were present at Skylar High School, the study suggested that these efforts needed to start early to have a meaningful impact on female high school students' decisions to take STEM courses. In summary, the study highlights the complex interplay of stereotypes, biases, and societal norms that affect female students' choices in STEM education.

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Student Engagement in a Gamified Online Learning Environment: A Data Mining Approach

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In education, gamification applies game design elements to non-game contexts to engage learners. This preliminary study explored the feasibility of using data mining to analyze student engagement patterns in an asynchronous online course that utilized gamification. We conducted a series of exploratory data analysis approaches, including keyword extraction, clustering, concordance analysis, and sequential pattern mining. Results showed peaks in engagement aligned with gamified challenges and rewards. Students discussed both academic and non-academic topics, indicating community-building. Sequence pattern mining revealed more consistent academic engagement for highly engaged students. Findings demonstrate the viability of using data mining techniques to assess cognitive engagement based on discussion patterns in a gamified online course.

Introduction

Online learning has become ubiquitous in higher education, with most courses offering a mix of fully online and hybrid courses (Allen & Seaman, 2017). However, this transformation brings the challenge of student engagement to the forefront, yet limited interactions in virtual/remote environments with a lack of physical presence remain (Dixson, 2015).

In response to learning interaction and subsequent engagement challenges, gamification has surfaced as a promising strategy. By including online courses with game design elements—points, badges, leaderboards, and more—educators aim to promote student motivation and engagement (Nacke & Deterding, 2017). While gamification's merits are clear, its ability to gauge students' engagement during a gamified online course is questionable. Traditional approaches, particularly self-reported measures, may fall short of capturing the full spectrum of student engagement, often missing subtle but valuable behavioral cues. The research echoes a more unobtrusive and alternative measurement approach to track students' learning engagement patterns in online learning.

This gap highlights the need for sophisticated, insightful approaches, where the potential of Educational Data Mining (EDM) becomes particularly significant. As a rapidly emerging field within learning analytics and computational social science, EDM offers a unique advantage in providing educators with deep insights into student learning. This goes beyond superficial analysis, delving into the complex dynamics of student interactions. Such depth is particularly critical in large-scale online learning environments, where subtle student behaviors might otherwise remain undetected. It is evident that EDM's ability to track detailed micro-interactions, as noted by Daghestani et al. (2020), allows educators and researchers to discern underlying behavioral patterns, including those that might indicate students at risk (Bošnjaković & Đurđević Babić, 2023). Given this context, our study aims to bridge these gaps by applying EDM to investigate learning engagement within gamified online courses. Specifically, we seek to answer two pivotal research questions:

- RQ1. How do students engage in a gamified online, asynchronous course?
- RQ2. What learning engagement patterns emerge from using a gamification approach in an online, asynchronous course?

Methods

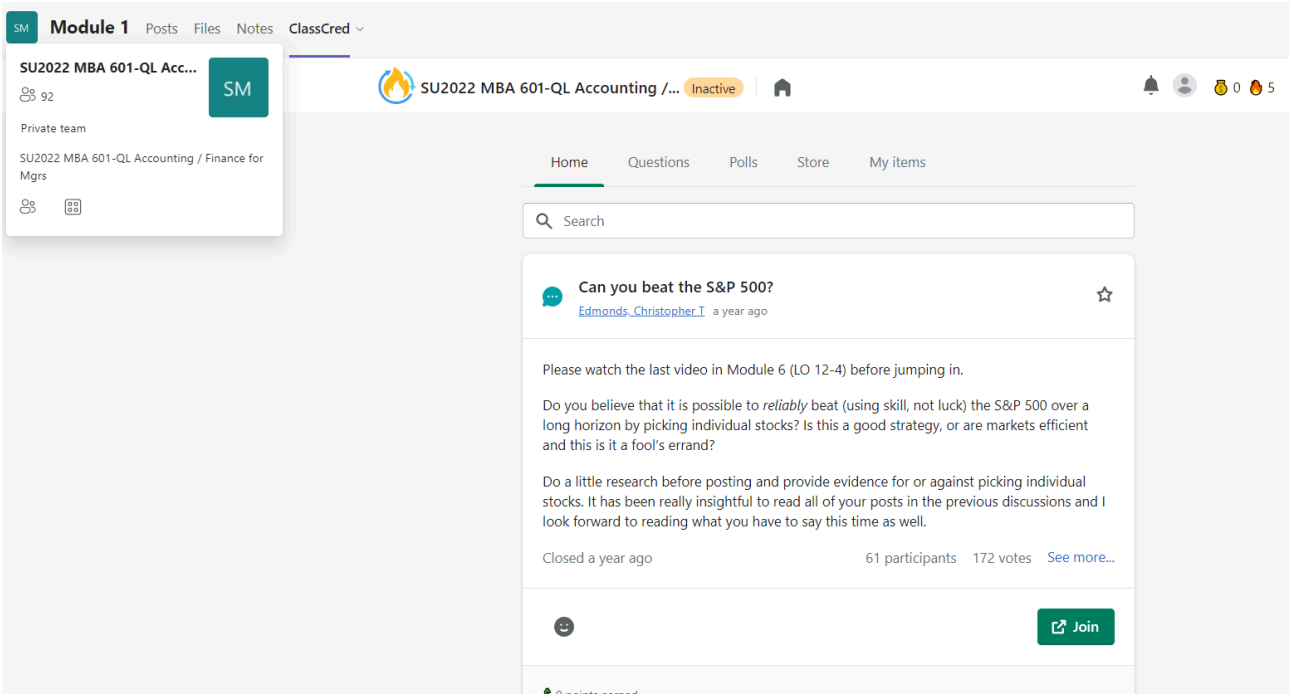
This case study analyzed data from 50 students in one online financial literacy course section at a large public university. The course utilized ClassCred, a gamification plug-in app (Figure 1) embedded within the Microsoft Teams learning management system (LMS). This plug-in allows

instructors to use or customize a collection of gamification functions, including points, badges, emojis, rewards, and social discussion features. We gathered a full semester of discussion posts (N=4,760), and data preprocessing was done to ensure accuracy, ethical compliance, and standardization of the textual data for subsequent analysis. This process included converting text to lowercase, removing punctuation and numbers, tokenizing the text, eliminating stop words, and applying stemming to reduce words to their root form. Analysis was completed using the following educational data mining techniques:

- Keyword extraction to identify academic topic-related posts.
- Clustering students into high and low-engagement groups
- Concordance analysis to examine the context of keyword usage (Adolphs, 2006).
- Sequence pattern mining to categorize discussion types and identify patterns (Mabroukeh & Ezeife, 2010).

Figure 1

ClassCred Interface



Preliminary Findings

The data analysis is incomplete as this study is currently in progress. However, preliminary results suggest that data mining techniques are feasible and useful in exploring students' online engagement patterns in a gamified learning system.

RQ1. How do students engage in a gamified online, asynchronous course?

We clustered students into 'high' and 'low' engagement groups based on their cumulative engagement-related term frequency, identifying the top and bottom 20%, respectively, through keyword extraction techniques. In our study involving 50 students, this resulted in 10 students in the 'high' engagement group and 10 students in the 'low' engagement group. Our findings indicated that both groups, highly engaged and low engaged, raised questions about grading and exams. Highly engaged students, totaling 14, were more involved in academically engaged discussions, whereas the seven low-engaged students primarily raised general queries about exams and time limits and made comments about their performance expectations.

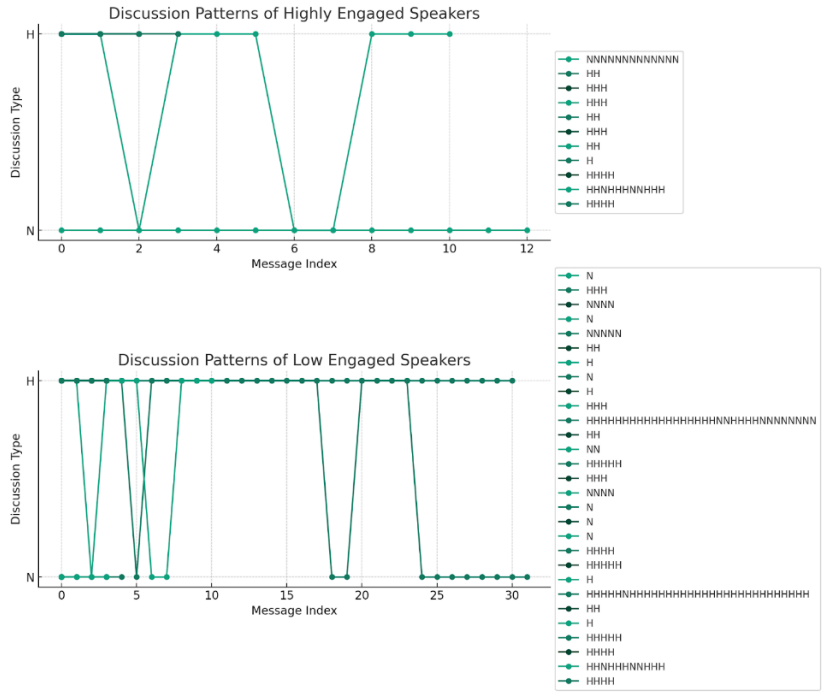
RQ2. What learning engagement patterns emerge from using a gamification approach in an online, asynchronous course?

The study's sequence pattern mining findings indicate that students with high engagement consistently engage in academic discussions, unlike their low-engagement counterparts, who display a wider variety of interaction patterns. Concordance analysis, particularly focusing on academic keywords like "exam" and "assignment," highlights the academic orientation of these discussions. Notably, student engagement fluctuated throughout the course, peaking alongside gamified rewards and milestones. Figure 2 exemplifies this by depicting two distinct learner groups, differentiated by their engagement levels (low vs. high). The high-engagement group predominantly participated in "Highly academically engaged" (H) discussions, interspersed with "Neutral" (N) discussions. The low-engagement group, while also engaging in some (H) discussions, showed a more diverse pattern, including a mix of (N) and "Irrelevant" (I) discussions. The categorization of discussion posts into (H), (N), and (I) was accomplished using an automated keyword extraction technique. This method identifies specific keywords and phrases that signify various levels of engagement. For example, frequent mentions of "exam" and "assignment" likely led to a post being classified as (H), reflecting a strong academic focus. In contrast, (N)

posts, while course-related, lacked these specific academic keywords, indicating moderate engagement. Posts categorized as (I) were devoid of such keywords, suggesting they were off-topic. This approach allowed for efficient processing of a large data set, facilitating the analysis of engagement patterns in the online course. However, it primarily relies on keyword frequency and may not fully capture the depth and context of discussions, a limitation of automated text analysis. In sequence pattern mining, different sequences of symbols with more frequent H represent varying lengths or intensities of the same behavior or characteristic. In the context of your study, where "H" signifies "Highly academically engaged" discussions, these sequences would indicate different extents of sustained high engagement in academic discussions. Longer sequences (like "HHHHHHHHHH") typically represent more prolonged and consistent behaviors or patterns, while shorter sequences (like "HH" or "HHH") may indicate more sporadic occurrences of the behavior. In educational contexts, longer sequences of high engagement could be particularly informative, possibly correlating with deeper or more effective learning experiences, or they might be influenced by course design elements like gamification, deadlines, or other motivating factors.

Figure 2

Sequence Pattern Mining Result



Discussion

The results of this study offer empirical evidence that discussion analysis through a data mining approach is feasible to capture more objective clues on engagement assessments. This preliminary work suggests that gamification contributes to multifaceted engagement. In this study, the introduction of gamification elements like points, badges, and leaderboards led to a 15.09% increase in the quantity of posts and a 25.88% increase in the average length of threads. Specifically, threads featuring badge incentives saw a 22% increase in replies, suggesting a significant boost in engagement. Point-based leaderboards, particularly when enhanced with specific emojis, caused a 17% rise in daily active users, indicating the effectiveness of these strategies in tapping into intrinsic motivations for recognition and competition. The strategic use of gamification, particularly points (mentioned 134 times), played a notable role in enhancing engagement and participation. While the direct impact on replies and idea integration was not quantifiable from the data, the frequent mention of points suggests they were a motivating factor for many participants. As a mixed qualitative lens, the data suggests that the gamified interactions in this business course likely fostered a vibrant social learning environment where students quickly build consensus and engage in problem construction. The diverse sequence patterns among less engaged students identify an opportunity to adapt course design to better support at-risk students. This study also complements existing empirical works by exploring data mining techniques. These insights are crucial for understanding how to deploy evidence-based gamification strategically, creating an environment that adaptively fosters learning engagement.

Conclusion

This exploratory study highlighted the potential of educational data mining as a powerful tool for identifying student learning engagement patterns in an asynchronous, gamified online course. We applied various data mining techniques, including keyword extraction, clustering, concordance analysis, and sequence pattern mining, to gain deep insights into student interactions within the gamified learning environment ClassCred. Building on these initial findings, future research should explore the long-term impact of gamification on student engagement and academic performance. Moreover, it would be beneficial to investigate the interaction between different gamification elements and personal factors such as learner profiles and individual

motivation levels. To expand the scope of research, it is advisable to use a broader range of data analysis techniques beyond those employed in this study. For instance, methods that can examine the relationships between multiple variables could provide a more comprehensive understanding of the effects of gamification. This approach would allow for a more nuanced comparison to non-gamified courses and help assess the influence of specific game elements. Such research efforts will be crucial for enhancing instructional/learning strategies to ensure they are effectively tailored and adaptive, enhancing student learning engagement.

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Supporting K-12 Educators' Professional Development Continuity: A Forecasting Approach for Curating Online Resources for Emergency Preparedness Planning

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THE JOURNAL OF APPLIED INSTRUCTIONAL DESIGN

This study, presented as a research poster for the 2023 AECT conference, identifies critical online professional development (PD) resources to support the PD continuity of about 38,000 K-12 educators as part of an emergency remote teaching (ERT) resource. The 2019, 2020, and 2021 academic year forecasting analyses showed 84 of the 537 online modules for ERT curation. The findings have implications for program evaluation in day-to-day operations and long-term emergency planning.

Introduction

The COVID-19 pandemic disrupted school student learning and on-site professional development (PD). K-12 educators shifted to online PD for emergency remote teaching (ERT), using synchronous and asynchronous learning (Cavanaugh & DeWeese, 2020; Hartshorne et al., 2020; Sparks, 2020). The EdHub Library, part of the University of Missouri's Network of Educator Effectiveness (NEE) since 2014, has provided 500+ asynchronous activities to around 38,000 educators in Missouri, Kansas, and Nebraska. After the 2019 redesign, EdHub improved PD material searchability and aligned it with Missouri Teacher Standards (Leung, 2021). Initially, subject matter experts identified three ERT resources to support K-12 educators at the pandemic's onset: Best Practices for Remote Instruction, Remote Learning Evaluation, and Google Classroom Help.

Literature review

Although forecasting methods are uncommon in online program management, they are prevalent in higher education and K-12 contexts. In higher education, these models predict student enrollment, demographic shifts, program evaluation, and budget allocation (Langston et al., 2016; Rossi et al., 2018). In K-12 settings, forecasting anticipates school expenditures and student population growth (Hasan et al., 2019; Yang et al., 2020). The COVID-19 pandemic has disrupted these predictions as historical data no longer reliably forecasts future trends due to sudden fluctuations. Uncertainties like economic policies, health mandates, and COVID-19 variants undermine forecasting activities. Scholars suggest new methodologies, employing alternative estimation techniques for outliers and introducing additional variables for stable and accurate forecasts during crises (Ho, 2021; Kumar et al., 2021; Pohlman, 2021).

Problem statement

Outlier and anomaly detection are data mining techniques used to identify unusual patterns in datasets. However, they face limitations due to timestamp considerations when describing resource access probabilities. Resource curation is challenging due to the continuous 24/7 availability of a vast library without defined start and end dates. Although subject matter experts' resource identification played a critical role during the pandemic, a data-driven approach is required by analyzing timestamp attributes for emergency preparedness planning.

Purpose and significance of the study

This study enhances ERT resource planning by forecasting online resource access using timestamps and metrics to ensure K-12 educators' PD continuity during times of crisis. It employs Facebook Prophet's changepoint detection to identify pivotal PD resources during the March 2020 COVID-19 crisis, analyzing trends from 2019 to 2021. Findings assist school leaders in evaluating teacher program materials, understanding K-12 educators' PD needs, and optimizing online PD deployment in the EdHub Library. Notably, there is a gap in the literature on forecasting studies in online teacher PD addressing learner interaction aspects, as initially outlined by Dede et al. (2009). This study explored the following research questions: RQ1: What are the trend characteristics of Pageviews, New Users, and Returning Users? RQ2: Which online instructional modules are required for the emergency preparedness planning resource?

Methods

Data description

Web analytics data from three academic years (2019, 2020, 2021) was extracted via a Python script in Jupyter Notebooks, connecting to the Google Analytics administrator property. For each academic year, three variables were obtained: New Users (first-time visitors), Returning Users, and Pageviews of resources. Data was reported in Central Standard Time, and the respective metrics were retrieved using the date timestamp. Pageviews represent views of accessed resources in a single session by new or returning users. To safeguard privacy, Google Analytics conceals internet protocol (IP) addresses, preventing individual user identification (UA Dimensions & Metrics Explorer, n.d.).

Facebook Prophet: Open-source time-series tool

Facebook Prophet, an open-source forecasting tool by Meta, was employed for time-series analysis, fitting non-linear trends with yearly, weekly, and daily seasonality and holiday effects (GitHub - Facebook/Prophet, n.d.). This additive regression method decomposes time-series data into trends, seasonalities, cyclic patterns, and random components, predicting future data points. The tool requires two columns: ds for date timestamps in DateTime format and y for the forecasting measurement. Academic years were studied individually using the three Google Analytics metrics to understand user and PD resource access patterns.

Observed trends and changepoints

Facebook Prophet identifies seasonal effects (yearly, weekly, daily) and adeptly handles missing data and outliers (Taylor & Letham 2018). Forecast models, using an 80% uncertainty interval, minimize training error for daily and monthly projections. Predicted values, also known as yhat, fall within a range of lower (yhat_lower) and upper (yhat_upper) bounds. These models reveal dataset trends and abrupt changes at the onset of the pandemic in March 2020. Facebook Prophet calculates daily magnitudes of change, aiding in detecting sudden shifts in Google Analytics variables. This insight informs the curation of online PD modules for emergency preparedness planning.

Findings

RQ1: What are the trend characteristics of Pageviews, New Users, and Returning Users?

After analyzing academic years, the EdHub Library noted a significant decline in Pageviews, New Users, and Returning Users from January to July 2020, attributed to the library's already substantial user base after the December 2019 interface redesign (Leung, 2021). Yearly, weekly, and daily seasonality analyses revealed an increasing trend at the school year's start (August-September) and summer (May-June), with peak web traffic on Mondays to Wednesdays and lower on Thursdays and Fridays. Daily user and resource access followed distinct patterns at 7:00 AM, 12:00 PM, and 5:00 PM during the week.

RQ2: Which online instructional modules are required for the emergency preparedness planning resource?

A total of 24 changepoints were identified across the Google Analytics variables amid the COVID-19 pandemic. From 03/02/2020 to 01/08/2021, each variable displayed eight changepoints as school districts resumed library usage at the pandemic's onset and winter break. Refer to Table 1 for the precise dates of these abrupt upward changes.

Table 1

Changepoints for Pageviews, New Users, and Returning Users

Pageviews	New Users	Returning Users
2020-03-21	2020-03-18	2020-03-02
2020-05-01	2020-04-27	2020-04-14
2020-06-10	2020-06-06	2020-05-25
2020-07-23	2020-07-21	2020-07-04
2020-09-01	2020-08-30	2020-08-15
2020-10-13	2020-10-11	2020-09-23
2020-11-22	2020-11-19	2020-11-01
2021-01-08	2021-01-05	2020-12-11

After detecting pandemic-related changepoints in Pageviews, eight dates revealed increased access to educational resources, including Getting Started with EdHub, Teacher Indicator Examples for Kindergarten, Teacher Summative Reports, Scoring Practice videos for English Language and Arts, Dyslexia and Learning, Beginning Teacher Support, and Remote Learning. Notably, K-12 educators engaged with dedicated sitemaps for PD selection, emphasizing Teacher Standards 4 (teaching critical thinking), 5 (creating a positive classroom environment), 6 (using effective communication), and 7 (monitoring the effect of instruction). New Users showed heightened interest in specific content, including Scoring Practice videos for Math and English Language and Arts, Social-Emotional Learning, Teacher Indicator 5.3b video examples (promoting social competence), Instructional Strategies, and Beginning Teacher Support, and performed search queries related to interactive classroom observation scoring training simulations. Returning Users displayed increased access to modules covering Teacher Standard 1 (using content knowledge with appropriate instruction), Beginning Teacher Support, Remote Learning, and various instructional videos. In total, 84 modules in 17 topic categories exhibited upward trends, as shown in Table 2. Figure 1 depicts the resource interface of all modules with a searchable component and a micro-survey for suggestions.

Table 2

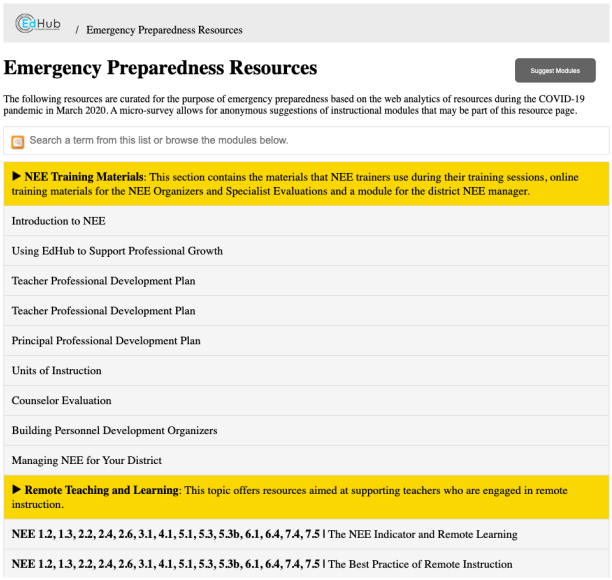
Curated Instructional Modules for the Emergency Preparedness Resource

Topics	Modules
1. NEE Training Materials	8
2. Remote Teaching and Learning	3
3. Assessment	7
4. Beginning Teacher Support	2
5. Building Instructional Skills	4
6. Classroom, School, and Community Culture	3

Topics	Modules
7. Classroom Management	1
8. Content Knowledge and Cognitive Engagement	2
9. Communication	2
10. Educational Leadership	4
11. Instructional Strategies	4
12. Professional Practices	1
13. Student Growth and Development	1
14. Technology	8
15. NEE Indicator Examples	8
16. Scoring Practice Videos	21
17. Units of Instruction Examples	5
Total	84

Figure 1

Emergency Preparedness Resource Interface



Discussion

This study examined user and resource access trends during the COVID-19 pandemic. Despite the downtrend in new users, resource access and web traffic exhibited a weekly uptrend at the start of the week (around 7:00 AM, 12:00 PM, and 5:00 PM), influenced by the start of the school year in August and the start of the summer session.

Implications for program management

These findings have implications for program evaluators, system administrators, and PD material developers. Evaluators should establish a baseline for user behavior, understand school year seasonality, and identify critical PD access times. Administrators should implement retention efforts and early alerts, especially when anticipated seasonality trends differ. PD material developers should strategically release online resources on Thursdays and Fridays. Thus, K-12 educators can access the latest PD releases during breaks on Mondays through Wednesdays of the following week.

Limitations

Although Google Analytics collects several variables, this study only considered Pageviews, New Users, and Returning Users as the most commonly used variables in previous studies (Leung, 2018; Leung, 2019; Leung, 2021). The study identified changepoints in PD resources at the second level of the EdHub Library module, covering all instructional activities. While not all module activities were accessed, the emergency preparedness resource is organized by modules to address K-12 educators' PD needs.

Conclusion

The study established a baseline for three academic years' user and resource access patterns. It also helped program managers select 84 online pedagogical resources for emergency preparedness planning to support K-12 educators' PD continuity efforts.

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Sustaining a Citizen Science Initiative Using an Augmented Reality-Related Technology Application

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This session presents reflections on the systematic process by which an Augmented Reality-related technology application coined as the Augmented Reality Rain Gauge (ARRG) was designed. After the design stage, ARRG was tested and deployed to support a citizen science initiative involving drought monitoring outreaches across Oklahoma public libraries. The goal of this initiative is to create awareness about drought and its related environmental conditions to educate volunteers on STEM library programs.

Introduction

Augmented reality (AR) enables users to superimpose virtual objects on a physical target in the real environment using a computer-assisted contextual layer of information (Azuma, 1997; Di Serio et al., 2013). The contextual layer of information employed by AR technology is usually made up of graphical texts and multimedia contents that are strategically situated around the physical object using digital platforms such as a mobile phone display, wearable glass, or goggles. The main reason for augmentation is to provide concise information situated around a physical object's attributes. However, additional characteristics of AR include its real-time interactivity and capacity to promote learning skills (Di Serio, et al., 2013). One of the advantages of the interactiveness of AR is that it enhances the "sense of place described as being comprised of two main elements: place attachment - the bond between people and places; and place meaning - the meanings that people ascribe to place" (Toomey, et al., 2020, p. 2). Creating a sense of place around a community's points of interest using AR encourages social collaboration within the community, which may ultimately motivate people to come back for more of such experience.

AR technology is also readily affordable as it improves learning performance through its effectiveness in improving user learning gains and motivation (Chen et al., 2017). Research has shown that AR helps increase student's academic achievement (Turan, et al., 2018; Yoon & Wand, 2014), increase student motivation (Di Serio, et al, 2013; Tobar-Munoz, et al., 2017; Yang, et al., 2018), and reduce the cognitive load (Turan, et al, 2018). The augmented reality rain gauge (ARRG) consists of a physical rain gauge embossed with an AR code that we designed for stickers that serve as an integral part of the gauge. Adding the AR code sticker to the rain gauge allows users to experience virtual interaction with the rain gauge through their mobile devices. One of the main attractive features of ARRG is the 'Make It Rain' application (MIRA), which runs on a smartphone or any mobile device connected to the Internet. The other main key design features of the ARRG applications are:

- Access to rain gauge installation guide for librarians.
- 3 CoCoRaHS videos on weather conditions monitoring.
- Access to CoCoRaHS weather station signup web page.
- Access to the spottyrain.org website resources, including factsheets on drought monitoring.
- Installation as a static display for library observation space.

Literature Review

Virtual and Augmented Realities in Learning

The concepts of virtual and augmented realities are relatively new in literature. The history dates back to Sutherland's work on head-mounted devices in the 1960s to the present situation, where there has been a tremendous advance in virtual and augmented reality through research work in the field of 2D image-based virtual reality and 3D graphics (Azuma et al., 2001; Di Serio et al., 2013; Liou et al., 2016;). An example of this development is visible in computer simulations, which are required to render augmented reality scenarios fully (Azuma et al., 2001; Vasilevski & Birt, 2020). According to Liou et al. (2016), learning scenarios embedded in augmented reality systems help student learning because students become more motivated in task repeatability and

completion. Similar to Liou et al. (2016) findings, as part of the mixed method study carried out by Di Serio et al. (2013) on students' motivation using augmented reality, Di Serio et al. (2013) discovered that many students achieve "higher levels of engagement in learning activities with less cognitive effort" (p. 595). Augmented reality has been used in the lab for science learning and corporate offices for workplace learning (Pejoska et al., 2016; Cheng & Tsai, 2012).

The social aspect of learning using augmented reality was explored by Pejoska et al. (2016) as a mobile learning discourse in the workplace. The researchers finding show that workplaces can be referred to as "microsites" where the focus is on personal learning experiences from available physical and social resources made possible by "augmenting synchronous communication in response to emerging contexts" (Pejoska et al., 2016, p. 476). In the same vein, Yang et al.'s (2016) observation of pre-service teachers indicates that social interaction increases with the use of mobile augmented reality applications in a chemistry lab. This interaction observed through a series of semi-structured interviews is relevant to my study because I can see how a clear collaborative effort emerges from participants in an augmented reality scenario, making them more motivated to work together efficiently. Considering the surmise that citizen science plays a major role as a prime mover of social learning and responsibility, Masters et al. (2016) claim that participation in citizen science projects has the potential to lead to increased scientific literacy. Another exciting part of this is that including augmented reality in education makes learning fun. It can increase motivation, which is also a significant factor in citizen science projects' volunteer recruitment (Saez-Lopez et al., 2020; Masters et al., 2016; Liou et al., 2017).

Purpose

The purpose of this study is to understand the experiences of Oklahoma library patrons, of small and rural libraries, who use the augmented reality application for community science projects. The study aims to find ways to increase the participation of rural Oklahoma library patrons in their use of the augmented reality application for community science projects such as drought monitoring. At this stage in the research, community Science is defined as the "scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions" (OED, 2014). On the other hand, augmented reality applications will be generally defined as visualized user interface tools that display multimedia content with physical objects on smart mobile devices. This study will find answers to the following research questions:

1. What are the experiences of Oklahoma library patrons, of small and rural libraries, who use the augmented reality application for community science projects?
2. What are ways to increase the participation of rural Oklahoma library patrons in their use of the augmented reality application for community science projects?
3. What are the attitudes of library patrons?

Method

The initial installment of the augmented reality rain gauge was done in coalition with the Southeast Oklahoma Library System (SEOLS), with 15 public libraries now having the rain gauges as static displays. To engage with the ARRG, the user downloads the Zappar app, which scans a code (like a QR code). Once scanned, the app provides both animation and audio effects that simulate heavy rain with thunderstorms. Participants engaged with the augmented reality rain gauge in the following steps:

The first point of engagement occurs when users see the Zapcode on the rain gauge, and they recognize that they must use an AR app to interact with the rain gauge. They can only interact with the app by installing the Zappar App on their smart devices. The second point of engagement occurs when users open the Zappar app on their devices and attempt to capture the Zapcode on the rain gauge using the back-facing camera of their device after a successful scan of the app a user-friendly interface is displayed on their device. The real engagement starts with the ARRG when users interact with menu items on the interface by tapping and selecting buttons such as 'Make It Rain' from where they can 'Play' or 'Stop' the rain effects, Home button is for the project's website homepage, while the Twitter button and Facebook button takes users to the project's Twitter page and Facebook page respectively.

If users do not have the Zappar App installed on their mobile devices, they will be directed to download it from either the Apple App Store or Google Play. The Zappar App is available for iPhone, iPad, iPod Touch, and most Android phones and tablets.

Findings and Discussion

The augmented reality rain gauge has been leading program changes because users find the application generally easy to use and interact with based on the affordability of the app and the physical rain gauge. The learning outcomes from our current iteration of ARRG arose from the installation of the gauge in library spaces to provide means by which librarians and library patrons can learn simple tasks and facts about drought monitoring and management. These learning outcomes include library patrons and librarians knowing where and how to access online resources containing information about weather conditions within their communities, library patrons learning how to set up their weather stations using the CoCoRaHS network webpage tool for signing up as precipitation observers and reporters, and library patrons knowing how to install their rain gauges with the help of the installation guide included with ARRG.

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Take Care of YOU: Guilt-Free Self Care

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Whether you are considering full-time remote work or you are a remote instructor, instructional designer, administrator, or corporate professional development personnel, understanding the need for self-care in a home-based work environment is important. During this conversational session, participants identified their challenges and benefits to working remotely. What was shared has also been found in research to exist. Additionally, participants shared their strategies for self-care and Dr. Kolski offered from research as well as her own experiences, additional strategies for maintaining physical and emotional well-being when being a full-time remote worker.

Introduction

Transitioning from a workplace office setting to a full-time remote, home-based working environment sounds easy. However, it then becomes more tempting to attend to domestic responsibilities, feelings of isolation can occur, or blurred work-life boundaries exist. Research is lagging on the utilization of effective self-care strategies - specifically for instructors, course designers, or other education/professional development occupations - when the person's work environment is solely remote or home-based. Through this conversational platform, participants shared the challenges and the benefits they find in working full-time remotely from home, as well as the self-care strategies they implement. Dr. Kolski shared self-care tips she has offered to others who have transitioned to full-time remote work.

Challenges when working full-time remotely, from home

Physical and emotional signs of stress and blurred boundaries between work and family roles dominate the challenges when working full-time remotely from home. Regarding physical health, working online can cause an individual to become sedentary. If one does not make intentional efforts to get up and move around, this can result in health issues such as heart disease and high blood pressure (Sprigg, 2020).

Working remotely can cause people to feel isolated when they do not come into an office daily. You miss the water cooler or coffee machine conversations that inherently happen in an office environment. Many people's motivation to

come to work involves social interaction (Cook, 2019). Additionally, when working remotely, you are more prone to working longer hours, which can lead to burnout.

Blurred work-life boundaries, or a lack of boundary setting between work and nonwork roles when working remotely from home, can lead to work or family conflicts and higher job turnover rates (Dahlberg et al., 2021). Difficulties detaching from work when working at home, having a lack of time buffers between role transitions, and having a limited space to create physical boundaries can result in boundary control challenges. Additionally, the technological enhancements lead to an 'always on' feeling (Dale, 2022).

Benefits when working full-time remotely, from home

Participants in the session identified the benefits of working from home as less time spent traveling, having fewer distractions or interruptions, engaging in exercise, and providing them increased flexibility to help with children, home-based chores, or doctor's appointments. Cook (2019) validated these perspectives in sharing working from home helps people manage their domestic responsibilities. However, caution should be taken to avoid these benefits from having a negative impact on their work productivity.

Self-care strategies when working full-time remotely, from home

Self-care refers to "the ability to refill and refuel oneself in healthy ways" (Gentry, 2002, p.48), including engagement in behaviors that maintain and promote physical and emotional wellbeing and that lessen the amount of stress, anxiety, or emotional reaction experienced when working remotely from home (Myers et al., 2012). The term self-care refers not only to an engagement in various practices but also to being caring toward oneself (Kissil & Niño, 2017).

Self-care in relation to physical health encompasses a focus on issues of sleep, exercise, and diet. Stress significantly reduces the quantity and quality of sleep, with poor sleep triggering greater stress the next day (Åkerstedt et al., 2013). Additionally, insufficient sleep is linked to exhaustion and low professional efficacy, and higher levels of stress. Effective sleep hygiene techniques include maintaining a regular sleep schedule, making one's sleep environment restful, and avoiding going to bed hungry or thirsty (Mairs & Mullan, 2015). Dale (2022) also suggested shutting off screens before bedtime and utilizing sleep apps that can help users fall asleep and track their sleep patterns. Regarding nutrition, participants shared their successes with keeping a water bottle at their desks to encourage drinking water during the day. Similarly, participants explained the importance of meal preparation and planning for lunch and snacks during the day.

Working remotely involves active time management and requires self-discipline. Creating work boundaries and setting boundaries when working from home to allow for a healthy work-life balance is an important self-care strategy. When working remotely, the volume of email traffic that you receive increases (Cook, 2019). Prioritize your reading and responding to email. Be realistic in what you can accomplish in eight hours. Use a schedule or hourly planner and designate time to completing tasks, then stick to your timeframe. Include in your schedule dedicated time for taking breaks. Take a three-to-five-minute break every hour by standing up and physically moving around. Other forms of exercise incorporated throughout the day could include walking, yoga, running, or stretching. There might be the temptation to take one's lunch break or snack breaks whenever it seems convenient, but it is a better practice to be intentional in preparing food to be consumed, scheduling snacks, movement breaks, and lunch breaks before beginning the workday. Create a shared household calendar, allowing all household members to be on the same page about meeting times and when quiet time is needed. Lastly, to establish work-life boundaries, it is important to turn off work computers outside of regular work hours.

Having a dedicated, private workspace that is also organized, clutter-free, and distraction-free is imperative when setting work-life boundaries while working from home (Dale, 2022). Create an office environment in your workplace area

of your home (i.e., put out family pictures, use ergonomic support products, have adjustable heights of desks and screens). Have a dedicated work space at home and the technology available to support remote working.

Establish a workday support network and an after-work support network and strive to maintain connections with bot. Connect with colleagues by engaging in and/or creating virtual coffee hours. It is also important to spend free time with household members, friends, community groups and organizations outside of work hours. Social support is a valuable element of self-care and a way to promote individual well-being (Barnett & Homany, 2022). Having a satisfying social support system is linked to greater self-esteem, lower anxiety and depression, and less use of avoidance coping strategies.

Emotional expressions and practicing mindfulness techniques are additional effective self-care strategies when working full-time remotely, from home. Emotional expression can include talking or writing about your day (i.e., in journals or through creative writing), having a good scream, cry, or creative expression (i.e., painting, coloring). Mindfulness is a mental state achieved by focusing one's awareness on the present moment while calmly acknowledging and accepting one's feelings, thoughts, and bodily sensations (Cook, 2019).

To truly engage in self-care, we must also consider how congruent our values are with our actions in all the other areas of our lives. A lack of congruence between personal and work values can be tied to burnout, while living according to one's personal values has clear implications for well-being (Veage et al., 2014). When we spend even just a few moments with what we value and take a break from our busy minds, we offer ourselves a small act of self-care. Even in small amounts, acts of self-care contribute to our overall sense of well-being and resiliency over time (Neff, 2023). Specific domains of self-care practice, include awareness, balance, flexibility, and spirituality.

Awareness

Awareness involves having knowledge about what is taking place around you, monitoring one's own needs, and being aware of work stressors (Lopez, 2017). Self-monitoring and awareness have also been related to experiencing lower levels of emotional exhaustion, burnout and compassion fatigue, a greater sense of gratification in one's work, and an ability to maintain emotional balance in difficult situations (Sansó et al., 2015).

Balance

Balance refers to distributing one's attention to various aspects of life, ensuring not to neglect important facets, and to maintaining a sense of equilibrium in both personal and professional realms (Sirgy & Wu, 2009). Strategies to achieve balance include leisure time, engaging in a variety of professional and personal activities, and cultivating non-work-related passions, interests, and relationships.

Flexibility

Flexibility includes finding ways to internally manage and externally respond to the varying demands of your work (Posluns & Gail, 2020). Having an inflexible coping response style can have a negative impact on ones' well-being. Attending to and regulating your emotions and setting and reappraising goals are practices that can promote flexibility (Miller & Sprang, 2017).

Spirituality

Posluns and Gail (2020) defines spirituality as a search for the sacred in one's life that encompasses aspects of connection with self, others, and the divine, as well as purpose and ultimate meaning. Experiencing a sense of spiritual connection dispels feelings of isolation and contributes to the belief that you are a part of something larger, more meaningful. Spiritual practices include prayer, meditation, and spending time in nature.

Self-Compassion

Self-care also includes the practice of self-compassion. Self-compassion is a practice of goodwill, not good feelings (Neff, 2023). The friendly, supportive stance of self-compassion is aimed at finding control over the situations we can

influence, focusing on our breathing, the sensation of the soles of your feet on the ground, or taking deep, cleansing breaths or petting the cat. By doing so we give ourselves what we need in the moment and is self-compassion that will allow us to move forward more effectively.

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Teaching Moral and Ethical Values Through Game-Based Learning

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This study explores the use of game-based learning to effectively teach moral and ethical values, employing the experiential learning theory). The research question seeks to understand how moral and ethical values can be taught through game-based learning. The literature review underscores the influential impact of games on behavioral patterns and cultural norms, emphasizing their relevance in teaching ethics. Engagement through game-based learning is discussed to enhance student involvement in the learning process, and the challenge of selecting appropriate games for ethical education is addressed, introducing the EPIC framework as a valuable tool for educators in game selection for teaching moral and ethical values.

Introduction

Core values like honesty and integrity are integral for success across various life domains. Scholars, exemplified by Turbill (2015), have expressed apprehensions regarding the efficacy of traditional face-to-face methods in imparting these values. Game-based learning offers a promising avenue for effectively teaching moral and ethical values by leveraging the historical use of games and play as educational tools (Schrier, 2019).

Research question

Building on the successes observed in the educational use of games over the past two decades, according to Schrier (2017), this study answers the question below:

How can teachers leverage games to teach moral and ethical values?

Theoretical framework

We employed the experiential learning theory David Kolbs et al. (2014) developed to facilitate a thorough understanding of this research. This theory underscores the significance of experiential learning in the educational process and is

divided into four key phases. The first involves the practical experience of engaging in real-life activities, which is critical for grasping concepts and gaining hands-on expertise. Second, learners observe and reflect upon their experiences. Third, learners conceptualize a theory or model based on their observations, and finally, learners plan how to test this theory or model in future experiences.

Applying this theory to our study, it is crucial to acknowledge that different professions require different experiences; for example, the experiences needed by an engineer differ from those required by a medical doctor, educator, and so on. These cognate experiences are integral to professionalism. Given this background, the game offers a neutral learning environment that enables learners to act out a variety of scenarios, engage in experimentation, and acquire knowledge through active participation (citations). Following a gaming session, students self-reflect to evaluate their performance and consider strategies for enhancement. They subsequently conceptualize and strategize for their successive gaming encounters. This cyclic process resonates with the core objective of imparting moral and ethical values, which can be challenging when employing traditional teaching methods.

Literature review

Because games play a very crucial role in experiential learning, teaching abstract concepts like ethics with games has been the subject of increasing attention. In a study, Khodabandeh and Garavand (2020) acknowledged parents' vital role in children's education. They encouraged them to take a fundamental principle seriously in the world of games, which is to understand and think at the child's level while engrossed in the games. They described such a good teaching strategy. They exemplify the need to defend the national value system of people against hidden intentions inherent in games, especially Western ones that may pose a significant threat to the younger generations, who are continually becoming much more fascinated by games.

In the qualitative study by Anggraini and Wahyuni (2021), religious and moral values are said to be essential in early childhood education, being the foundational level of their lives. Hence, there is a need for all hands to be on deck regarding the development of children's moral and religious values, aimed at a better society. The authors also posited that children learn quickly when knowledge is embedded in play. To develop the moral and religious values of a child, therefore, the hope is that games can provide vital support, like in the case of the “cublak-cubla suweng” game, which bears values such as cooperation, proactiveness, creativity, accuracy, and responsiveness (Anggraini & Wahyuni, 2021).

Playing games involves making a lot of critical decisions. According to Staine et al., (2019), cognitive psychologists noted moral decision-making as a dual process: implicit intuition and explicit reasoning. While implicit intuition indicates a cognitive process that happens automatically, explicit reasoning is rational and requires deliberate efforts. Staine et al. (2019) believe that the designers of serious games find the interaction between implicit and explicit cognitive processes very relevant. Susi et al. (2007) define serious games as games designed for other purposes besides pure entertainment. Against the backdrop that serious game design is often based on the constructivist view; a view that learners can construct knowledge when they are motivated, Staines et al. (2019) designed a model based on moral psychology and serious games. Such a motivational component of serious games underscores the widespread application of serious games in various fields to enhance learning experiences.

To our knowledge, the ongoing discussion needs an explicit exploration of how games, designed for educational purposes beyond entertainment, address the intricate moral decision-making process identified by cognitive psychologists like Staine et al. (2019).

Methods

Our literature review followed the Cresswell (2018) outline by first prioritizing pertinent terms such as "ethics," "morals," "game-based learning," and "ethics and games." Subsequently, we searched Google Scholar, the University Library system, and the ERIC database to locate relevant academic literature, employing peer-reviewed journals as an inclusion criterion, and ranked the search results to concentrate on the most valuable materials. We proceeded to scan and map related literature and categorized the results topically. We synthesized literature to provide clarity and coherence in the study.

Based on thematic analysis, the review revealed key findings relating to the benefits of employing games to teach ethics, selecting suitable games to teach ethics, and the roles of games in culture preservation.

Themes

Why games?

Generally, games are credited with many benefits that educators can leverage in this age and time. They make a powerful and lasting impact, especially on young children, as players are always willing to stay committed to gameplay for as long as possible, even when it distracts and reduces productivity. Indeed, many studies have attested that games can influence children's behavioral patterns and cultural norms as well as make content more personally relevant to learners (e.g., Schrier, 2019; Khodabandeh & Garavand, 2020; Anggraini & Wahyuni, 2021).

In a descriptive study, Khodabandeh and Garavand (2020) established and recognized games as excellent means through which "producers' concepts 'are conveyed to the target audience, more often children, who are easily fascinated by games. Anggraini and Wahyuni (2021) highlight getting used to being friendly, introducing honest behavior, introducing sporty behavior, introducing polite behavior, teaching a sense of tolerance, teaching cooperation, and training children's creativity as virtues that games, especially local games, offer the gamers. Recall that younger students are easily motivated and attracted to playing games and carrying out game-related activities. In view of this, Anggraini, R., & Wahyuni, A. (2021) indicated a significant impact on the social interaction of each child in doing the cubak-cublak Suweng. While video game experts are skilled at tracking objects and making quick, accurate decisions, traditional games typically involve singing and playing (Walter et al., 2008). Schrier (2019) argues that games should be used to promote moral and ethical behavior in the pursuit of humanity's betterment.

Engagement through game-based learning

Educators face many difficulties engaging students in teaching and Learning; they battle for their attention amidst distractions with the advent of emerging technologies. Appropriating games in the learning process can increase students' engagement (citations). It can support learners changing views and keep them fully engaged within the classrooms. Khan et al. (2022) utilized the Game-Based Learning approach to design a self-paced-cybersecurity platform where students could learn different walk-through challenges, given the right tools to enhance better engagement.

Choosing appropriate games

Educators often face challenges in selecting suitable teaching and learning games, particularly those that incorporate moral values. This section introduces relevant theories and a framework for identifying and choosing games aligned with ethical principles. Various research studies, including those by Haidt & Bjorklund (2007), Kohlberg (1984), Lapsley & Narvaez (2005), and Rest (1983), apply a cognitive approach to elucidate moral structure and function. Schrier's (2015)

Ethics Practice and Implementation Categorization (EPIC) framework emerges as a valuable tool for educators, providing a structured approach to choosing video games that support the teaching of moral and ethical values (Schrier 2017). The EPIC framework encompasses educational objectives, emphasizing ethical awareness, emotional intelligence, character development, and knowledge of critical ethical concerns. Additionally, it outlines educational strategies associated with effective ethics education. While the framework aids in classifying games, Schrier (2017) extends the criteria to include factors such as availability, mainstream popularity, ethical considerations, and player responses when making game selections for ethical teaching.

Analysis

Based on the themes that emerged, this study reflected the contributions of various scholars, such as Khodabandeh and Garavand (2020), who argued that some foreign games usually come with predetermined goals that are capable of eroding cultural values, thereby advocating for incorporating indigenous content in game development. Anggraini and Wahyuni (2021) highlighted the role of traditional games in connecting family members and promoting cultural values.

Finally, Khan et al. (2022) underscored the capacity of game-based learning to facilitate the comprehension of complex concepts.

Additionally, the preservation of cultural and moral values through games, especially traditional games, is emphasized. Traditional games are acknowledged as essential in promoting religious and moral values among individuals from childhood, fostering lifelong bonding and engagement within families (Wahyuni, 2021). Overall, the major findings point to the potential of game-based learning in addressing the complexities of teaching moral and ethical values, as summarized in the chart below.

Figure 1

Summary of the findings from the literature

Implications

Including moral principles through games in the curriculum is crucial for tech-savvy students who are easily drawn to games and play.

Conclusion

An extensive study on the effects of games on students' academic achievement is highlighted in the literature review, which also emphasizes the significance of discovering extra advantages and aims, particularly in encouraging moral and ethical development. The emphasis is on how educators can use games or game elements to teach students moral values effectively, realizing that teachers can use games to impact outside of the classroom, where students spend a large portion of their waking hours.

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Technology for Good or Evil? Asking Five Critical Questions of ClassDojo

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ClassDojo is a widely popular PK-12 classroom management platform. Recently, critical Ed-Tech scholars have advocated for examining whether or not educational technology is designed ethically. As such, we adopt a technoethical approach where we ask five critical questions about ClassDojo (Krutka, Metzger, & Seitz, 2022) to examine its pedagogical and ethical impacts. Our findings indicate that ClassDojo can reinforce behaviorist teaching and learning practices in exchange for pedagogically-sound practices.

Introduction

ClassDojo is a widely popular PK-12 classroom behavior management tool used by over 50 million teachers (ClassDojo, n.d.) and 90 percent of schools in the United States (Chaykowski, 2017). Marketed as a classroom management tool, "where classrooms become communities, (ClassDojo, n.d.), ClassDojo is a staple in PK-12 classrooms. As a platform, ClassDojo provides an online space where teachers and parents can share students' learning experiences in school and at home through photos, videos, and messages. At first glance, ClassDojo seems to be a resource that every teacher should use and will benefit from. However, upon further inspection, and partly driven by our own experiences with the platform, we question if it is ethical to use ClassDojo as a tool to "manage" learners. In this article, we conduct a technoethical audit by asking five critical questions of ClassDojo (e.g., Krutka, Heath, & Smits, 2022; Krutka, Metzger, & Seitz, 2022) to better understand if ClassDojo is designed ethically and the impact it can have on teaching and learning practices. This research contributes to an ever-growing corpus of critical scholarship employing technoethical approaches (e.g., Gleason & Heath, 2021). In addition to being of value to the field broadly, we argue that this article will be especially beneficial for pre-service and current educators. In the following section, we review relevant literature exploring the use of ClassDojo in PK-12 classrooms. We also leverage the work of critical educational technology researchers to frame our examination of ClassDojo. Lastly, we detail the steps we took to conduct our technoethical audit.

Literature review

Our initial interest in being critical of technology is inspired by the work of Audrey Watters (2019, 2021), who illuminates how beliefs and assumptions about teaching and learning, typically resting on behaviorist practices, often guide the development and use of educational technology. Leveraging Watters' (2019) work, we consider how technologies, like ClassDojo, have become a method for socially engineering classroom interactions. To prepare for this endeavor, we reviewed existing literature surrounding ClassDojo as a means to inform our "data collection" and our perspective.

Generally, research exploring ClassDojo identifies the potential it has for improving teaching and learning and often features a techno-solutionism ideology. For instance, Bahçeci (2019) found that ClassDojo is an effective method for increasing tenth-grade students' positive behaviors, that is, adherence to classroom social norms and academic studying habits. More specifically, Bahçeci identified that ClassDojo resulted in learners having a higher awareness of their behaviors and whether or not their behaviors needed to improve without prompting. Similarly, Cetin and Cetin's (2018) research with middle school students found ClassDojo to improve students' emotional and behavioral regulation skills and identified that middle school students generally had positive opinions of ClassDojo. However, critical scholars have argued that further inspection of ClassDojo reveals more troubling concerns. Manolev (2019) suggests that although ClassDojo may encourage positive behaviors (i.e., staying on task, being obedient, doing work quietly, etc.), it does not address the root cause of a behavior issue, in turn creating a "performative culture" where students act in a manner that will award them points. As a result, there is no guarantee that the behaviors that are performed will remain the same when the point system is removed. Further, Robinson (2021) argues that the public tracking of students' behavior data creates skewed power structures that reinforce teacher surveillance practices and leave students "feeling frustrated by perceived failure, stymied by a lack of agency, anxious about exposure, or nervous about surveillance" (p. 600). As a result of these surveillance practices, Krach and colleagues (2017) raise concerns regarding students' privacy and the impact these practices may have on students' health and well-being (see also Soroko, 2016).

With the immense popularity that ClassDojo has received paired with more critical critiques of ClassDojo's integration in PK-12 classrooms, we find it necessary to embark on a technoethical review of the platform. Technoethical audits (Krutka et al., 2019) are used to better understand if a technology is designed ethically. In particular, technoethical audits seek to generate a holistic understanding of a particular technology, the guiding principles embedded in the technology, and the impact the technology can have on teaching and learning practices.

Method and procedure

Our critical evaluation of ClassDojo began in an undergraduate Introduction to Technology in Education course. In this course, students (i.e., pre-service educators) are exposed to a wide range of educational technologies that they can consider for use in their future classrooms. Additionally, students evaluate popular classroom technologies, including how they can impact teaching and learning practices and the values and assumptions about learning that may be embedded in the technologies.

We first encountered the "ethics" of ClassDojo during a two-part class activity. Prior to this activity, students had been investigating how "sketchy" technological practices, like surveillance, are often integrated into popular educational technology currently used in PK-12 schools. In the first part of this activity, students spent about thirty minutes exploring the ClassDojo website, paying particularly close attention to how the site was designed, what sort of language was used to describe ClassDojo, including how the product was marketed and the promises it made to potential users. Ultimately, students revealed several positive characteristics, from the uplifting messages the site advertised to the cute monsters that were included on the homepage. In the second half of this activity, students revisited the ClassDojo website, however, this time their review was framed by Watters' (2014) critique of "teaching machines." Leveraging Watters' (2014) language, students raised several concerns, the impact of publicly displaying students' behavioral data on learners being the most prominent. Although this initial examination of ClassDojo resulted in several concerns, we recognized a need to take a more systematic approach to our investigation. So, we adopted Krutka and colleagues' (2022) five critical questions about technology to better understand the unintended consequences of using ClassDojo (see also Krutka et al., 2022). Following Krutka and colleagues, we use the following questions to guide our analysis:

1. What does society give up for the benefit of ClassDojo?
2. Who is harmed, and who benefits from ClassDojo?
3. What does ClassDojo need?
4. What are the unintended or unexpected changes caused by ClassDojo? And,
5. Why is it difficult to imagine our world without ClassDojo?

Using publicly available data, we briefly share our findings in the following section and identify the implications of our findings for both pre-service and current educators.

Findings

At first glance, ClassDojo is appealing with its simple interface, bright colors, and animated characters (i.e., Dojo Monsters), along with its branding reinforcing the idea that ClassDojo will "Engage students!" and "Communicate with families!" (ClassDojo, n.d.).

However, inspection of ClassDojo's terms of service reveals concerning data collection practices, including the privacy of its users. Agreeing to use ClassDojo can grant the platform access to students' "juvenile dependency records, medical records, social security numbers, biometric information, disabilities, socioeconomic information, political affiliations, religious information, search activity, and geolocation information," among other forms of personal data. Additionally, positive behaviors are encouraged by displaying behavior points for all students to see (e.g., Soroko, 2016). As willing users give up personal data to use the platform, ClassDojo renders its most harm on students with behavioral problems, or those students lacking emotional or behavioral support, and grants all students visual access to their peers' behavioral ranking. In turn, ClassDojo can reinforce teacher biases, and lead to teachers implicitly labeling "problem students" based on their behavioral data.

Further, and although it may be unintended, ClassDojo's tracking system places additional pressure on both students and teachers. This simple yet consequential system can perpetuate unhealthy competition standards that decrease students' participation and sense of belonging (Wang & Holcombe, 2010). Students may also become focused on their points instead of their educational growth, resulting in detrimental comparative habits. Similarly, it persuades educators to focus away from content instruction to desired behavior adherence. As current educators and pre-service teachers continue to be trained on the importance of classroom management, it becomes even more difficult to avoid tools that suggest that they can easily manage students' behaviors for them.

Discussion

Our review of ClassDojo reveals problematic pedagogical implications, especially in terms of how it can impact instructional practices. As current and pre-service educators, we advocate for critical reviews of technology use. Further, we hope this review prompts new pathways for how pre-service educators are introduced to technology and its capabilities throughout their training and coursework. We suggest that critical examination of technology becomes a focal point of teacher training, including how to evaluate the pedagogical impacts of emerging technologies holistically.

Furthermore, as we reflect on educational technology that is becoming increasingly available, we must be mindful of how technology can transform learning experiences positively and negatively. As Watters (2014) suggests, our aim should not be to condemn, but to better "understand, explicate, and to place in practice" (p. 46-47). Thus, we encourage greater emphasis on examining the design and ethical use of technologies that are being promoted for inclusion in schools and educational systems and argue for broader adoption of techno-skeptical practices. Our goal with this approach is not to suggest that technologies like ClassDojo are exclusively harmful, rather we use it as a reminder to not overlook dangerous drawbacks concerning data usage, privacy, and pedagogy (Krutka et al., 2019, Watters, 2019).

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The Application of Automatic Teaching Evaluation System Based on UTOP and ST Analysis

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AECT
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Teaching evaluation is an effective way to improve the quality of teaching. Nevertheless, traditional teaching evaluation has some problems, such as high labor costs, low efficiency and, based on experience or standards, etc. As well, EAIT has been highly developed in recent years. In this study, the automatic teaching evaluation system is adopted. Through focus group interviews, a comprehensive investigation is conducted on the views and improvement of teachers of various subjects in primary school on automatic teaching evaluation.

Introduction

Research shows the most effective teacher professional development has the following characteristics: expect teachers to examine and reflect on their own practice (Putnam, 2000; Richardson, 1994). The assessment of teaching can support after-class reflection and practice improvement. However, traditional assessment activities have developed some problems that need to be improved, such as the evaluation of lessons based on experience and standards, the lack of evidence-based opinions, etc. (Fang J.2014).

At present, artificial intelligence is gradually integrated into the reform of education evaluation, and a series of Educational Artificial Intelligence Tools (EAIT) have appeared, which can support the automatic teaching evaluation system (AET-system) of elementary education teachers' teaching quality. The quantitative evaluation of classroom teaching behavior reduces the influence of evaluators' subjective experience (Haudek, K.C, 2020). Simultaneously, automated collection and analysis decrease labor costs and can promote the improvement of teaching quality (Kashyap, M.C, 2018).

This paper primarily applies the AET system in experimental schools and analyzes teachers' views through questionnaire surveys and focus group interviews. We will explore the trend of teaching assessment in the future from the advantages and disadvantages of automated teaching evaluation, hoping to promote the development of classroom evaluation in China.

Literature review

Development of assessment tools

The traditional classroom teaching evaluation in China mainly includes two parts. First of all, the evaluator will listen to the teacher's whole teaching process to understand the characteristics of the teacher's teaching. Secondly, teachers should be evaluated, including evaluating teachers' success or failure in classroom teaching and giving reasons. At the same time, evaluators should also analyze the problems in the classroom and propose solutions (Lei Li, 2015). Teaching evaluation can improve teachers' ability to solve practical classroom teaching problems (Guanghua Shao, 2004). Absolutely, the evaluation tools have also been advanced in the development of technology, which has gone through two stages (see Table 1).

The traditional paper and pencil recording stage mainly relies on manual observation of the classroom record after class analysis. Labor costs are high, and the dimensions of records are not comprehensive. There are primarily seating chart observation records (SCORE) (Acheson, 1987), the FIAS interactive analysis system (Flanders, 1970), and the S-T analysis method (Yingjie Shan, 2008).

In the stage of multimedia technology recording, classroom teaching behavior is mainly recorded with the assistance of experts, a camera, or portable equipment. After each dimension is quantified by computer, it is analyzed manually or with the help of big data. For example, an interactive analysis coding system (ITIAS) based on information technology (Xiaoqing Gu, 2004) and wearable sensors record teaching behavior (Prieto, 2018).

It can be seen that China's current teaching evaluation still has the following deficiencies: high labor cost and low efficiency; evaluation data is not easy to keep; class evaluation is based on experience and criteria. Nowadays, teaching evaluation is turning to “subjective experience” and “data.” The AET-system not only provides data but also supports the reasonable selection of expert comments. Meanwhile, it greatly decreases evaluating costs and changes the traditional pattern.

Table 1

Development of evaluation tools

Stage	Method	Record	Content	Disadvantage
Traditional	SCORE	Manual	teacher-student interaction	high labors; not comprehensive
	FIAS	Manual and Computer	teacher-students interaction	
	S-T	Manual and Computer	teacher-students interaction	
Multimedia	ITIAS	Computer	interaction	High costs Poor efficiency
	Wearable device	Computer	Voice and physiological data	Not comprehensive

AI-system for Automated Teaching Evaluation

The AET-system mainly uses voice and text analysis technology based on the classroom observation evaluation framework UTOP (UTeach Observation Protocol) and S - T class teaching method to automatically analyze the classroom.

After the automatic evaluation of a lesson, the AET-system will automatically generate a report. The evaluation report can be seen in Figure 1. In addition, various dimension indexes and explanations based on the UTOP and the ratio of S-T behavior will be presented. The system will also present the visualized graphs of teacher intervention times, student participation activities, high-frequency words, immediate evaluation, exploratory questions, resource application, the proportion of content asked, the proportion of teacher-student interaction, the proportion of teacher-student behavior, etc.

Figure 1

AI system evaluation report

二、课堂教学行为数据概览

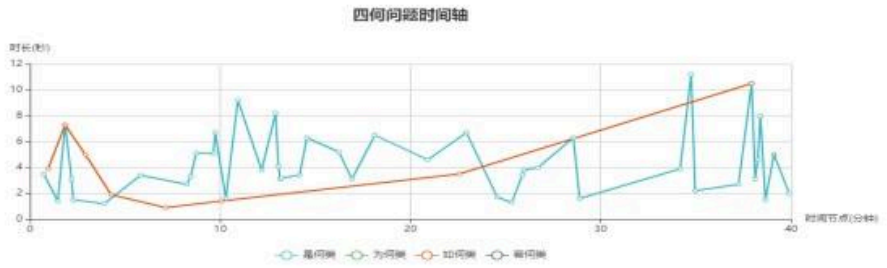
1.课堂环境 Classroom Environment

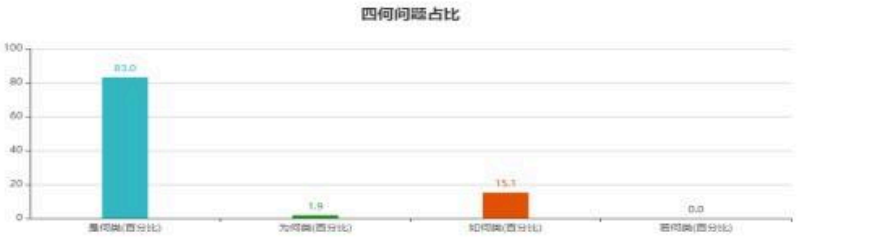
依据	证据或关键点	数据或信息	指数	说明
课堂互动	小组活动或展示(百分比)	88.9	6.1	学生之间通过合作解决问题。
	实验实践(百分比)	11.1		
课堂干预	教师课堂管控(百分比)	10.0	9.6	教师的管理指令清楚有效，学生能保持良好的课堂纪律。
	教师观察或巡视(百分比)	90.0		
课堂参与	学生参与度（百分比）	93.1	9.3	创造良好的课堂氛围，让学生提出想法、问题等。
课堂对话	学生机械性回答(百分比)	28.7	8.5	课堂检查、活动关注。
	学生认知记忆性回答(百分比)	49.5		
	学生推理性回答(百分比)	19.8		
	学生创造性回答(百分比)	2.0		

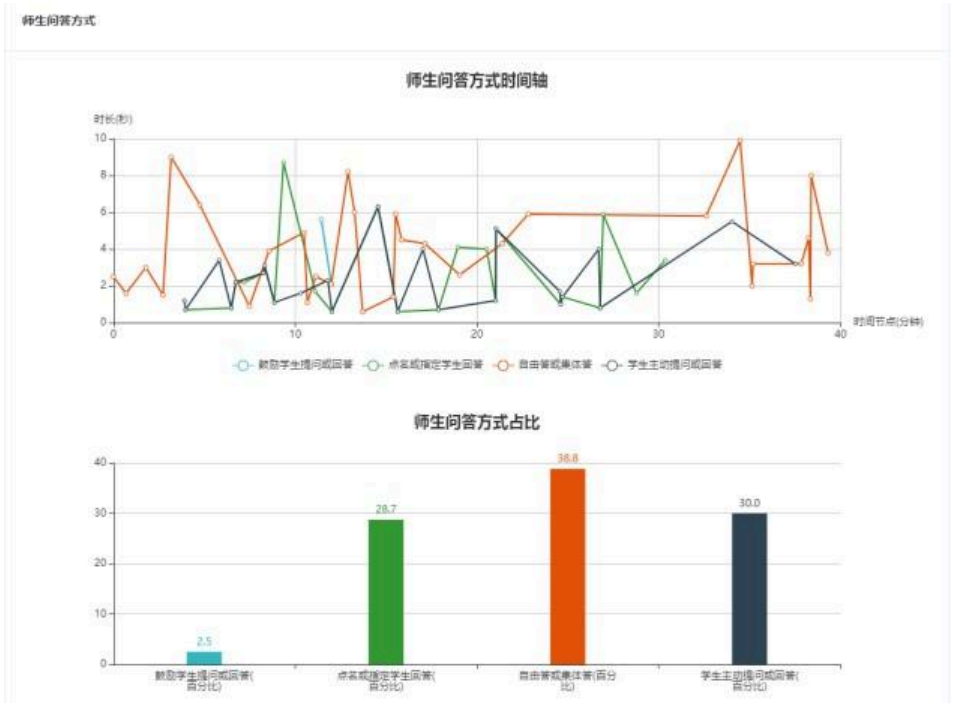
四、4MAT分析

1.四何问题

四何问题







Research Questions

The purpose of this study is to empirically examine teachers' perceptions of accepting an automated lesson evaluation system. Specifically, three research questions are set for achieving the research goal:

RQ1: What are the advantages of using an automated teaching evaluation system in teaching?

RQ2: What are the disadvantages of using an automated teaching evaluation system in teaching?

RQ3: What should the automated teaching evaluation system improve in the future?

Method

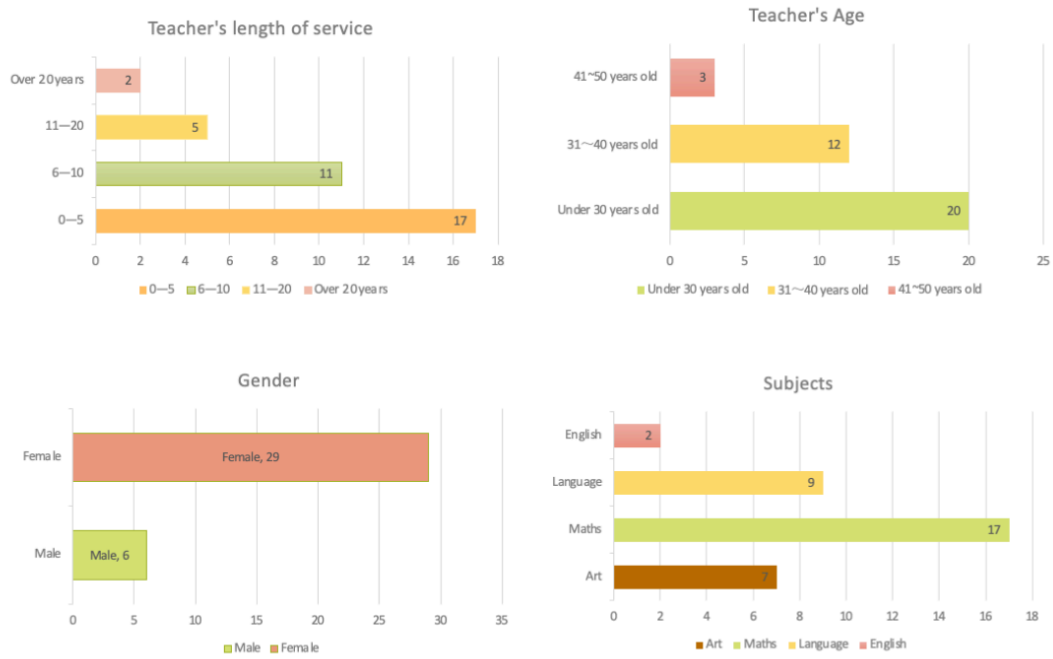
Participants

Prior to the experiment, all participants had signed informed consent forms, agreeing that their information would be used for research purposes. The current study involved 35 teachers, including 83% female (n = 29) and 17% male (n = 6). The English teacher, Language teacher, Math teacher, and art teacher were 2, 9, 17, and 7, respectively. Detailed demographic characteristics of the participants are presented in Figure 2.

Eight people were randomly selected to participate in interviews. When the eight participants entered the classroom, they were told the purpose and topic of the interview. The survey took about 1.5 hours.

Figure 2

Experimenter related information



Procedure

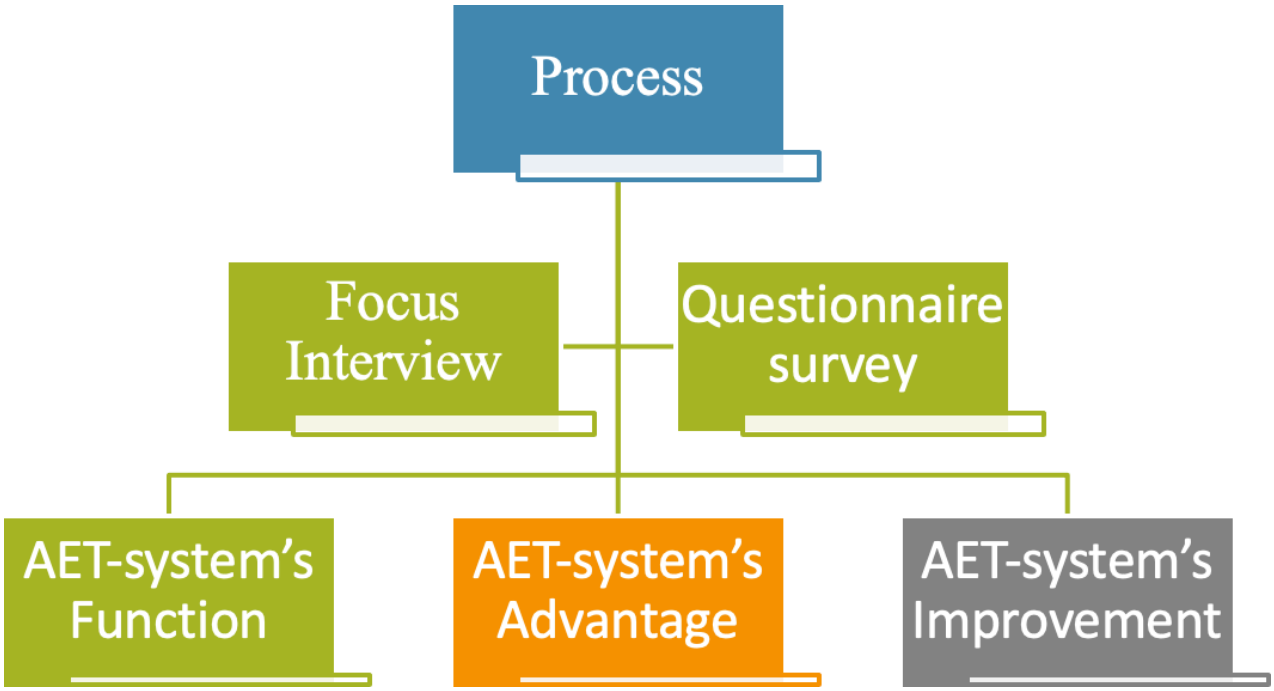
This study will introduce participants to the automated teaching evaluation system, including how the system operates, its functions, and the results of system analysis. Use the system to evaluate the teacher's classroom teaching and present the analysis results to the teacher. It mainly includes classroom environment, lesson structure, implementation, and content, as shown in Figure 1. After the teachers had checked the evaluation results, questionnaires were issued to investigate the teachers who had participated in the evaluation. And randomly selected teachers to conduct interviews. The main experimental process is shown in Figure 3.

The questionnaire was designed to be completed independently by participants using their personal electronic devices. Participants were estimated to spend approximately 15 minutes in total providing responses to the demographic items (1 minute), 17 items on the result's validity and accuracy (6 minutes), as well as 15 items on the system's usefulness and ease of use questionnaire (6 minutes).

We mainly adopt Focus Group Interview, which is a method by which researchers formulate specific topics and collect materials in group discussions. Using this method, we can carry out a "conversational" exploration of the research object, deeply understand the interview object, and obtain original materials in the actual investigation. Thus, the topic of the interview is whether the results of automatic evaluation based on the system contribute to the improvement of teaching quality.

Figure 3

Experimental process



In the interview process, the researcher will gradually draw out the teachers' opinions and suggestions on the application of automatic evaluation of educational products, including their own requirements. After sorting out the interview content, the advantages and disadvantages of applying AET-system in primary schools and the improvement direction of course evaluation in the future are preliminarily determined.

Results

Reliability analysis

To ensure that the study maintained good quality data, data with missing answers were discarded, leaving valid answers. 35 valid questionnaires were collected. The reliability analysis conducted on the questionnaire demonstrated good internal consistency, with a Cronbach's alpha coefficientof 0.963.

Table 2

The questionnaire Cronbach α coefficient

Subject		Cronbach α
	Classroom Environment	0.942
AET-system's validity and	Lesson Structure	0.914
accuracy of the results	Implementation	0.866
	Content	0.928
AET-system's the usefulness and ease of use 0.943		

Advantages and Disadvantages of AET-system

Most teachers agree that the application of automatic evaluation systems in the teaching and research activities of primary schools can effectively solve the limitations of time and space. It can support teachers to conduct timely evaluation in their spare time after class. At the same time, the method of automatic record analysis provides a certain basis for evaluation, and it is highly efficient so that the classroom can be analyzed quickly and the teaching strategy can be adjusted in a timely manner.

Interview data：

Teacher A: "Automated evaluation can greatly reduce the time we spend writing notes and give more time on advising teachers."

Teacher B: "The quantitative method provides evidence to support our suggestions, making them more accurate and appropriate."

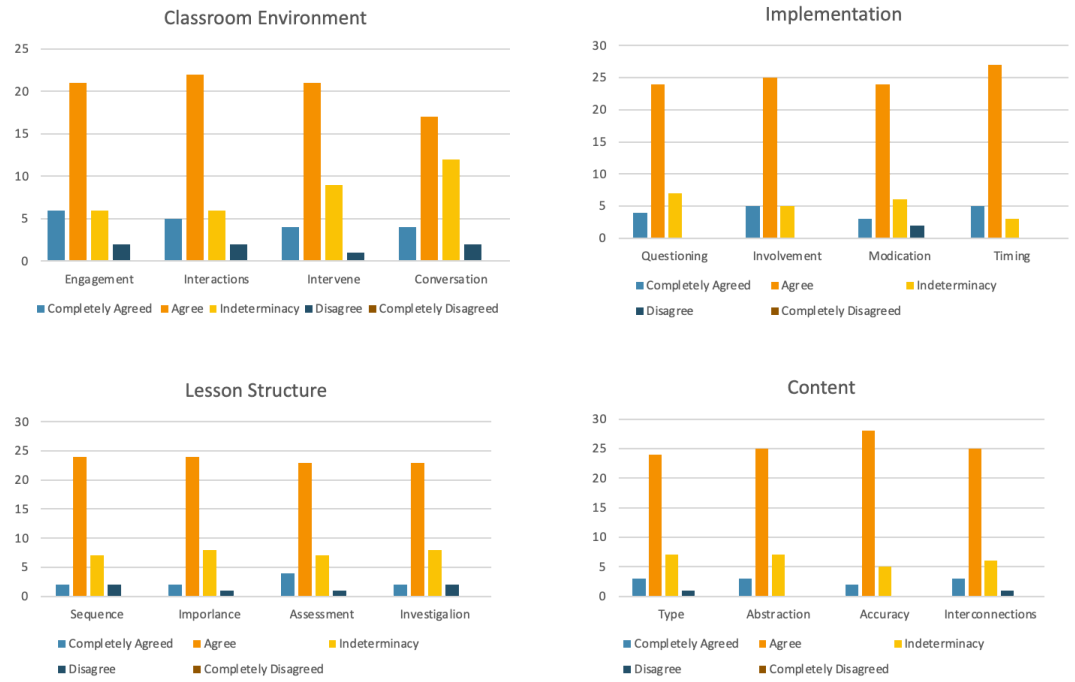
Teacher C: "The generation time of evaluation results is fast, and teaching can be improved according to the evaluation report in time."

Teacher D: "But the evaluation results were presented only in charts without corresponding improvement strategies."

Teacher E: "The evaluation of the class was fragmentary and incomplete, and the interpretation of visual charts was few, and no constructive suggestions were put forward. It may lead to formalization of teaching and deviation from art."

Figure 4

Data analysis result



The Direction of Improvement

In addition to the graphic presentation, the automatic evaluation report also needs to put forward a diagnostic evaluation. According to the improvement points of the teachers, the corresponding improvement suggestions can be given from multiple perspectives, so as to enable the teachers to make improvements based on their own teaching.

Interview data:

Teacher B: "The evaluation criteria should be divided according to subject knowledge field, teacher development stage, subject research situation, curriculum type, etc."

Meanwhile, the evaluation criteria should absorb excellent scales and combine the subject characteristics to develop the evaluation criteria of each subject, so that the evaluation results are more accurate and appropriate.

Conclusion

Nowadays, teaching evaluation is turning to "subjective experience" and "data." The AET-system not only provides data, but also supports the reasonable selection of expert comment. Meanwhile, it greatly decreases the cost of evaluating and changes the traditional pattern.

This study finds that the automatic evaluation system can be accepted and applied by primary school, and it has benefits in the evaluation subjects, manners and results, etc. However, it also has the following shortcomings: lack of in-depth exploration of the evaluation subject needs; evaluation results are simple, lack of diagnostic evaluation of teachers, difficult to support teachers personalized reflection.

Therefore, the future automated evaluation system will be human-AI coordination and mutual promotion, multi-subject division of labor cooperation, multi-subject evaluation mode, and integration of multi-subject knowledge and wisdom forming a perfect evaluation system to provide more diverse and comprehensive evaluation results.

The limitation of this study is that only 8 teachers from one school were selected to participate in the study, with a small sample size and no combination of quantitative research. In the future, the number of samples can be expanded, and qualitative and quantitative research methods can

be adopted, which is more conducive to the promotion of the conclusion.

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The Impact of AI-based Technology such as Chat-GPT on Second Language (L2) Learners' Academic Writing

Fatemeh Rezaie Navaie, Kirtika Panwar, & Tutaleni I. Asino

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This study examines how AI, more especially ChatGPT, can help second language (L2) and non-native scholar (NNS) learners with academic writing. To comprehend its acceptance, it uses the diffusion of innovation (DOI) theory. The study looks into how ChatGPT affects NNSs' confidence and writing abilities. The study supports a balanced strategy in incorporating ChatGPT to help NNSs in academics while noting problems such as plagiarism.

Introduction

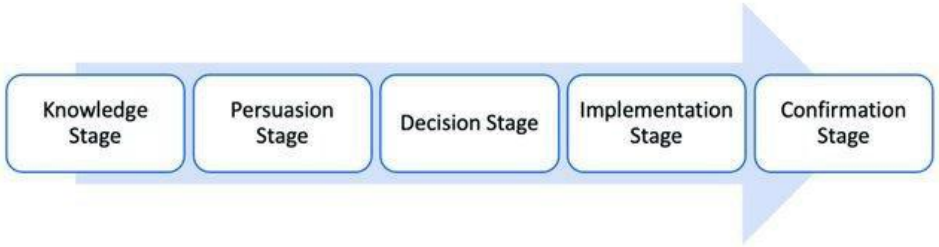
Interest in Artificial Intelligence (AI) has been gaining momentum globally in recent times, especially among Non-Native Scholars (NNSs) and Second Language (L2) learners. With the advancement of this technology, researchers and practitioners in educational institutions are exploring how AI can be used as a learning tool to help students in their learning process. One of the AI tools that have been getting a lot of admiration as well as criticism is ChatGPT (Generative Pre-training Transformer) used in writing academic papers. As researchers and practitioners in education who embrace the use of these technologies, this also brings excitement, new ideas, and unexplored opportunities that can be explored, such as the usefulness of this technology as a tool in students' learning process, especially in their academic writing. OpenAI's GPT specializes in replicating human-like writing through intensive text training. With its ability in Natural Language Processing (NPL), this AI model is frequently employed in chatbot applications such as ChatGPT, which displays interactions resembling those of an individual (Biswas, 2023). This paper will present a problem faced by NNSs, in particular, Doctoral students (Li et al., 2015), who encounter considerable difficulties meeting the linguistic requirement set by international English-language journals (Chen et al., 2020; Flowerdew, 2019). In contrast to Native Scholars (NSs), NNSs frequently have difficulty locating competent editors who are also experts in their field of study. NNSs are burdened excessively by these restrictions, which might lead them to be marginalized and discouraged from publishing in academic journals. (Hanauer & Englander, 2011; Flowerdew, 2019).

Theoretical Perspective

This study aims to employ AI-based technologies to aid NNSs in writing academic research papers. This review investigates how NNSs can use new technologies to help them write academic papers. The diffusion of innovation (DoI) theoretical framework (Rogers, 1995) will be applied to explain how AI-based technology is adapted over time. The DoI process consists of five steps: (1) the knowledge stage, (2) the persuasion stage, (3) the decision stage, (4) the implementation state, and (5) the confirmation stage. The decision to adopt innovations into current practices is evaluated and made by a person (or decision-making unit, or cultural system). In this study, the person in the unit or the cultural system is the NNSs, who are interested in using ChatGPT in their writing process. In the knowledge stage, when an individual or group such as the NNSs make efforts to learn about the innovation (ChatGPT) and starts to comprehend how it works, the diffusion of innovation process shown in Figure 1 gets started. A favorable or unfavorable opinion is created based on the perceived qualities of the innovation during the persuasive stage. In the decision stage, actions are taken by a person (or decision-making unit) that result in a decision regarding whether to accept or reject the invention. In other words, adoption denotes a change from the past behavior of a person or group of people in charge of making decisions. The innovation is applied in the implementation phase. The individual or unit making the decision then seeks confirmation of the choice to accept or reject the innovation during the confirmation step (Asino et. al., 2022). For example, NNSs accept the use of ChatGPT, and it helps them write papers, while other users, such as faculty members, refuse to accept the use of this technology since they consider it unfair.

Figure 1

Five stages in the diffusion process (Asino et al., 2022)



Research Questions

The main research objective is to investigate how AI such as ChatGPT can assist research academics for whom English is not their first language, specifically, to explore how ChatGPT can assist NNSs with low writing proficiency, and communicate and publish more effectively within their field and keep them from marginalization or discouragement in academic discourse (Hyland, 2016; Ramírez-Castañeda, 2020). To achieve this objective, the following research questions were answered:

1. How does the utilization of ChatGPT on NNSs impact their writing performance?
2. Does the integration of ChatGPT encourage self-confidence and improve NNSs' writing ability?

Data Collection

The data collection and analysis were directed by the questions mentioned above. The research's unit of analysis is "AI-based Technology and Academic Writing for Non-Native Scholars." The use of AI-based tools such as ChatGPT in various educational settings was gathered by looking for peer-reviewed articles in Google Scholar. These search criteria were applied to find these articles:

- Searchfield: (TX"AI-based technology") AND (Academic Writing for Non-Native Scholars)
- Limit to: Full Text AND Peer Review
- Publication Date: 2000 to 2023
- Document Type: Journal Article
- Language: English

The results from the above search query were used for this study. The goal was to identify literature from 2015 to the end of 2023 on AI-based technology and Academic Writing for NNSs. The initial search on Google Scholar yielded 8 articles. A separate search was conducted on the Oklahoma State Library database that yielded 150 articles. For this study, 35 articles were selected from the 150 articles that were retrieved. A brief analysis of the abstracts was conducted, and 12 articles were selected. Further review of the selected articles was performed, and the selections were narrowed down to 8 articles. Additional articles were identified and included in this study. In total, 24 articles were identified using Google Scholar and used in writing this review.

Findings

This paper presents a review of the literature published on the use of AI such as ChatGPT, an Automated Writing Evaluation (AWE) in writing academic papers, and how ChatGPT can be utilized by NNSs to help them write scholarly papers and articles for publications. Studies (Gea-Valor et al., 2014; Zhai, 2022) have shown that there is potential in the use of ChatGPT to write academic papers in the United States (US) and globally. This shows that ChatGPT as a learning tool has potential and can contribute significantly to the improvement and quality of writing in academia. With this potential, this AI-based learning tool can be used to assist NNSs who face the issue of writing proficiency when trying to publish their research in internationally based English-based journals. The findings from this study discussed the use of ChatGPT and explained why this emerging technology should be used in writing different academic papers. By discussing the findings, this literature review hopes to demonstrate the impact ChatGPT can have on NNSs' academic writing proficiency and how that can lead to them publishing in English-based journals overseas.

ChatGPT and its Impact on NNSs' Writing Performance

AI, like ChatGPT, is growing in popularity and is used in education (Gea-Valor et al., 2014). Despite this positive momentum, educators, particularly those in higher education, have expressed concern about the usage of ChatGPT to assist students in writing papers and how it is perceived as harming students' learning process. Despite the potential advantages, such as improving students' critical and writing skills that this technology brings, some educators in the field of education still see it negatively. However, those educators who support the use of technology in the classroom see it as a tool for teaching that can help students in the development of their learning process. Interestingly, despite the drawbacks, there are numerous instances of students using ChatGPT to assist them in writing academic papers (Zhai, 2022). By giving them personalized feedback on their writing, ChatGPT enables NNSs and minimizes the need for constant supervision from NSs (Flowerdew, 2019). Additionally, NNSs' learning autonomy grows, and critical pedagogy is promoted by AI-powered tools to monitor progress, modify the difficulty, and provide personalized material (Nazari et al., 2021). This makes it possible for NNSs to efficiently establish and maintain their academic goals while evaluating their strengths as well as their weaknesses.

ChatGPT: Challenges in Higher Education

While ChatGPT has potential advantages, there are drawbacks in terms of evaluation in higher education, such as issues with plagiarism (Pecorari & Petrić, 2014). This technology has the potential to undermine education by enabling students to turn in assignments that are not their own (Cotton et al., 2023). Furthermore, it might provide users unfair advantages while making it harder for teachers to effectively assess the understanding of learners (Cotton et al., 2023).

Discussion

According to the literature, there is interest in using AL in educational settings. Researchers and practitioners in the field of education have been showing interest in AI tools such as ChatGPT and how they can be utilized in education (Pokrivcakova, 2019). However, there is resistance by faculty members, especially in higher education, to disallow students to use AI technologies like ChatGPT to write academic papers. Many of these faculty members resist the use of ChatGPT because they think it is cheating and unfair. Even though faculty members resist the use of ChatGPT when writing academic papers, studies show that ChatGPT has many benefits in an academic environment if fostered in a manner that will support students' learning.

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The Role of Identity in the Success of Black and Hispanic Professionals in Learning, Design and Technology

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Currently, there is a dwindling supply of highly qualified and diverse scientists, engineers, researchers, and scholars in the United States. The National Center for Science and Engineering Statistics (NCSES) within the National Science Foundation posits that "doctoral education trains[ed] scientists, engineers, researchers, and scholars, all [of whom] are critical to the United States' progress (NCSES, 2021, p. 5)." These professions contribute to economic growth, cultural development, and the standard of living in the United States (NCSES, 2017, 2018, 2021). Learning, Design, and Technology (LDT), a STEM field, is rapidly growing and requires more well-trained and diverse researchers to advance knowledge of the field. This research prospectus suggests a case study design to explore the experiences of successful underrepresented groups in LDT research and practice, particularly Black and Hispanic doctorate recipients.

Introduction

The United States is experiencing a diversity crisis whereby a limited number of highly qualified and diverse scientists, engineers, researchers, and scholars. This diversity crisis is not only limited to the workforce but also presents itself in the research produced and doctoral education recipients. According to the National Center for Science and Engineering Statistics, White Americans are significantly more likely to have doctoral degrees in science, technology, engineering, and mathematics (STEM) than other races (NCSES, 2021). Between 2011 and 2021, minorities were underrepresented in STEM and other fields (Table 1).

Table 1

Research doctorate recipients by ethnicity, race, and citizenship status: 2011–2021 (Source: NCSES, 2021)

Ethnicity, race, and citizenship status by year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
All doctorate recipients	31,725	32,981	33,964	34,003	35,071	35,678	35,736	35,350	35,227	34,473	31,674
Hispanic or Latino	1,989	2,144	2,135	2,190	2,449	2,548	2,536	2,572	2,844	2,850	2,856
Not Hispanic or Latino											
American Indian or Alaska Native	127	104	119	103	131	128	109	115	119	97	100
Asian	2,832	2,943	2,892	2,881	3,072	3,084	3,499	3,302	3,418	3,217	3,022
Black or African American	1,899	2,055	2,172	2,172	2,275	2,358	2,400	2,449	2,512	2,453	2,431
White	23,278	24,010	24,749	24,829	25,375	25,502	24,844	24,925	24,214	23,934	21,333

Diversity in STEM field research and education is vital for the progress of the United States. Learning, Design, and Technology (LDT) is a STEM field practiced and investigated across all levels and fields (OSTP, 2018). The Association for Educational Communications and Technology (AECT) explains LDT as "the study and ethical practice of creating, utilizing, and managing appropriate technological processes and resources to facilitate learning and improve performance" (Januszewski & Molenda, 2007, p.1). For two decades, it has been argued that AECT faces unique challenges of diversity of professional practice due to the organization's many attempts to adopt an inclusive definition or an identity encompassing its philosophy, practice, and research (Persichitte, 2007).

The necessity to investigate the role of identity, focusing on the success of Black and Hispanic doctorate recipients, is necessary to ensure past exclusions of racial and ethnic groups are not repeated. Garcia and Martinez (2017) explored the intersectionality of equity and educational technology, and the role technology played in achievement disparities amongst learners. They investigate how students from different racial and gender backgrounds engage with and experience educational technology, highlighting the importance of considering multiple dimensions of identity in technology design and implementation (Garcia & Martinez, 2017). To address the underrepresentation and to enrich research and education in the LDT field studies on the intersection of diversity, identity, and the professional practice of LDT are

necessary to gain knowledge to help address the diversity crisis in doctorates earned by Black and Hispanic U.S. citizens and permanent residents and to bring new knowledge to research and education in the field.

Review of Literature

Diverse perspectives and approaches are essential for scientific advance (Bernard & Cooperdock, 2018). In LDT, a STEM field, curriculum, and research should challenge stereotypes and biases and promote comprehensive understanding (Woodley et al., 2017a; 2017b; Benson, 2018; Bernard & Cooperdock, 2018).

Minorities have significantly contributed to LDT by exploring culturally responsive teaching practices for social justice education (Woodley et al., 2017a, 2017b). Woodley et al. (2017a; 2017b) and Benson (2018) have emphasized culture and identity to create ethical and inclusive practices. Creating equity in LDT requires more critical, cultural, and identity-based research (Persichitte, 2007; Woodley et al., 2017a, 2017b; Benson, 2018). Diverse identities, cultures, and perspectives should be represented in the curriculum to challenge stereotypes and biases. LDT is not free of values, biases, and perspectives often reflected in the technologies created by its creators (Benjamin, 2019).

Patterson-Stephens et al. (2017) cited a gap in the literature on the shared experiences of women of color in doctoral programs and explored the barriers and facilitators of the success of seven Black doctoral women in graduate education in the United States. The researchers identified themes of potential barriers to socialization experiences, student success, and challenges. More barriers surfaced, including lack of mentorship, imposter phenomenon, and social location (Patterson-Stephens et al., 2017). Dortch (2016) used a phenomenological approach to understand the self-efficacy of African American women in doctoral studies, identifying key support strategies like faculty support and peer mentorship as essential for success.

Researchers have used the autoethnography narrative to examine women's experiences in instruction design and technology, a discipline of LDT that focused on navigating academia as a minority and the challenges (Romero-Hall et al., 2018; Romero-Hall, 2021). Romero-Hall (2021) used intersectional feminism as the lens to analyze the personal journey of Afro-Latinx female researchers. A collective autoethnography exploring the experiences of multiple women scholars – faculty, and students in instructional design conducted using the feminist lens, emphasizing the role of consciousness-raising and the intertwined nature of identity (Romero-Hall et al., 2018). The researcher intended to raise awareness and promote understanding of the systemic barriers faced by women in instructional design and technology (Romero-Hall et al., 2018; Romero-Hall, 2021).

LDT focuses little on understanding the experiences of successful, underrepresented, and marginalized professionals. This study can contribute to developing ethical guidelines and best practices for designing and implementing LDT that respects and values diverse identities.

Methodology

This proposed case study aims to delve into the personal and collective experiences of successful LDT Black and Hispanic recipients of the doctorate degree. Case study research is an effective way of understanding an individual's accounts and the collective experiences of these groups. Case study allows a researcher to understand the individual's experiences and how they fit into the larger context of a phenomenon. This philosophical approach is phenomenological as it focuses on a worldview to gain knowledge of the individual's experience.

The rationale for employing a case study approach in this study is grounded inquiry, which delves into 'how' and 'why', as well as its exploration of lived experiences from individual perspectives. (Yin, 2014; Glesne, 2016). This study explores the experiences of successful Black and Hispanic LDT doctorate recipients. The main research question (RQ) guiding this research is: What insights can be derived from examining the experiences of Black and Hispanic LDT doctorate recipients concerning representation, identity, and its impact on their academic and career achievements?

RQ 1: How do Black and Hispanic doctorate recipients in Learning, Design, and Technology professionals perceive diversity's role in their professional experiences?

RQ 2: How do Black and Hispanic doctorate recipients in Learning, Design, and Technology perceive the role of identity and navigate and negotiate it in their profession?

RQ 3: What are the specific challenges and opportunities that Black and Hispanic doctorate recipients encounter in Learning, Design, and Technology, particularly concerning representation, identity, and equity?

RQ 4: What strategies do Black and Hispanic doctorate recipients employ to promote diversity, inclusion and equity, and accurate representation in Learning, Design, and Technology research?

Summary

A case study aims to learn about the experiences of successful Black and Hispanic doctorate recipients in LDT by intersecting representation, identity, and LDT. Diversity is a challenge and an opportunity for Black and Hispanic practitioners and researchers in LDT to share by describing the challenges and strategies shaping their success as LDT professionals self-identifying as members of these groups. My lived experience profoundly influences my desire to explore the experiences of successful Black and Hispanic professionals in the field of LDT and to examine the intersection of representation and identity in these professionals' academic and career success.

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Transformation or Indoctrination through Critical Pedagogy: Strategic Planning, Digital Literacy, and Technology Infusion in K-12

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The impact of critical theory on students has sparked false accusations, leading to book banning and restrictive policies in the classroom. While some argue that teachers are being radicalized, scholars advocate for integrating critical pedagogy in teacher education to address the influences of media messages on students' thinking. Critical literacy involves recognizing and challenging societal power structures in media. To support diverse student perspectives, educators must understand social and cultural forces. Digital literacy is crucial for critically evaluating digital content and ensures safety and privacy. The graduate programs emphasize the application of critical pedagogy for infusing technology in schooling to prepare culturally diverse students. The importance of critical media education is emphasized by the essential task of fostering intelligent, critical thinkers among students as they interact with media.

Fostering Critical Media Literacy in Education

False accusations regarding the presumed negative impact of critical theory on school students have emerged in response to culturally relevant, sustaining, and transforming curricula (Burmester & Howard, 2022). These accusations resulted in book banning and other policies that negatively impact what teachers are allowed to do in their classrooms. Some believe that teachers are being radicalized by their professors (Benson, 2021).

However, many scholars and teachers believe that the ubiquity of media messages that influence students' thinking indicates a profound need for inclusion of critical pedagogy in teacher education programs (Giroux, 2020). Educators need to know how to prepare students to be smart, critical thinkers as they consume media (Hostetler & Luo, 2021).

To be critically literate means that one is able to recognize, reveal, critique, and challenge societal and institutional power structures in media messages. Social structures and cultural customs are at the root of social problems. In order to prepare educators to teach in schools, they need to understand social and cultural forces at play and be prepared to support their students' diverse perspectives. Lewison et al. (2002) describe four components of critical literacy: disrupting the commonplace, interrogating multiple viewpoints, focusing on sociopolitical issues, and promoting social justice. Additionally, digital literacy skills keep people safe, maintain their privacy, and help individuals evaluate digital content through a critical and analytical lens. Our Educational Design and Learning Technologies graduate programs require our culturally diverse students to apply critical pedagogy for technology infusion in schooling.

Example 1: Explore a Topic

In a course entitled Critical Digital Literacy, students select a controversial topic in education. Topics of choice have included brain development and social media, self-esteem and social media, evolution, gender and mathematics, vaccination, climate change, and the 1619 Project. Students explore perspectives, identify relevant evidence, describe the impact of bias and power on people's points of view, and discuss the relevance of the issue to social justice and literacy. They spend the first half of the course identifying resources to inform themselves of the role that digital literacy plays in the controversy. They read about the importance of applying a critical lens to digital materials (Allen-Brown, & Nichols, 2004; Choi, 2016; Goering & Thomas, 2018; Hinrichsen & Coombs,2014; Kellner & Share, 2019; Morris & Stommel, 2018; Pandya, 2019). They write and post their essays to their blog in the second half and produce an audio recording, an infographic, a Tweet, and several visualizations regarding their topic. By sharing their productions with each other, they broaden their perspectives regarding digital literacy.

One student's productions focused on the controversial 1619 Project. A common criticism is that the project revises American history and questions the accuracy of the stories emerging from the contributors of the project (Magness, 2020). Proponents of the 1619 Project call into question the historical accuracies of certain events and historical figures that our education system holds as absolute truths (Morel, 2020). Authors of the 1619 Project are asking readers to use their critical literacy skills to disrupt common threads of historical 'accuracies' by revisiting what they know as historical facts. Book banning, micromanaged classrooms, political attacks, funding tied to student performance, and restrictive curricula are just some repercussions educators face.

Example 2: Teamwork to Write a Strategic Plan

In another course, Technology, Society, and Education, students spend the term in small groups developing strategic plans for infusing the Internet of Things, immersive technologies, games, social media, artificial intelligence, and data analytics in a school. They read works by scholars who espouse the importance of applying a critical lens to digital materials (Benjamin, 2019; Eubanks, 2019; Greengard, 2021; Jenkins, 2009; Pangrazio & Selwyn, 2019; Rheingold, 2012; Woodley & Rice, 2022). Their assignment is to embed critical approaches to technology adoption in their plans by exploring the potential of each technology to impact the user's agency, power, abuse of power, or bias. They also investigate the extent to which the technology developer considered issues of equity, race, gender, representation, and authority in their product development. Both plans described here were presented to schools.

First, the vision presented to a preschool that serves children with Down syndrome is to create an educational environment whereby students, families, and staff can learn, access, and use best practices, research-based methods, and state-of-the-art technology within and across the educational environment and community. Parents can learn how to use technologies to support their children's development.

Second, a local charter school serves K-12 students and specializes in technology, multilingualism, acceptance for all, and restorative justice. To ensure success of the students as future leaders, the commitments to students include interacting with multiple forms of technology. A central technology infrastructure ensures all students have internet accessibility and have the best opportunities to succeed in an ever-changing tech-based society.

Discussion

Students' conceptions of digital literacy transformed into a combination of traditional and critical skills. Traditional conceptions of digital literacy consist of digital citizenship, ethics, engagement, and safety. They include technical skills for locating and interpreting information and data. Using digital tools, including text, signs, symbols, emoticons, slang, and pictures, to communicate meaning, feeling, and understanding is also an element of traditional digital literacies toolkits (Hobbs, 2017; Talib, 2018). And, of course, the ability to create digital documents, audio/visual files, presentations, graphics, and social media literacies. For educators, abilities to learn and teach using digital technologies are part of the definition of digital literacy (Dede and Richards, 2012).

Students in our graduate programs define digital literacy to include both traditional and critical elements. By exploring the relationship between digital literacy and educational-issues from a critical lens and by embedding critical elements in plans to infuse emerging technologies in schools, educators in our graduate programs are able to conduct meaningful and transformative experiences to positively impact society (see Figure 1).

Figure 1

Traditional and Critical Digital Literacy Elements Combined to Define Digital Literacy

Our discipline should focus beyond the traditional path to digital literacy to include lessons learned when educators apply critical theory and pedagogy. Given that focus, students conduct meaningful activities for high impact.

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Unveiling the Measurement of Self-efficacy in Game-based Learning

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This scoping review explores the relationship between self-efficacy and game-based learning (GBL). The study identifies the primary subject areas studied in GBL, such as STEM and language learning, and examines the instruments used to measure self-efficacy. While many studies measured self-efficacy as a dependent variable, some used it as an independent variable alongside other factors. The most commonly used self-efficacy scales are identified. The results suggest that GBL positively impacts self-efficacy, but the improvement in self-efficacy may not match the performance improvement. This review highlights the need for more precise and context-specific measurement of self-efficacy in GBL research, emphasizing the importance of reliable measurement practices.

Background

The motivational benefit is a major influence of game-based learning (GBL) on the affective domain (Shaffer et al., 2005). Self-efficacy is a core component of motivation that "exists with a broad system of multicausality" (Bandura, 1997; Bandura, 1999, p. 35; Eseryel et al., 2014), meaning self-efficacy is part of a complex network of cognitive and non-cognitive constructs. The role self-efficacy plays is unique as, given the credibility of negative feedback, even "highly talented individuals" can have their skills "easily overruled by self-doubts" (Bandura, 1997, p. 37). Therefore, to determine whether game-based learning has a real positive effect on motivation—beyond the effect of novelty—a thorough understanding of how the game-based learning experience influences self-efficacy beliefs is essential. Bandura provides a clear description of how best to measure self-efficacy (Bandura, 1997). Each question should be written in terms of "I can." Enough questions that target concrete tasks within the target content area (e.g., Mathematics) and vary in difficulty should be included. This allows for a generalizable estimate of the respondent's efficacy beliefs—i.e., self-efficacy for the construct (e.g., Mathematics) rather than the specific task (e.g., summing two numbers).

Our purpose for this scoping review is to gauge the existing research on self-efficacy and how it changes or doesn't change in experimental studies of GBL. Beyond collecting general information about the studies being conducted (e.g., location, outcomes, populations), we are interested in exploring common elements of the instruments being used to measure self-efficacy. Specifically, we seek to answer the following research questions:

1. What are the primary areas being studied? (e.g., STEM, language)
2. What types of instruments are being used to measure self-efficacy?
3. What are common outcomes for self-efficacy in game-based learning (GBL)?

Methods

The foundation of this review was initiated by searching a series of relevant terms using Boolean logic in common databases focusing on self-efficacy and game-based learning. Table 1 shows the specifics of the search parameters and terms for the three databases: PsycINFO, Education Source, and ERIC. The results yielded 194 total publications. The results were screened with the following criteria: (1) an empirical study published in the past 10 years, (2) to a peer-reviewed or refereed journal, and (3) measured self-efficacy at least once during the intervention. The screening yielded 47 articles which were transferred to the full-text review process. After excluding 6 studies of which full text was unavailable and 12 studies that measured self-efficacy but used it as a mediating variable, 29 articles were extracted and compared to establish data to answer the research questions.

Table 1

Databases and search criteria used

Database name	Search Criteria	n
PsychInfo	"self-efficacy OR self efficacy" AND "game-based learning OR game based learning"	102
Education Source	"self-efficacy OR self efficacy" AND "game based learning OR game based learining"	31
ERIC	"self-efficacy OR self efficacy" AND "game-based learning OR game based learning"	61

n = number of publications found in search.

Results

As shown in Figure 1, the main subject area being studied was STEM, followed by vocational training and language learning. Other areas included general logic for puzzle solving (Bilgin, 2015), nursing training (Chang et al., 2022), earthquake emergency training for children (Feng et al., 2021), and history (Chu et al., 2015). Self-efficacy was measured as a dependent in 21 studies while playing a role as an independent in 8 studies, usually with other variables shown in Figure 2. Learning achievement (also described as an outcome or performance) was the most commonly measured variable. Other variables measured along with self-efficacy included the perceived ease of play, 21st-century skills, challenge, control, frustration, and empathy along with self-efficacy (See Figure 2).

Figure 1

Subject Areas of studies measuring self-efficacy

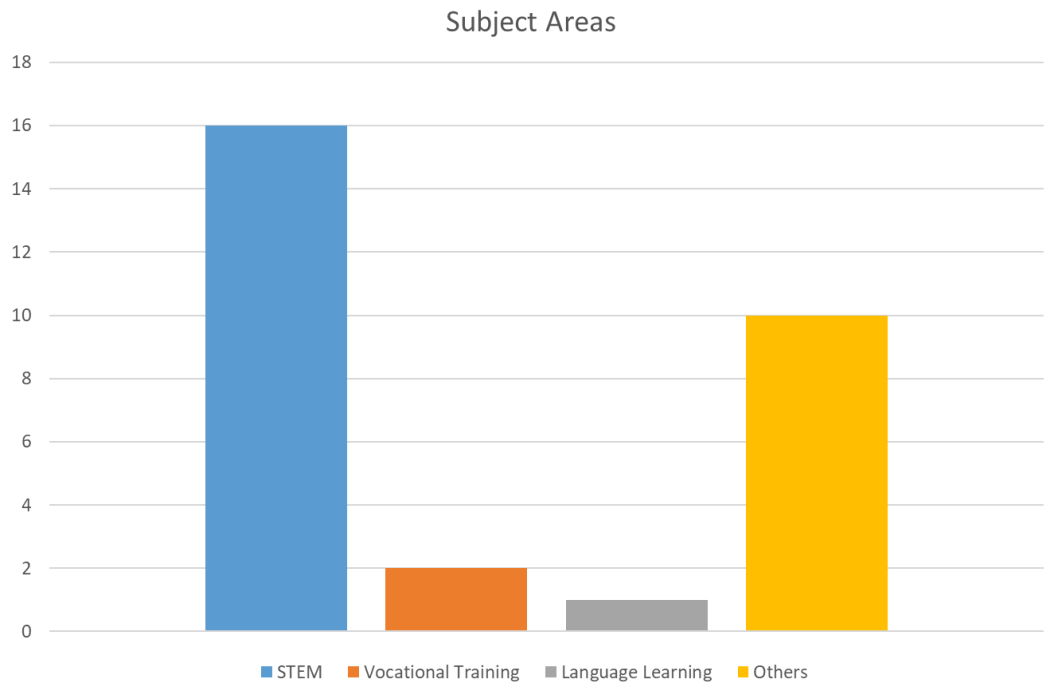
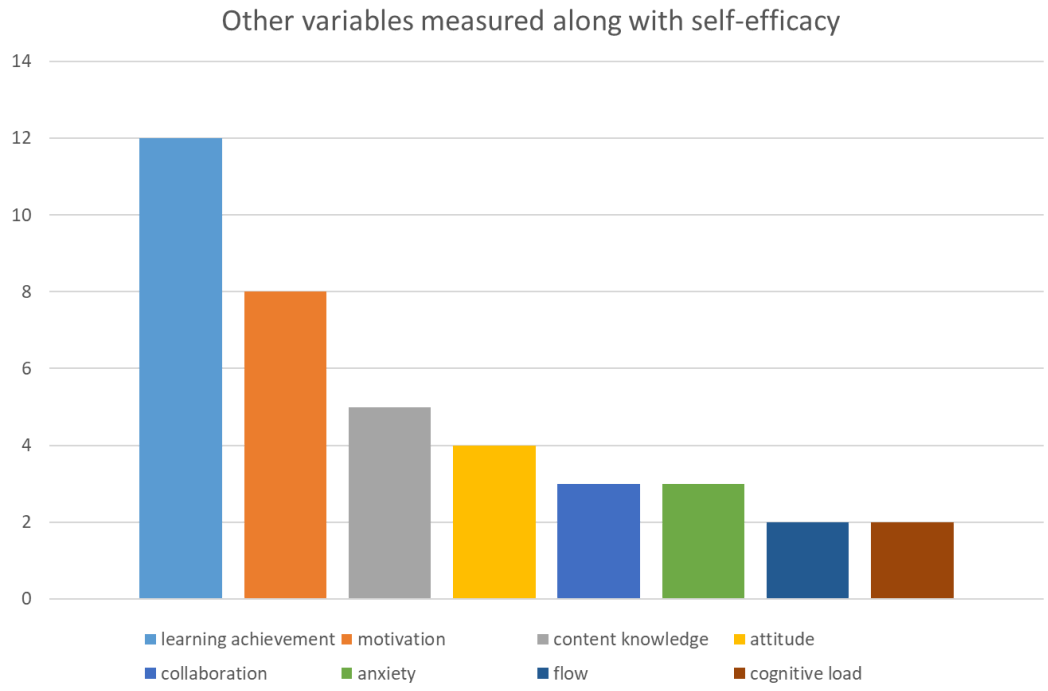


Figure 2

Other variables measured along with self-efficacy



With some variations according to each study's context, the most frequently used scales were those of Pintrich et al. (1991), Pintrich & Groot (1990), Bandura (2006), and Britner & Pajares (2006). Six studies identified and adopted the most suitable self-efficacy measure that fits their context (i.e., population, subject area). They also cited the first validated source for the scale, which is a desirable practice considering the definition of self-efficacy (Bandura, 1997) which makes a premise of context-specific understanding.

An interesting finding emerged from the review process: many games have proved themselves to be effective in enhancing students' performance in the target content, while the improvement in self-efficacy was not as great as that of actual performance. In other words, learners tended not to believe that they were not as good as they were after the intervention. As this is a preliminary qualitative finding, further research is needed to understand this gap between students' beliefs about their performance and their actual performance.

Overall, the studies indicated that GBL has a positive impact on improving students' self-efficacy. However, it can also be interpreted to be affected by publication bias (Gage et al., 2017) that larger positive effect sizes are always welcomed. To precisely measure self-efficacy in GBL, a longitudinal approach is needed along with a precaution about collinearity. Since self-efficacy is sometimes nested in motivation (Schunk, 1995), high collinearity between the variables can compromise the reliability of some studies.

Discussion and Significance

Although a significant number of studies measured self-efficacy as one of the means to prove that their research on GBL is effective, their understanding of self-efficacy tended to be shallow in many cases. It is observed that some studies adopted a general self-efficacy scale, which directly opposes the concept of self-efficacy initially proposed by Bandura (1997). In addition, five studies included in the review used a self-efficacy measure with an unvalidated scale or from a second source, which potentially includes some distortion from the original items. This study is meaningful in that it provides a retrospective for measuring self-efficacy in GBL and refreshes the academic community for a more trustworthy practice of measurement.

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“Why did we do that?” A Systematic Approach to Tracking Decisions in the Design and Iteration of Learning Experiences

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Practitioners today are often tasked with designing learning experiences situated in increasingly complex contexts where defining the challenge, understanding learners and stakeholders, and being informed by theory and evidence must all be taken into consideration when planning and implementing a solution. The Learning Engineering Evidence and Decision (LEED) tracker is one possible tool for managing these various channels of influence by recording, revisiting, and iterating upon actionable design decisions in an evidence-grounded way. Emerging from specific examples of LEED tracker use by a learning engineering team at the Massachusetts Institute of Technology are general benefits for others engaging in design for learning: it concretizes decisions grounded in understandings of pedagogical approaches and context, facilitates iteration and improvement based on data, and serves as a communication tool among stakeholders.

Introduction

The Learning Engineering Evidence and Decision (LEED) tracker is a tool used by members of the Residential Education team at the Massachusetts Institute of Technology (MIT) when designing learning experiences as a means to record, revisit, and iterate upon actionable design decisions in an evidence-grounded way. While the LEED tracker was originally developed and adapted within the MIT context for designing instructor support resources, the general form and function of the tool emphasize writing down and justifying implementable design decisions. Inspired by a learning engineering approach to supporting learners (Goodell & Kolodner, 2022), the goal of maintaining a LEED tracker is to make explicit a team’s thought processes, different channels of influence such as evidence from the learning sciences, instrumented data, and contextual factors in a way that is easy to revisit and update during cycles of design iteration.

The challenge: Design decisions and managing complexity

Early work exploring design decisions within Instructional Design (ID) focused on understanding how heuristics and other procedural approaches to design work may fail to fully account for design decisions (Kerr, 1983). More recent work has argued that designers employ decision-making in cycles that are contextually situated and often based on constraints (Jonassen, 2008) and that further efforts are needed “to guide how instructional designers engage in decision-making while designing for situated, real-world experiences” (Stefaniak, Tawfik, & Sentz, 2023). Communities outside of ID have noted the importance of design decisions as a way for practitioners to justify and ground their work in research (Kolodner et al., 2003) and from various sources (Hazelrigg, 1998).

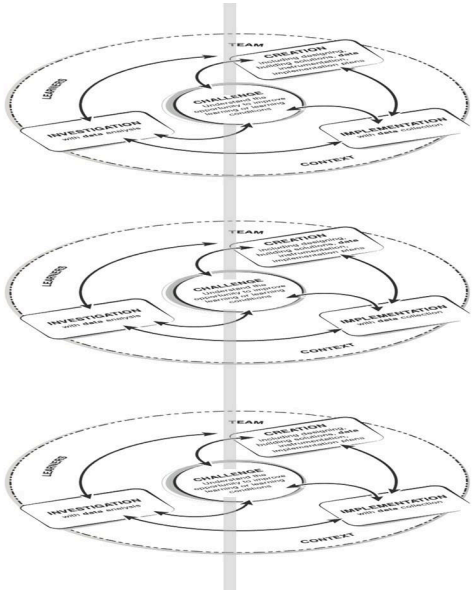
Taken together, it is clear that practitioners who design learning experiences and products are often situated in increasingly complex contexts where defining the learning-related challenge, understanding learners and stakeholders, and being informed by theory and evidence must all be taken into consideration when planning and implementing a solution. Yet the practical work of how such design decisions can be recorded and maintained for research and practical purposes is drastically underreported in the literature.

The framework: Learning engineering

The Residential Education team at MIT supports instructors and course teams across the institute to improve teaching and learning with digital technologies. Similar to many other industries and organizations, this work is situated in a culturally unique environment where many contextual factors and specific goals for learners and stakeholders shape each learning challenge. Encouraging systematic practices within a contextually conscious frame of designing for learners and learning, the learning engineering process (Kessler et al., 2022) guides the team’s work and facilitates how the team navigates complexity across design iterations. Within a complex system, design decisions are not always made in a linear fashion, nor do they happen completely independently of one another; rather, they occur in nested or concurrent learning engineering processes (see Figure 1). When the complexity of a context grows but keeping learners at the center remains a priority, maintaining a record of design decisions and related justifications becomes necessary for understanding how each piece of the design goes together and why it works.

Figure 1

Nested Learning Engineering Processes Model (Kessler & Totino, 2023)



The solution: LEED tracker

The LEED tracker is one tool that exposes thinking, reasoning, and evidence in a systematic way throughout the design of a learning experience or product. Though adjusted as needed depending on the project, a LEED tracker is a tangible artifact that generally includes labeled columns and rows, such as in Excel or a table in a word processor (see Figure 2). Its form is purposefully low-tech, low-overhead, and shareable to encourage the habit of continually returning to it and consistently using it.

Decisions that get enacted in a design are recorded in the LEED tracker (Figure 2, Column A), as well as the source of influence that supports the decision to include that element or strategy in the learning experience (Figure 2, Column B). Underscoring the importance of evidence and reasoning to inform decisions, a justification is also recorded (Figure 2, Column C), which is often a part of the thought process that loses critical nuance or is difficult to communicate unless written down. When thought processes become explicit, it is easier to know what further evidence needs to be collected from the implementation to understand whether the solution is effective for learning (Figure 2, Column E). The goal is to revisit the tracker on an ongoing basis as teams examine what worked and has not worked in a design (Figure 2, Column D), refer back to why a design element was implemented in the first place (Figure 2, Column C), and iterate while keeping the learners' needs at the forefront (Figure 2, Column F).

Figure 2

Suggested columns to include in a LEED tracker

A. Design Decision	B. Influence or Source of Decision	C. Justification	D. Revisited Decision?	E. Source (i.e., data collected)	F. Resulted in Iteration?

LEED tracker key benefits and examples

This section describes three key benefits of the LEED tracker while highlighting specific features of the tracker through examples from the MIT context.

Key benefit 1: Decisions and justifications become concrete

The LEED tracker concretizes decisions grounded in an understanding of pedagogical approaches and context. By giving teams a place to record not just the decisions that get enacted in the design but also the reason behind each decision, the tracker elicits evidence as the source of actions taken. Several sources of evidence can inform the creation of a learning experience or solution, including research, literature, learning design principles, contextual factors, platform data, stakeholder interviews, learner feedback, and one's own experiences and observations.

The example in Figure 3 is based on a LEED tracker used for the design of technology training for instructors. Being informed by the learning sciences as well as contextual factors like constraints of the training platform helped generate design ideas and supported decisions that centered on the learners' (instructors') needs. Having this information recorded made actions throughout the design process more concrete and justifiable compared to acting on instinct, and additionally gave space to acknowledge any alternatives that were considered.

Figure 3

Excerpt adapted from a LEED tracker for the design of an instructor training

Design Decision	Justification
Use existing videos featuring faculty in favor of recreating videos, so faculty will be motivated by "seeing themselves" in a variety of video examples.	Related learning design principle/heuristic: Make learning activities personally meaningful, authentic, and connected to prior knowledge.
The organization/flow of the training content will be linear: intro → technical specs and process → best practices and pedagogies → use cases → additional resources.	Constraint of the technology: It is challenging to weave content because the platform is naturally set up to have a linear approach to content delivery. Weaving can mean making links to other sections, which is hard to maintain.

Some projects, such as the example in Figure 4, involve managing multiple channels of influence on the design of one solution (in this case, a resource for instructors about using a learning management system) that affect decisions of varying "grain size" from overall strategy to specific content choices. In a highly iterative space, such as one in which technology is constantly being updated, LEED tracking helps teams recall the foundations and intended functions of prior decisions before further changes are made to the implementation.

Figure 4

Excerpt adapted from a LEED tracker for the design of an LMS resource site for instructors

Key Decision or Edit/Update?	Description	Date of Decision or Edit/Update	Source	Justification
Key Decision	Created a "What's New?" page linked to the home page as a place for LMS and LTI updates and tips, each written as a brief description with a screenshot.	Aug 2023	User feedback	The page serves as a one stop shop for instructors to learn about tool updates that affect their work, in an easily digestible format.
Edit/Update	Added a new item to "What's New?" page re: editing page titles without breaking links.	Sept 2023	LMS release notes	This is a positive change to communicate to instructors, as it saves time and effort.

Key benefit 2: Decisions become entry points to iteration, supported by new evidence

With these tracked decisions as potential entry points to further improve the learning experience, the LEED tracker facilitates iteration informed by multiple streams of data and feedback collected about the learner experience. The tracker is revisited on an ongoing basis as teams examine what has worked or not worked in a design, refer back to why a design element was implemented in the first place, and iterate while continuing to centralize the learners' needs. Within the learning engineering framework, instrumenting to collect data from the learning experience is part of the creation process, after which data from the implementation is analyzed to inform improvements to the design.

Figure 5 shows an example of a LEED tracker from the design of a training for teaching assistants. Recording decisions about the enrollment strategy for the optional training and decisions about the actual training experience allowed the team to easily revisit and rapidly iterate on the enrollment strategy when actionable data related to that particular sub-process became available first. Unlike other approaches, learning engineering opens the door for practitioners to make design decisions on aspects of implementation or the larger systems in which the learning experiences are taking place (Kessler et al., 2022). The example in Figure 5 shows how the LEED tracker can maintain a log of such decisions.

Figure 5

Excerpt adapted from a LEED tracker for the design of a teaching assistant training

Design Decision	Influence/ Source	Justification	Revisited Decision?	Source (i.e., data collected)	Resulted in Iteration?
Send a 2nd round of communication to "target" departments	Enrollment strategy	To increase enrollment from departments with high numbers of TAs and that are likely to engage with the training	Yes - prep for 2nd round of enrollment strategy implementation	System data that tells us when TAs are assigned for a term, filterable by department	Now start pulling TA assignment data before, during, and after semester to watch for dept trends

Key benefit 3: Explicit evidence and reasoning guide stakeholder conversations

Because the LEED tracker gives space to track both a decision and its justification, it serves as a communication tool to provide stakeholders from a range of disciplines with a shared understanding of the central challenge for learners. The content of the tracker provides a clear "what" and "why" to shape discourse with subject matter experts, team members, learners, and other stakeholders who have questions, ideas, and feedback about the design and expected outcomes.

A recent initiative at MIT involved the team working with instructors and student learning technologists to improve the design of courses using digital technologies. Figure 6 shows an example of a LEED tracker from one of these projects that labels decisions to incorporate certain digital tools in the course as being aligned with the instructor's goals, among other influences such as the learning technologist's familiarity with the student experience. Since the instructor is ultimately responsible for implementing changes to the course, and since the time between instructor meetings can sometimes be weeks apart, the LEED tracker is helpful in grounding instructor conversations in previously stated goals.

Figure 6

Excerpt adapted from a LEED tracker for the redesign of a music course at MIT

Feature	Influence(s)	Justification
Perusall	Instructor Goal Technical Limitations	Students can have additional practice for identifying musical characteristics and the influence of those characteristics. Since students can see each others' comments and reply to each other, Perusall fosters collaborative studying.
Perusall Guide for Students	Student Experience Instructor Goal	Since Perusall may be a new tool for students and is used in different contexts, this guide explains the intentions of using the tool for the class.

Conclusion and implications for practitioners

The LEED tracker is a tool that reflects a design process deeply grounded in learning engineering, where decisions, sources of evidence, and justifications are made concretely in order to facilitate iteration and communication in a way that addresses the complex nature of challenges to learners and learning. Through various examples from MIT, practitioners in other industries and organizations are encouraged to think of ways to adapt the LEED tracker to their practice, or consider similar approaches to expose their thinking in a systematic way throughout the design of a learning experience or product for different audiences. While specific elements of the LEED tracker, like column titles, labels, and the content in the tracker, will vary depending on project context, the general form and function of the LEED tracker make it one possible tool for teams to address challenges in an evidence-grounded way.

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