Introduction to OLJ Volume 28, Issue 1

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Once again, on behalf of OLC, it is my pleasure to provide a brief overview of the first issue of 2024. These articles cover a broad range of topics including engagement, academic integrity, faculty concerns, Massive Open Online Courses, and student and community issues in online learning environments.

The initial four articles in this issue are concerned with student engagement. The first of these is "The Role of Self-Regulation in the Relationship Between Adaptability and Engagement: A Case of Online Mathematics Learning for Elementary School Students" by Yoppy Wahyu Purnomo, Irfan Wahyu Prananto ,Yeni Fitriya of Universitas Negeri Yogyakarta, Indonesia, and Amrita Kaur of Wenzhou-Kean University, China. Like this issues papers from the Philippines and Jordan, this study also investigates pandemic era online learning in a developing country – Indonesia. The authors indicate that the pandemic required rapid adjustments and adaptability on the part of learners and instructors. Working with 339 students in elementary school, they develop a model of engagement and adaptability as it applies to math learning, a particularly challenging subject, especially in the hastily developed emergency remote teaching environments typically implemented in response to COVID. Given the average age of these students was eleven; the authors also consider the role of parents in this form of distance education. The study presents and validates a model describing the relationship among adaptability, self-regulation, and engagement in elementary-level math learning while accounting for other external factors such as parental involvement and their level of education (with surprising results). The authors provide recommendations for developing environmental conditions that encourage online learning engagement through adaptability and self-regulation.

The next article in this section is "Students' Perceived Social presence and Media Richness of a Synchronous Videoconferencing Learning Environment" by Brandie Wempe, of the U.S. Department of Agriculture and Royce Ann Collins, of Kansas State University. Social presence has been studied in the online asynchronous environment, but the vast expansion of post COVID synchronous learning is new to students, instructors and researchers, a point that these authors address in their work. Another strength of this article is in the recognition of the complexity of the social presence construct and application of more contemporary accounts of social presence drawn from researchers such as Karl Kreijns, as well as the views of Community of Inquiry and communications theory investigators. The authors used a correlational research design to describe and measure the nature of the relationship among social presence, social space, sociability, and media richness with synchronous videoconferencing. Results support synchronous videoconferencing with distance delivered courses, which can assist with the reception of messages through multiple channels and increase the immediacy of feedback.

The issue of student engagement with online learning is shaped by the level of education in which students are enrolled. As noted in the previous study, students in pre-college settings have additional needs to engage successfully in online environments, often including the participation of parents. Generally speaking, this parental involvement requirement increases as the age of the student decreases. While online learning works well with adults in higher education settings enrolled in mature, planned distance education programs, all of these assumptions were violated during the pandemic, especially in the case of k-12 emergency remote instruction. In "Parent's Perceptions of Online Learning during COVID-19 Pandemic: The Road Ahead" author Tarek Shal of the Social & Economic Survey Research Institute (SESRI), at Qatar University investigates these issues. Again, as many other researchers have found, this paper indicates that the hastily constructed distance education solutions developed for learners in pre-college settings in Qatar left faculty, students and parents with mixed feelings. While the majority of parents in this study felt that the school in which their children experienced remote instruction coped well with this sudden change, the parents experienced significant difficulties with balancing their own work and support for children, helping their children stay motivated (especially with multiple children in the home), and felt overwhelmed themselves. The author includes parents' suggestions for improving remote instruction should there be a need to implement it again.

The fourth article on the topic of engagement is "Using Learning Analytics to Understand K–12 Learner Behaviour in Online Video-Based Learning" by Eamon Vale and Garry Falloon of Macquarie University, Australia. These author note the relative paucity of research in k-12 online environments and highlight the promise of learning analytics (LA) to both optimize learning and the digital environments in which it takes place. The authors apply Chi's ICAP theory as a framework for describing learner viewing-engagement with video content, discovering patterns of viewing that both the LA data and questionnaires indicate as "active" engagement within Chi's theory. This paper contributes to LA research through it application of an established theory allowing for more precise (though admittedly tentative) description of what active video viewing looks like in autonomous course settings in k-12 online contexts.

In "Assuring Academic Integrity of Online Testing in Fundamentals of Accounting Courses by Elizabeth Whitlow and Stephanie Metts of Southeastern Oklahoma State University", the authors investigate academic dishonesty in online environments. They review the voluminous literature on cheating and plagiarism in higher education and note that, while academic dishonesty is common both online and in physical classrooms, the absence of any proctoring in high-stakes testing situation invites dishonest behaviour. This is a common concern in online environments in which some faculty use tests as a core assessment method. Though there is a longstanding recommendation to use alternative means of assessment that make academic dishonesty less likely, such methods can be more time consuming and less scalable than traditional testing. The authors note that in previous research in which online proctors or online proctoring software are used; un-proctored online exam scores are higher. They conduct a study that demonstrates this same result in two accounting courses. While acknowledging that the use of proctoring software can create a more anxiety-provoking environment, the authors report the same trends of higher scores in un-proctored online testing occurred throughout the semester. The authors assert that students would become accustomed to the proctored environment at some point and conclude that the differences are very likely to indicate academic dishonesty at higher levels in the un-

proctored condition. As we enter the age of artificial intelligence, concerns about academic integrity are growing, and this area of research will continue to be of interest.

The authors of "Instructor Leadership in Online Learning: Predictive Relationships between Servant Leadership and the Community of Inquiry Framework" Sally Meech and Adrie Koehler of Purdue University note that research on instructor leadership in online settings are rare. The frequently cited Community of Inquiry model suggests that instructor leadership is a core component of effective online collaborative learning environments. However, the model does not provide a clear definition of exactly what instructor leadership entails. Meech and Koehler argue that theories derived from the field of educational leadership, for example servant-leadership theory, can clarify this aspect of the CoI model. They note that Servant leadership is a values-based approach in which leaders prioritize the needs, goals, development, and well-being of followers, leading to outcomes such as increased engagement, satisfaction, and effective performance. The authors used a predictive correlational design to investigate potential relationships between students' perceptions of instructors' servant leadership (SL) and Community of Inquiry (CoI). Their analysis indicates a significant positive correlation between these instruments. The predictive model as a whole explained 66% of the variance in students' perceptions of a CoI. The results are significant, as extant literature does not offer clarity about the dimensions of and operationalization of instructor leadership in a CoI but SL does, so can help offer this missing clarity.

The next article "What It Takes to Teach in a Fully Online Learning Environment: Provisional Views from a Developing Country" is by Jessie Barrot, of the National University, Philippines, Joan Agdeppa of the University of Manitoba, Canada and Brendalyn Manzano of the College of Arts and Social Sciences, Tarlac State University, Philippines. These investigators note that while many studies explore teachers' challenges in online learning, there is a scarcity of research examining this phenomenon within the context of developing countries, such as the Philippines. They conducted semi-structured interviews with 17 faculty with varying backgrounds to gain insight into online instruction in this context, employing multilevel coding to classify themes from the interview transcripts. Their findings shed light on the various challenges that online teachers face and highlighted the importance of their readiness for fully online teaching, particularly within a learning context with poor internet connectivity and limited resources.

Also investigating faculty issues in a developing country are the authors of "The Interplay of Institutional Support and Faculty Roles During the COVID-19 Pandemic: Implications for the Future of Online Teaching and Learning" by Samar Aada, Manal Ginzarlyb, F. Jordan Srourc of the Lebanese American University, Beirut, Lebanon. These authors again note that research on faculty experiences during the pandemic is relatively limited, especially in countries like Jordan. In their study the analyse interview data with 30 faculty to provide insights. They identify roles played by faculty and institutional support offered to them that shapes and describe faculty emotions in response to the pandemic. They supplement the interview data with posts to the X platform (formerly Twitter) to further characterize affective states of educators confronted with COVID restrictions in the Lebanese context. The authors found that younger faculty and those more comfortable with technology more likely to adopt OTL and believe that hybrid teaching

will be most useful going forward; but nearly all faculty members— including those not comfortable with technology prior to the crisis—were willing to teach online in the future.

The next paper investigates Massive Open Online Courses (MOOCs). In "The Viability of Topic Modeling to Identify Participant Motivations for Enrolling in Online Professional Development" authors Heather Barker of Elon University and Hollylynne Lee, Shaun Kellogg, and Robin Anderson of North Carolina State University" the authors use a form of computational text mining combined with traditional qualitative coding to better understand why learners enroll in MOOCs. Understanding MOOC participant motivation is an important step in gaining insight into the high rate of drop out MOOCs learners exhibit and the authors tested several text mining and hand coding approaches to try to identify a method that reduces the number of hours required for manual approaches while retaining accuracy. They present results of a semi-supervised method that appears to hold promise in attaining this goal.

The final set of papers in this issue are concerned with topics related to learners and community in online environments. The first of these is "Comparison of On-Campus and Virtual Self-Assessment Outcomes for Incoming Appalachian STEM Undergraduates' First Research Experience" by Kristin Stover of The Ohio State University College of Medicine, Kimberly Cowley of Youth and Adult Education, ICF, Gillian Gaunt, Olivia George, Tuoen Liu, Christopher L. Pankey West Virginia School of Osteopathic Medicine, and Kristy Henson of Fairmont State University. Increasing participation in STEM education and diversifying the STEM workforce in the United States is a widely shared goal of US higher education, funding agencies, and other educational organizations. The authors of this paper investigated an NSF funded initiative to achieve some of these goals in rural West Virginia. Students in this area confront financial hardship, limited technology and broadband access, insufficient academic preparation, and lower educational expectations. The students in rural Appalachia are about half as likely to obtain a bachelor's degree compared to the US overall average. The authors describe a summer immersion program to try to improve STEM education among this population in which data were collected during face-to-face versions of the program and a COVID motivated remote experience of the program. Unsurprisingly, the remote version, which was not originally planned, had some challenges which are documented here. However, there was some evidence that virtual approach had some benefits despite challenges associated with the unplanned implementation.

The next paper in this section is "Online University Students' Perceptions of Institution and Program Community and the Activities that Support Them" by Craig Shepherd of Memphis University, Doris Bolliger of Texas Tech University and Courtney McKim of Franklin University. While many researchers have investigated the development and benefits associated with the sense of belonging, trust, and shared purpose that community can provide with online courses, the authors of this paper identify aspects of this topic that have received less attention. These are important concerns given the longstanding research that indicates that both social and academic integration reduces student attrition. However, students' sense of community at the academic program and the institutional levels remain under investigated. The study concludes

that academic program support is more important to students than social support, but there were sub-group differences that add nuance to these findings.

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Finally a huge thank you to our editors, authors, reviewers and the staff at OLC for their many contributions to support the success of the journal.

The Role of Self-Regulation in the Relationship Between Adaptability and Engagement: A Case of Online Mathematics Learning for Elementary School Students

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Abstract
The dynamics of students' engagement in online mathematics learning during the pandemic have differed significantly from face-to-face learning. To further investigate this, the current study aims to examine the relationship between student adaptability and engagement, taking into account the mediating role of self-regulation and the influence of grade level, parental education level, student age, and student gender. A total of 339 students, with an average age of 11.16 years, from three public elementary schools in Yogyakarta, Indonesia, participated in this study. The findings of the study revealed the following: 1) adaptability significantly and positively predicts students' self-regulation, 2) in turn, self-regulation significantly and positively predicts student engagement in online mathematics learning, and 3) adaptability has a significant positive impact on student engagement, both directly and through the mediation of student self-regulation. These findings have significant implications for the student learning environment, particularly with regard to parental involvement. Recommendations are provided for creating environmental conditions that promote online learning engagement through adaptability and self-regulation.

Keywords: Adaptability, elementary school, online mathematic learning, self-regulation, student engagement

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Finding ways to preserve the benefits of in-person classroom instruction is a major challenge in online education. Sustaining students' attention and engagement during online lessons requires incorporating gestures, ensuring visibility to students as they interact with the material, and effectively conveying non-verbal social cues such as body language and eye contact (Fiorella et al., 2018; Stull et al., 2018). These factors are especially critical when teaching abstract concepts or utilizing mathematical notions to facilitate effective student learning.

Research has consistently shown that student engagement plays a central role in academic achievement and overall academic well-being across various subjects (Fung et al., 2018; Zhang et al., 2021). However, the shift to remote learning has presented students with new challenges, compelling them to adapt and adjust rapidly in order to avoid falling behind. In this study, we specifically focused on students' adaptation and self-regulation in response to change, particularly during the COVID-19 pandemic, and examined how these factors were related to student engagement in online mathematics learning.

The multidimensional nature of school engagement is widely recognized. In particular, there is general agreement with the conceptualization of engagement proposed by Fredricks et al. (2004), which encompasses affective, cognitive, and behavioral elements. Affective involvement refers to a sense of belonging to the school, feelings of acceptance from teachers and peers, and perceiving the school as a supportive environment. “Behavioral engagement includes actions such as attendance and participation in school activities,” while “cognitive engagement” is defined as “the willingness to engage in challenging tasks, goal-directedness, strategic use, and self-regulation” (Sinatra et al., 2015, p.2). In today's context, engagement may also encompass the environment (Shernoff & Bempechat, 2014) and technology (Schindler et al., 2017) as relevant factors.

The learning environment is seen to be very influential and flexible in terms of engagement. Online learners complete their coursework in one or more behavioral settings that aren't always intended as learning environments. The physical environment can impact students' learning and performance through cognitive factors, such as attention disturbance and decreased concentration, physiological factors, such as changes in temperature and comfort level; and affective factors, for example, motivation. This is supported by the revised edition of the cognitive load model (Choi et al., 2014). Students in online programs have highlighted the need for a practical and comfortable environment with adjustable lighting, noise levels, temperature, movement and ergonomic furniture (Alphonse et al., 2019; Beckers et al., 2016). Online teachers and students require access to a variety of computer equipment, high-speed Internet, wireless connections, and power outlets (Beckers et al., 2016). Additionally, parents play a significant role in directing and supervising their children's at-home teaching and learning activities in accordance with the teacher's instructions. According to Alia and Irwansyah (2018), parents play a crucial part in helping kids use technology. Parents who struggle with technology and are unable to operate it can inadvertently add pressure on their children, as they are unable to assist them in using technology (Purnomo et al., 2022).

For the majority of students, online learning became the new norm during the COVID-19 pandemic that struck the world in the years 2020–2022. Online learning, which entails

interaction between students and teachers via remote access to the Internet (Casimiro, 2016), requires swift adaptation from both instructors and students. This, in turn, contributed to issues regarding student engagement, including a lack of supporting infrastructure, negative student-teacher attitudes toward online learning, boredom, failed classes, and psychological stress (Ferri et al., 2020; Irfan et al., 2020; Purnomo et al., 2021; Xu & Xu, 2019).

The lack of face-to-face connection in online learning can cause students to feel isolated and separated from their learning community since communicating and sharing information with classmates and instructors becomes challenging (Friesen & Kuskis, 2013; Xu & Jaggars, 2014).

According to Irfan et al. (2020), online teaching presents challenges, particularly in math education, due to limitations in representing mathematical symbols and the functional capacity of the learning management system to facilitate communication during math lessons. Mathematical concepts are often complex and abstract, and teachers typically rely on various tools such as charts, whiteboards, and manipulatives to convey these concepts. The exchange of information and communication patterns with students in online settings requires teachers to adapt and switch between different modes.

Drawing from the theory of embodied cognition, learning is viewed as involving not only the mind but also the entire body. Researchers have also identified three types of gestures that embody mathematical knowledge: pointing, symbolic, and metaphorical. These gestures can enhance students' visual perception (Alibali & Nathan, 2012) and aid in their understanding of abstract concepts. Therefore, learning mathematics online requires a unique set of soft skills, which we identify as adaptability and self-regulation in this study.

Adaptability refers to how students respond and adjust to new situations (Collie et al., 2017; Collie & Martin, 2017; Holliman et al., 2018). In the context of online mathematics learning, adaptability becomes particularly crucial due to its unique challenges and demands. Mathematics encompasses a broader scope beyond counting, memorization, and formula application, involving human activity (Pramudiani et al., 2016), context (Pramudiani et al., 2017), and social connectedness (Yoppy Wahyu Purnomo et al., 2016). Therefore, online mathematics learning poses significant challenges.

Engaging in online mathematics learning requires students to navigate the digital environment, interact with online resources, and engage in virtual communication and collaboration. This dynamic context necessitates adaptability as students must adjust their ideas, attitudes, and behaviors to effectively learn and engage in online mathematics activities. Students who demonstrate adaptability are more likely to possess the self-regulatory skills necessary for effective online mathematics learning. They can set clear objectives, control their behaviors, and make necessary adjustments to their learning process (Zimmerman, 2000). Adaptability enables students to cope with uncertainties, embrace new technologies, and explore alternative approaches. Their ability to adjust and regulate their learning process in the online environment sets them up for success in their mathematical pursuits. Previous research by Collie and Martin, (2017) has shown that student-reported adaptability predicts students' mathematical engagement, indicating the importance of adaptability for present and future learning.

While previous studies have examined adaptability and student engagement in the context of online learning (Besser, Flett, & Zeigler-Hill, 2020; Besser, Flett, Nepon, et al., 2020; Dumford & Miller, 2018; Gopakumar, 2020; Lee et al., 2023; Zhang et al., 2021), the role of self-regulation in the relationship between adaptability and student engagement, particularly in online mathematics learning for elementary school students, remains unexplored.

This study aims to investigate the role of self-regulation in the relationship between adaptability and engagement in the context of elementary school students and online mathematics learning. To meet the research aims, the following research questions were asked:

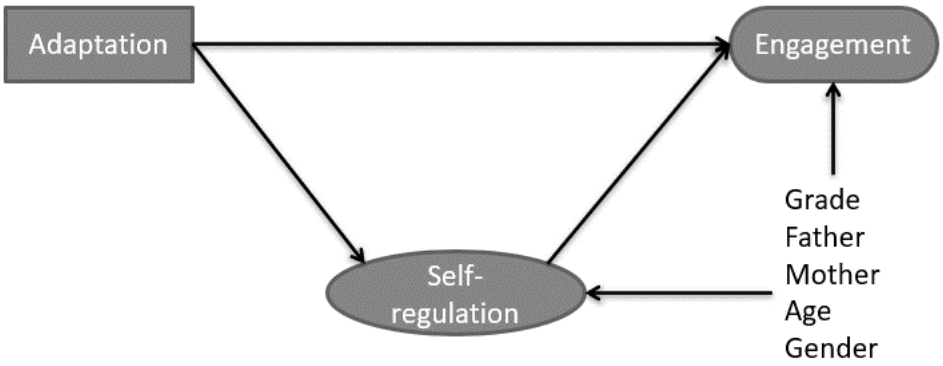
1. How does adaptability predict self-regulation?
2. How does self-regulation predict student engagement?
3. How does adaptability predict student engagement, either directly or through the mediation of self-regulation?

Additionally, we aim to examine how covariate factors such as grade level, parental education level, student age, and student gender predict student engagement and self-regulation.

Figure 1 depicts a graphic mediation model that depicts these study concerns. In addition, this paper also presents psychometric evidence of the measurement scale.

Figure 1

Mediation Model of Self-Regulation in Terms of the Relationship Between Adaptability and Student Engagement



Studies on student self-regulation and engagement have examined various demographic factors, including gender, age, class, and parental education, which are believed to influence students' abilities to regulate their own learning and engage in educational activities. For example, Liu et al. (2021) dan Zhao et al. (2014) have explored gender and its relationship with student self-regulation, while (Holliman et al., 2018) and (Wang et al., 2016) have examined the connection between gender and student engagement. These studies have investigated how gender influences students' self-regulatory skills and their level of engagement in educational activities.

Age has also been a demographic factor of interest in relation to student self-regulation and engagement. Zhao et al. (2014) and Holliman et al. (2018) have examined the association between age and these variables, exploring how students' developmental stage may affect their ability to self-regulate and engage in learning activities.

Grade level has been considered another demographic variable concerning student self-regulation and engagement. Gomes et al. (2019), Zhao et al., (2014), and Wang et al. (2016) have studied the impact of grade level on these factors, investigating how students' educational experiences and classroom environments contribute to their self-regulatory abilities and level of engagement. In addition to the aforementioned demographic factors, parents' educational level has gained attention in relation to student engagement in online learning. (Purnomo, et al., 2022) emphasized that highly educated parents, regardless of their socio-economic status, are thought to possess more knowledge and resources to support their children's learning, including promoting self-regulation and effectively leveraging technology.

It is important to acknowledge that these demographic factors may vary across different cultural, social, and educational contexts, leading to inconsistent findings in the literature. Nevertheless, studying these factors in greater depth can provide valuable insights into the specific characteristics that influence student self-regulation and engagement in learning.

Theoretical Underpinning

Adaptability

The ability to adapt to a new and unexpected academic environment is referred to as adaptability in the context of learning and schooling. Our viewpoint aligns with Collie and colleagues (Collie et al., 2017; Collie & Martin, 2017; Holliman et al., 2018), who define adaptability as the capacity to adjust to new situations. They describe adaptability as the modification and regulation of cognitive, behavioral, and emotional functions in an uncertain and constantly changing environment, condition, or situation.

Adaptability is often associated with theories of resilience, coping ability, and buoyancy (Martin et al., 2012, 2013). However, adaptability differs from resilience, coping, and buoyancy as it focuses on managing change and uncertainty, among other factors, rather than specifically dealing with difficult or stressful situations.

In addition, Martin et al. (2012) developed a scale with four components to assess adaptability: (a) responses to newness, change, variability, or uncertainty; (b) cognitive, behavioral, or affective functions; (c) regulation, adjustment, improvement, or new forms of accessing the three functions; and (d) constructive goals or outcomes. The analysis resulted in the identification of two factors: cognitive-behavioral and affective factors. These factors slightly differ from those proposed previously. We utilized this scale to measure student adaptability.

Self-Regulation in Online Mathematics Learning

Referring to the empirical test conducted by Martin et al. (2013), adaptability and self-regulation are differentiated in their study, exploring their individual contributions to academic and non-academic outcomes. Self-regulation models typically encompass a broad focus on

managing and directing one's thoughts and behaviors in various learning contexts and in response to academic demands. In contrast, adaptability narrows its focus to the specific ability to navigate and cope with uncertainty, novelty, and challenging situations.

According to Zimmerman (2000), self-regulation is not merely a mental capacity or skill for academic success; rather, it is a self-directed process through which learners translate their mental abilities into academic skills. Learning is seen as a proactive activity in which students engage, rather than a passive occurrence resulting solely from instruction. Self-regulation involves generating, monitoring, organizing, and controlling one's ideas, attitudes, and actions aimed at achieving goals (Pintrich, 2000; Zimmerman, 2000).

In terms of measurement, Koivuniemi et al. (2021) mention that self-regulated learning (SRL) is commonly assessed using questionnaires and self-reports, with the Motivated Strategies for Learning Questionnaire (MSLQ) being the most frequently used instrument. However, the MSLQ was originally designed for college students and may not be suitable for elementary school students due to the number of items. Therefore, we employ the Self-Regulation Questionnaire-Academic (SRQ-A), developed by Ryan & Connel (1989). Additionally, Gomes et al. (2019) state that the SRQ-A is specifically designed for elementary and secondary school students. The SRQ-A assesses the extent to which an individual's motivation for a specific behavior is relatively autonomous or controlled, based on the reasons provided by students for their engagement in school-related activities. The SRQ-A consists of four subscales that reflect the continuum of Self-Determination Theory, ranging from extrinsic motivation to intrinsically motivated behavior, along with four corresponding regulatory styles: three types of extrinsic motivation (external, introjected regulation, and identified regulation) and intrinsic motivation (intrinsic regulation). Gomes et al. (2019) evaluated this questionnaire in the context of primary school students in Portugal for the study. They produced a valid and dependable instrument. We used the same questionnaire but translated it into Indonesian.

Student Engagement in Online Mathematics Learning

For decades, students' engagement in learning has been studied and demanded in the literature (Ferrer et al., 2020; Fredricks et al., 2011). According to Fredricks and colleagues (Fredricks & McColskey., 2011; Fredricks et al., 2004), the concept of student engagement includes at least three constructs: behavioral engagement, emotional engagement, and cognitive engagement.

Behavioural engagement refers to students' participation in academic, social, or extracurricular activities both at and outside school (Fredricks et al., 2004). Research by Fung et al. (2018) suggests that students who actively participate and are organized in class are more likely to overcome learning difficulties. For example, students who dedicate effort to completing math homework and engage in discussions with their peers about math problems demonstrate better preparation for success in school.

Emotional engagement focuses on students' positive or negative reactions to teachers, classmates, lessons, and the overall school environment. Positive emotional engagement fosters a sense of connection between students and the school, influencing their motivation to learn. In the case of mathematics, which is sometimes perceived as less interesting and can provoke anxiety

among students, affective engagement becomes crucial for successful mathematics learning (Radišić et al., 2015).

Lastly, cognitive engagement pertains to students' persistence and the use of cognitive strategies during the learning process. This includes not giving up when faced with challenges and going beyond what is expected to solve math problems. Furthermore, cognitive engagement involves employing effective strategies to handle and process large amounts of information while solving mathematical problems (Fredricks et al., 2004). So, in this study, we combined the three types of engagement to measure mathematical engagement constructs commonly used in the literature comprehensively. We also include an online component in mathematics learning that is relevant to current situations and conditions.

Method

Participants

The participants of this study were 339 students from three public primary schools in Yogyakarta Special Region, Indonesia. Participants were selected using convenience sampling. They consist of students in the upper grades 4, 5, and 6 with an average age of 11,16 years (SD = 0.99). All respondents provided informed consent to participate in the study/processing of their replies. Details of participants can be seen in Table 1.

Table 1
Student Participant Profile

Based on		Sub-sum	%
Class	IV	120	35.4
	V	112	33.0
	VI	107	31.6
Gender	Male	156	46
	Female	183	54
Age	7 years	1	0.3
	9 years	1	0.3
	10 years	90	26.5
	11 years	123	36.3
	12 years	104	30.7
	13 years	16	4.7
	14 years	2	0.6
	16 years	2	0.6
Mother's last education	Elementary school	26	7.7
	Junior high school	63	18.6
	Senior high school	194	57.2
	Higher education	52	15.3
	No description	4	1.2
Father's last education	Elementary school	40	11.8
	Junior high school	61	18.0
	Senior high school	194	57.2
	Higher education	44	13.0

As Table 1 shows, our sample is fairly balanced across gender: 46% for male and 54% for female. The last education of their mothers and fathers tends to be dominated by high school level and equal.

Instruments and Data Collection

Online questionnaires were utilized as a means to collect data. Researchers sought assistance from teachers to distribute the questionnaires by sharing links with their students through various communication channels, including WhatsApp groups, email, or instant messages. This collaborative approach proved effective in reaching a larger sample size and facilitating data collection. Teachers are often valuable allies in research as they have direct access to students and can help ensure a higher response rate. A consent form, instructions, and brief information on the research accompanied the link.

This online questionnaire is divided into two parts. The first part deals with demographic questions such as name, age, school origin, grade, father's last education, and mother's last education. The second part is the core part of the measured three scales: adaptability, independence, and student engagement in online mathematics learning. Each of these scales is explained separately in the following points.

Student Adaptability

This study measured adaptability using a five-point Likert scale adapted from Martin et al. (2012). This scale has two components: six for cognitive-behavioral adaptability and three items for affective adaptability. Martin et al. (2012) used this scale to assess middle and high school students. As a result, the statement items on this were adapted to the context of elementary school students' levels and mathematics classes in Bahasa Indonesia following back translation method. For example, the original statement, "I am able to think through a number of possible options to assist me in a new situation" was translated as "I can think of a number of possible options to help me in a new situation."

Student Self-Regulation in Online Mathematics Learning

The self-regulation instrument of this study was adapted from Gomes et al. (2019). This study involved 341 Portuguese elementary school children ranging from 8 to 11 years old from the third and fourth grades. This study produced 16 out of 24 items that were developed and included in four factors: external, introjected, identified, and intrinsic. The items are rated along a 5-point response scale ranging from 1 (never) to 5 (always). The reliability of each of these factors is 0.80, 0.76, 0.79, and 0.82, respectively.

Student Engagement in Online Mathematics Learning

The student engagement instrument used in this study was an adaptation of the Rimm-Kaufman and colleagues' instrument (Leis et al., 2015; Rimm-Kaufman et al., 2015). Rimm-Kaufman and colleagues used this scale with 387 grade 5 students in one suburban district in the mid-Atlantic states. The scale assesses engagement on three aspects: social, cognitive, and emotional. Thirteen of the 15 items compiled met the validity and reliability criteria, including five items of emotional engagement ($\alpha = 0.91$), four items of social engagement ($\alpha = 0.98$), and four items of cognitive engagement ($\alpha = 0.89$).

We adapted the instrument to be used for online mathematics learning. All statements included the phrase "in online mathematics learning." Some phrases were added at the beginning of the sentence and some at the end. For example, the original item was "Students in my math class helped each other to learn today." But after the translation, the item read as "Friends help each other in online learning math."

Data Analysis

Descriptive statistical analysis, such as the mean (M), standard deviation (SD), and the range between the average items (minimum and maximum), was used to examine the profile trends associated with each variable. We used mediation analysis using PROCESS to examine the relationship between the main and moderating variables.

The confirmatory factor analysis (CFA) procedure was conducted prior to the main analysis to assess the convergent and discriminant validity of the instruments. Internal consistency testing was performed using Cronbach's alpha, with a coefficient of 0.6 being the threshold to meet the criteria (Clark & Watson, 1995; Nunnally & Bernstein, 1994).

Results

Preliminary Analysis

Along with descriptive and correlation analysis, we conducted a confirmatory factor analysis (CFA) for each instrument to examine their construct validity. Additionally, this analysis helped assess the possibility of enhancing the scale's structure. The reliability of each factor in the scales was also assessed using Cronbach's alpha.

Adaptability

The model fit for the adaptability scale was at a good level with NC = 1.70, CFI = 0.98, RMSEA = 0.05, and SRMR = 0.04. The model retained 16 existing items. Each item has a loading factor of more than 0.5 with a minimum of 0.59 and a high of 0.816. In addition, the composite reliability for the behavior is 0.86, and the affective factor is 0.73. The Average Variance Extracted (AVE) coefficient obtained a value close to 0.5, namely 0.473 for the affective factor and 0.498 for the behavior factor. The results of the descriptive validity test using Heterotrait-Monotrait (HTMT) analysis obtained a coefficient value of 0.808. Therefore, the issues concerning discriminant validity were addressed, and based on the obtained test results for convergent validity and discriminant validity, the constructs met the criteria for both validity measures.

Self-Regulation

The CFA for the self-regulation scale was carried out using two simulations. The first simulation used the first-order factor, and the second simulation used the second-order factor. The first model obtained NC = 3.25, CFI = 0.92, SRMR = 0.06 and RMSEA = 0.08. Similar results were obtained by model 2, namely NC = 3.27, CFI = 0.92, SRMR = 0.06, and RMSEA = 0.08. We used the second model to describe the self-regulation scale. The second model contained two dimensions: intrinsic regulation and extrinsic regulation factor. For the second model, the loading factor of each item in the first factor ranged between 0.79 and 0.94, while the items in the second order factor ranged between 0.52 and 0.89. All items were included in the

subsequent analysis. In addition to factor loading, several criteria were used to analyze convergent and discriminant validity and reliability.

The CR (Composite Reliability) for the two factors obtained decent coefficients: 0.86 for the extrinsic factor and 0.88 for the internal factor. The AVE coefficients for these two factors were also adequate as they were above 0.5. Specifically, the extrinsic factor had an AVE coefficient of 0.75, and the internal factor had an AVE coefficient of 0.78. Therefore, this model demonstrated very good convergent validity. The analysis of discriminant validity also yielded positive results, as indicated by the HTMT analysis. The HTMT values were below the threshold of 0.85, with a value of 0.37, indicating satisfactory discriminant validity. Reliability, assessed using Cronbach's alpha, also yielded coefficients higher than 0.7 for both factors: 0.89 for the extrinsic factor and 0.89 for the intrinsic factor.

Engagement

The three factors engagement scale showed a good fit with NC = 2.43, CFI = 0.94, RMSEA = 0.07, and SRMR = 0.07. This 3-factor model retained 13 items with a loading factor of 0.51 to 0.86. The CR coefficients for each factor were 0.76 for the cognitive-behavior factor, 0.69 for the social factor, and 0.79 for the emotional factor. The AVE values were also close to 0.5, with the cognitive-behavior factor at 0.44, the emotional factor at 0.53, and the social factor at 0.49. Based on the loading factors, CR coefficients, and AVE values, the engagement scale met the requirements for convergent validity. The discriminant validity of the scale was also adequate, as indicated by the HTMT. The HTMT values were 0.33, 0.44, and 0.78, all below the threshold of 0.85, indicating satisfactory discriminant validity.

Descriptive Data and the Relationship Between Factors

Table 2 provides descriptive statistics such as mean, SD, minimum and maximum, and skewness, kurtosis, and bivariate correlation for study variables. Based on the data in Table 2, the difference between the two factors is not too big for the adaptability variable. The cognitive-behavior factor (M = 3.42, SD = 0.85) is higher than the affective factor (M = 3.22, SD = 0.93). The highest average for factors in student engagement is obtained by cognitive factor (M = 3.15 and SD 0.45), followed by social and emotional factors. The lowest mean for the self-regulation variable was introjected (M = 2.45, SD = 1.25). This result also aligns with the mean of extrinsic factors in the second fit model of student self-regulation (M = 2.87, SD = 1.14). On the other hand, the identified factor obtained the highest mean (M = 4.06, SD = 0.88).

Each pair was positively and significantly correlated with $p < 0.001$ among the three variables. The strongest correlation was between adaptability and self-regulation ($r = 0.45$, $p < 0.001$). Each factor in adaptability, both cognitive-behavior and affective, were significantly correlated with each factor on the dimensions of self-regulation and engagement. The strongest correlation was the pair of cognitive-behavior and intrinsic ($r = 0.48$, $p < 0.01$) and followed by cognitive-behavior and identified factor ($r = 0.48$, $p < 0.01$) and cognitive-behavior and internal factor ($r = 0.41$, $p < 0.01$). The weakest correlation was shown by affective and extrinsic pairs ($r = 0.115$, $p < 0.01$). Apart from that, Table 2 also shows that all extrinsic factors in self-regulation

Table 2

Descriptive Data and Correlation Between Factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Ext	1	0.65**	0.26**	0.27**	0.28**	0.91**	0.02	0.03	0.08	0.25**	0.12*	0.79**	0.06	0.20**	-0.15**	0.06	-0.16**	-0.01	-0.07
2. Intro		1	0.26**	0.30**	0.30**	0.91**	0.02	0.07	0.14*	0.27**	0.15**	0.80**	0.10	0.23**	-0.09	0.05	-0.14**	-0.04	-0.12*
3. Iden			1	0.73**	0.93**	0.29**	0.35**	0.06	0.21**	0.48**	0.36**	0.68**	0.27**	0.46**	-0.07	0.18**	-0.08	0.10	-0.05
4. Int				1	0.93**	0.31**	0.34**	0.16**	0.37**	0.42**	0.37**	0.70**	0.38**	0.44**	-0.16**	0.14**	-0.19**	0.05	-0.05
5. Intrin					1	0.32**	0.37**	0.12*	0.31**	0.48**	0.39**	0.74**	0.35**	0.48**	-0.12*	0.17**	-0.14**	0.08	-0.06
6. Extern						1	0.03	0.05	0.12*	0.29**	0.15**	0.87**	0.10	0.26**	-0.13*	0.06	-0.16**	-0.02	-0.11
7. Cog							1	0.25**	0.49**	0.27**	0.24**	0.21**	0.76**	0.28**	0.03	0.29**	0.06	0.14*	0.01
8. Soc								1	0.26**	0.15**	0.14**	0.10	0.71**	0.16**	0.02	0.06	0.01	-0.06	0.01
9. Emo									1	0.22**	0.19**	0.25**	0.77**	0.22**	-0.03	0.16**	0.02	-0.01	-0.01
10. Cogbeh										1	0.63**	0.45**	0.28**	0.89**	0.02	0.12*	0.07	0.08	0.06
11. Affect											1	0.31**	0.25**	0.91**	-0.04	0.11*	0.01	0.12*	0.10
12. Self												1	0.24**	0.42**	-0.16**	0.13*	-0.19**	0.03	-0.10
13. Engage													1	0.29**	0.01	0.22**	0.03	0.02	0.00
14. Adapt														1	-0.01	0.13*	0.05	0.11*	0.09
15. Age															1	-0.09	0.71**	0.07	0.06
16. Gender																1	-0.02	-0.04	-0.07
17. Grade																	1	0.12*	0.10
18. Father																		1	0.55**
19. Mother																			1
Mean	3.32	2.42	4.06	3.75	3.91	2.87	3.15	2.80	2.65	3.42	3.22	3.39	2.86	3.32	11.17	0.54	4.96	2.71	2.81
SD	1.26	1.25	0.88	0.90	0.83	1.14	0.45	0.53	0.48	0.85	0.93	0.81	0.36	0.80	1.00	0.50	0.82	0.84	0.79
Min	3.14	2.10	3.66	3.48	3.48	2.10	2.96	2.68	2.46	3.29	3.18	1.75	1.80	1.33					
Max	3.56	2.73	4.24	3.78	4.24	3.56	3.21	2.89	2.84	3.58	3.27	5.00	4.00	5.00					
Skewness	-0.22	0.52	-0.70	-0.26	-0.44	0.18	0.12	-0.44	0.40	0.20	0.18	0.18	0.25	0.24	0.62	-0.16	0.07	-0.64	-0.62
Kurtosis	-1.19	-0.91	-0.58	-0.58	-0.67	-1.04	-0.00	0.51	0.27	-0.62	-0.36	-0.75	0.64	-0.35	2.87	-1.99	-1.50	-0.08	0.23

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

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

have no significant correlation with student engagement, except for introjected pairs and emotional engagement ($r = 0.14$, $p < 0.05$), although the relationship is weak.

Mediation Analysis

We used the PROCESS feature in SPSS version 24 to examine the role of SRL mediation in the relationship between adaptability and engagement. We also used covariate variables namely student grade, father's education level, mother's education level, age, and gender. The results of this analysis can be summarized in Table 3.

Table 3

Analysis of Covariate Variable

	Coeff.	SE	*t*	*P*	LLCI	ULCI
OUTCOME VARIABLE: SELF REGULATION $R^2 = 0.25$, $F(6, 33) = 18.27$, $p < 0.001$						
Constant	3.13	0.50	6.32	0.00	2.16	4.15
Adapt	0.44	0.05	8.89	**0.00**	0.34	0.53
Age	0.00	0.06	0.04	0.97	-0.11	0.11
Gender	0.11	0.08	1.34	0.18	-0.05	0.26
Grade	-0.21	0.07	-3.12	**0.00**	-0.34	-0.08
Father	0.10	0.06	1.84	0.07	-0.01	0.21
Mother	-0.18	0.06	-3.06	**0.00**	-0.30	-0.06
OUTCOME VARIABLE: ENGAGE, $R^2 = 0.14$, $F(7, 33) = 7.41$, $p < 0.001$						
Constant	2.09	0.23	8.29	0.00	1.59	2.58
Adapt	0.10	0.03	3.66	**0.00**	0.05	0.15
Self	0.06	0.03	2.38	**0.02**	0.01	0.12
Age	0.01	0.03	0.28	0.78	-0.05	0.06
Gender	0.13	0.04	3.31	**0.00**	0.05	0.20
Grade	0.02	0.03	0.59	0.61	-0.05	0.08
Father	-0.00	0.03	-0.06	0.95	-0.05	0.05
Mother	0.00	0.03	0.15	0.88	-0.05	0.06

Note: Indirect effect(s) of X on Y:

	Effect	BootSE	BootLLCI	BootULCI
SELF	0.03	0.01	0.01	0.05

Note:
Coeff is the Coefficient Value of each variable; SE stands for Student Engagement; LLCI stands for Lower Level Confidence Interval; ULCI stands for Upper Level Confidence Interval; BootSE stands for Bootstrapping Student Engagement; BootLLCI stands for Bootstrapping Lower Level Confidence Interval; BootULCI stands for from the Bootstrap Top Level Confidence Interval.

Table 3 shows the data from the mediation analysis. The regression model describes a significant measure of variance in both self-regulation ($R^2 = 0.25$, $F(6, 33) = 18.27$, $p < 0.01$), and student engagement in online mathematics learning $R^2 = 0.14$, $F(7, 33) = 7.41$, $p < 0.01$). Table 3 also explains that path *a*, adaptability significantly predicts students' self-regulation with $b = 0.44$, $p < 0.01$. Track *c'* (direct effect) is also significant ($b = 0.10$, $p < 0.01$); that is, adaptability influences student engagement in online mathematics learning. Track *b*, namely student self-regulation, has a significant prediction on student engagement in online mathematics learning ($b = 0.06$, $p < 0.05$). Second, Table 3 also shows evidence for the mediation hypothesis of the self-regulation of the relationship between adaptability and student engagement is also significant ($b = 0.03$, BootLLCI = 0.01 and BootULCI = 0.05). Indirect effect (*a*b*) is significant because the bootstrap confidence interval does not include zero.

Table 3 also shows the grade of the covariate variable (b = -0.21, $p < 0.05$) and the mother's level of education (b = -0.18, $p < 0.05$); both have a negative and significant prediction on students' self-regulation. As for student engagement, only the gender variable has a positive and significant prediction (b = 0.13, $p < 0.05$).

We also conducted parallel mediation, which analyzed the mediating role of two intrinsic and extrinsic SRL factors in the relationship between adaptability and engagement. The analysis is to discover which SRL factors play a significant role in the relationship between adaptability and student engagement. The analysis using the PROCESS feature in SPSS using the same covariate variables.

The analysis results indicate that pathway adaptability has a significant positive effect on both intrinsic student self-regulation (b = 0.50, p < 0.01) and extrinsic self-regulation (b = 0.37, p < 0.01). This means that higher levels of pathway adaptability are associated with increased intrinsic and extrinsic self-regulation levels. Regarding student engagement, only the intrinsic factors show a significant positive relationship (b = 0.12, p < 0.01), indicating that higher levels of intrinsic engagement are associated with greater student engagement. On the other hand, the extrinsic factors are found to be insignificant in predicting student engagement (b = -0.01, p = 0.57), suggesting that they do not significantly influence student engagement.

Total indirect effects mediated by intrinsic or extrinsic factors together are significant (b = 0.06, BootLLCI = 0.03 and BootULCI = 0.09), while only indirect effects mediated by intrinsic factors are significant (b = 0.06, BootLLCI = 0.03 and BootULCI = 0.09).

The analysis results also show that all covariates except age variables significantly predict student engagement and self-regulation. Furthermore, similar to previous findings, grade (b = -0.19, $p < 0.05$) and mother's education level (b = -0.16, $p < 0.05$) both had a negative and significant predict on students' intrinsic self-regulation ability. These two covariate variables are also significant to the extrinsic factors of self-regulation.

Discussion

This study aims to investigate the role of self-regulation in the relationship between adaptability and engagement of elementary school students in online mathematics learning. The findings answered the research questions: (1) How does adaptability predict self-regulation? (2) How does self-regulation predict student engagement? (3) How does adaptability predict student engagement either directly or through the mediation of self-regulation? We also examined whether the covariate variables, namely gender, age, and education levels of the mother and father, influence self-regulation and student engagement. In addition, this study also validated the instruments that we had adapted according to the context of the study.

The findings of research question one demonstrate that adaptability significantly influences self-regulation, including intrinsic and extrinsic regulation factors. This aligns with several researchers who state that adaptability is part of self-regulation (Holliman et al., 2018; Martin et al., 2013), specifically related to coping with situational uncertainty and novelty. Thus, adaptability is useful for monitoring, directing, and managing thinking and behavior to lead to

the goals to be achieved in diverse situations (Martin et al., 2013). This finding is further supported by Xu's (2022) research on the adaptation of online learning to students' self-regulation during the COVID-19 period. Xu (2022) emphasizes the importance of self-regulation in managing emotions, behaviors, and thoughts, highlighting that the shift to online learning necessitates a quick adaptation to self-regulation, particularly for students accustomed to traditional classroom settings.

The findings of research question two reveal a significant and positive relationship between self-regulation and student engagement in online mathematics learning. This finding is consistent with the study conducted by Sun & Rueda (2012), who investigated 203 students taking online classes and found that self-regulation positively influenced cognitive, emotional, and behavioral engagement. In the context of children's development, self-regulation is a strong predictor of student engagement (Jahromi et al., 2013). Children with higher self-regulation abilities are more likely to overcome challenges, regulate their emotions and behavior, and be accepted by their peers, leading to increased attention to learning opportunities and a desire to be actively involved in the learning process (Drake et al., 2014). Therefore, a higher degree of self-regulation in online learning can facilitate students to manage time, stay disciplined, set goals, engage in metacognition, adapt to new situations, and seek feedback for effective learning and overcoming challenges. Self-regulation is closely intertwined with behavioral, emotional, and cognitive engagement. Bandura's cognitive theory posits that learning occurs through reciprocal interactions among personal, behavioral, and environmental factors. Personal factors contribute to learning, including self-efficacy, self-regulation, and interests influenced by teachers, parents, and the surrounding community. Therefore, it can be concluded that self-regulation is crucial in fostering high levels of student engagement in online learning.

Our findings further indicate that adaptability has a significant positive prediction on student engagement both directly and through the mediation of student self-regulation. This finding reinforces previous evidence by showing that there is a positive relationship between adaptability and student engagement in various modes of mathematics learning (Collie & Martin, 2017). Previous studies showed that adaptability not only directly predicts student engagement but also affects student engagement through the mediation of positive academic chains and negative emotions. Adaptability predicts student engagement; when students are faced with new situations (face-to-face learning to online learning), they will tend to change the behavior, emotions, and cognition (Zhang et al., 2021). Previous research has indicated that emotions play a crucial role in the relationship between adaptation and student engagement within the educational setting (Chen et al., 2020; Jiang et al., 2020). When students are able to adapt well, they experience positive emotions such as joy and pride.

Conversely, students who experience negative emotions like anxiety and boredom tend to struggle with adaptation. These negative emotions act as barriers, hindering active participation in the learning process. Specifically, in the context of online mathematics learning, adaptability refers to the ability to employ strategies that assist students in navigating new challenges or changes that may arise (Martin et al., 2013). Students who possess strong adaptability tend to utilize their self-regulatory abilities to effectively manage their thoughts, behaviors, and emotions. Consequently, they are more likely to engage cognitively, behaviorally, and emotionally in learning mathematics online (Collie & Martin, 2017).

The covariate variables, specifically the grade level and the level of the mother's education, have a significant and negative impact on students' self-regulation. This means that their self-regulation tends to decrease as the student's grade level increases. Similarly, a higher level of education for mothers predicts a negative effect on their children's self-regulation. These findings are surprising as they reject our initial hypothesis, which suggested that higher levels of maternal education and higher grades would lead to increased self-regulation in students. One plausible explanation for these results is that mothers with higher education often have full-time jobs, leaving them with less time to support their children's learning (Purnomo et al., 2022). This lack of support can influence children's habits and ability to regulate their own learning, as previous studies have emphasized the importance of parental involvement in shaping parenting concepts (Purnomo et al., 2022; Silinskas & Kikas, 2019), as well as their involvement in the classroom (Yoppy Wahyu Purnomo et al., 2021). The negative relationship between grade level and self-regulation is indeed intriguing. Although studies have shown that self-regulation typically improves with age (Orgeta, 2009), individual personality traits also play a role in its development (Reed et al., 2020). Further investigation into students' personality types could provide additional insights into this relationship.

Conclusion

This research suggests that adaptability plays a crucial role in predicting students' ability to regulate themselves. Self-regulation, in turn, positively and significantly impacts students' active participation in online mathematics learning. Additionally, adaptability, directly and indirectly, affects student engagement, with the indirect effect mediated by student self-regulation. In addition to the three primary conclusions mentioned above, this study confirms the validity and reliability of the instruments adopted in Bahasa, Indonesia.

Other findings conclude that a number of covariate factors substantially impact self-regulation and student engagement. For example, mother education level significantly and negatively impacts students' self-regulation. We conclude that parental involvement is significant for students' engagement and the development of self-regulation even for online learning. The quality of parental involvement is related to students' self-concept and engagement in online mathematics learning. It is also important for schools to provide opportunities for parents, teachers, and the school itself to improve communication related to school programs, increase parents' knowledge and skills, and/or emotional closeness between teachers, parents, and students.

The study is not without its limitations. In the current study, only upper grades students were used as study participants. Future research needs to examine whether the lower and the upper elementary grades have significant differences concerning the variables studied and to expand the range of samples taken to increase generalizability. Additionally, the converse relationship between students' grade level and their self-regulation level needs to be examined in relationship with personality characteristics.

We are also limited to focusing on gender, grade, grade level, father and mother education levels, student age, and student gender. Future researchers may consider other

covariate variables such as socioeconomic status or family income. Socioeconomic status or family income is indeed a relevant covariate to consider, as it can significantly impact students' access to resources and support for online mathematics learning. Socioeconomic status encompasses various factors such as income, occupation, and education level within a family. It has been shown to influence students' access to technology, internet connectivity, learning materials, and supportive learning environments. These factors can directly impact students' opportunities and experiences in online mathematics learning.

The findings regarding students' self-regulation and adaptability in online learning have important implications for their engagement in both home and online classroom settings. To cultivate self-regulation and adaptability in both home and online classroom settings, consider creating a supportive and structured learning environment, teaching self-regulation strategies explicitly, promoting metacognitive awareness, encouraging self-directed learning, and supporting the development of time management skills. Establish clear routines, resources, and expectations to support student engagement, and encourage students to take ownership of their learning and set goals. Educators can help students develop essential skills for effective learning and adaptability by fostering autonomy and promoting self-directed learning. Engage students in online learning environments by managing their time effectively, cultivating a growth mindset, promoting collaborative learning experiences, utilizing interactive and varied instructional methods, and providing regular feedback and support. By embracing challenges and setbacks, educators and parents can enhance student engagement and improve learning outcomes. By incorporating diverse learning materials, providing constructive guidance, and offering timely feedback, educators and parents can effectively cultivate self-regulation and adaptability skills in both home and online classroom settings.

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Students' perceived social presence and media richness of a synchronous videoconferencing learning environment

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Abstract
This correlational cross-sectional study was conducted with 60 graduate students to explore their perceived social experiences with the use of synchronous videoconferencing in the online learning environment. By applying the theories of social presence and media richness, this study investigated the perceived relationship between social presence, social space, sociability, and media richness. The communication theories of social presence and media richness were applied to better understand the relationship between the communication medium (videoconferencing) and the interactions within the mediated environments (e.g., Zoom). This correlational cross-sectional study explored graduate students perceived social presence and media richness of a synchronous videoconferencing learning environment by investigating how strongly and in what direction social presence, social space, sociability, and media richness were related. A Pearson correlation analysis was conducted to investigate how strongly and in what direction social presence, social space, sociability, and media richness were related in a synchronous videoconferencing learning environment. The results indicated a strong, positive correlation between Social Presence and Social Space (Positive Group Behavior); Social Presence and Sociability; Social Presence and Media Richness; Social Space (Positive Group Behavior) and Sociability; Social Space (Positive Group Behavior) and Media Richness; and Sociability and Media Richness. A moderate, negative correlation was indicated between Social Space (Negative Group Behavior) and Social Presence; Social Space (Negative Group Behavior) and Sociability; and Social Space (Negative Group Behavior) and Media Richness.

Keywords: synchronous videoconferencing, media richness, social presence, social interaction

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Introduction

In April 2020, lockdown and social distancing measures immediately affected higher education, requiring instructors to switch from teaching face-to-face to an online hybrid style that incorporated synchronous videoconferencing into the course delivery (Skulmowski & Rey, 2020). Although using technology to deliver online classroom instruction and online course enrollments have continued to increase over the past two decades (Allen & Seaman, 2017; Berry, 2017; Weidlich & Bastiaens, 2017), low retention rates have persisted (Muilenburg & Berge, 2005; Ng, 2019) due to feelings of isolation and a lack of social connection (Baxter, 2012; Lowenthal, 2009; Pinsk et al., 2014). Feelings of isolation, a lack of social connection, and high dropout rates indicate that the learners' online learning needs are not being met (Ali et al., 2018; McInnerney & Roberts, 2004; Ng, 2019; Shelton et al., 2017).

Educators have identified social interaction in the learning environment as a vital element in the learning process (Bandura, 1979; Kreijns & Kirschner, 2001; Vygotsky, 1978) and that social interaction is necessary for group cohesion and collaboration to occur (Kreijns & Kirschner, 2001; Weidlich & Bastiaens, 2017). If cohesion and collaboration fail to occur, it can create a barrier to student learning. Low retention rates, feelings of isolation, and a lack of social connection are attributed to a perceived lack of social presence. Face-to-face communication is described as the richest communication medium in both media richness theory and social presence theory. Videoconferencing is a communication medium, high in richness, that makes the online students' experience comparable to that of their traditional face-to-face on-campus student counterparts. It supports immediate communication that creates a sense of having a face-to-face conversation while promoting feelings that the other person is *real* in the interaction, therefore creating higher perceived social presence.

Emerging technologies and media in online educational environments are continuously changing (Cocquyt et al., 2017), resulting in technology-mediated learning as the technological means by which information is conveyed and people are linked together (Bower, 2019). In the online environment, videoconferencing provides the visual of non-verbal facial and physical cues that are present in face-to-face courses but lacking in text-based only discussion posts. While face-to-face learning naturally creates an environment with rich social interaction opportunities, the online learning environment relies solely on technology to mediate all social interactions (Kreijns et al., 2004a, 2004b; Weidlich & Bastiaens, 2017). Unfortunately, when cohesion and collaboration fail to occur, barriers to student learning, increased feelings of isolation (Baxter, 2012; Borup et al., 2013; McInnerney & Roberts, 2004), and class dropout can result (Shelton et al., 2017).

Synchronous videoconferencing is a communication medium that provides students a human feel or real-life experience in the online learning environment by incorporating real-time communication software tools such as Skype, Zoom, Adobe Connect, or Microsoft Teams (Guo et al., 2010; Martin et al., 2017; Mulder, 2019). Using synchronous videoconferencing in online classes allows users to share audio and visual facilities in real-time, without delay (Al-Samarraie et al., 2019). It enables education, instruction, and learning to occur at the same time without requiring students to be in the same geographical location. Unlike asynchronous communication, synchronous videoconferencing provides the visual of non-verbal, facial, and physical cues that are present in face-to-face courses but lacking in text-based only discussion posts.

While we know that face-to-face communication is important for social presence, little is known about the impact of synchronous videoconferencing in college courses. In 2020, higher education institutions had to quickly move to distance learning, and some instructors incorporated synchronous videoconferencing in a variety of ways. This research was completed during this timeframe and looked specifically at the effects synchronous videoconferencing had on media richness and social presence. Therefore, the underlying research questions for this study were designed to explore students' perceptions on the social presence, social space, sociability, and media richness scales.

How strongly and in what direction are social presence, social space, sociability, and media richness related in a synchronous videoconferencing learning environment? On average, how often was the student's camera turned on during the class sessions? How important was it to the students to see the faces and hear voices of others? From a list of potential activities in the synchronous videoconferencing environment of Zoom, what did students use in their courses?

Literature Review

The literature review for this study revealed that although online course enrollments have increased over the past two decades (Berry, 2017), low retention rates persist (Muilenburg & Berge, 2005; Ng, 2019). Online students often feel isolated and lack a social connection with their instructor and classmates (Baxter, 2012; Pinsk et al., 2014). Feelings of isolation, lack of social connection, and high dropout rates indicate that the learners' learning needs are not being sufficiently addressed in the online learning environment (Baxter, 2012; Borup et al., 2013; McInnerney & Roberts, 2004; Shelton et al., 2017). A lack of social interaction is a barrier to students' learning. A communication medium's ability to provide a sense that the communication partner is immediately available has been found to affect communication content, satisfaction, and the ability to communicate complex information (Kuyath & Winter, 2006). Synchronous videoconferencing is a communication medium that allows users to share audio and visual facilities in real-time without delay (Al-Samarraie et al., 2019), which adds a real-life experience to the online learning environment (Guo et al., 2010; Martin et al., 2017; McInnerney & Roberts, 2004).

Research that specifically examined synchronous videoconferencing investigated how it related to engagement and communication (Basko & Hartman, 2017); combating feelings of isolation (McInnerney & Roberts, 2004); creating a sense of community (Berry, 2019; Lowenthal & Trespalacios, 2022; McInnerney & Roberts, 2004); learner characteristics and online technology self-efficacy (Kobayashi, 2017); communication platforms such as Remind (Basko & Hartman, 2017), VoIP, social bookmarking, social networks, Facebook, and YouTube (Hitrec et al., 2011); audio communication problems (Earnshaw, 2017); videoconferencing in an office setting (Campbell, 2006), and the effects of media richness on decision-making with two-person teams (Dennis & Kinney, 1998). Martin et al. (2017) conducted a systematic review of 157 articles from 34 countries and identified a number of meta-analyses and systematic reviews conducted on distance education and online learning, but none specifically examined synchronous online learning. Though previous studies researched barriers to students learning (Ali et al., 2018; Muilenburg & Berge, 2005), student motivation (Muilenburg & Berge, 2005; Ng, 2019), social interaction, social presence (Gunawardena & Zittle, 1997; Kreijns et al., 2013; Ladyshewsky, 2013), and media richness (Campbell, 2006; Daft et al., 1987; Oregon et al.,

2018), much of the research focused on asynchronous communication platforms.

Although previous research has examined students' needs and online engagement in asynchronous and synchronous online classes, little is known of students' perceptions of social presence, social space, sociability, and media richness in a synchronous videoconferencing learning environment.

Social Presence Theory

Social presence is described as the psychological phenomenon that the other is perceived *real* in the communication (Kreijns et al., 2020; Weidlich et al., 2018). Social presence theory originated from computer-mediated communication (CMC), which grew out of the telecommunication era of the late 1960s and 1970s. It is defined as "the degree of psychological sensation in which the illusion exists that the other in the communication appears to be a 'real' person" (Kreijns et al., 2013, p. 236). Kreijns et al. (2011) state, "Social presence theory has often been used to rank telecommunication media according to the degree of social presence (i.e., face-to-face > videoconferencing > audio). Media higher in social presence are more appropriate for carrying-out interpersonal tasks" (p. 367). In the view of Short et al. (1976), technology is a determinant of the perception of social presence. In contrast, others such as Gunawardena and Zittle (1997) and Tu (2002) argue that media attributes are irrelevant, that social factors are instead what is important in determining social presence (Kreijns et al., 2011).

Social presence has been examined as one of the social conditions capable of supporting online learning and is often described as a mechanism governing beneficial learning climates and interpersonal connections among online learners (Weidlich & Bastiaens, 2017). Social presence theory indicates that the *realness* of the perceived other is also increased when the richness of the communication medium is increased. Therefore, social presence is not about experiencing the environment; instead, it is the perception of another in the environment (Felnhofer et al., 2014). Kreijns et al. (2013) separated social presence into three core elements: social presence, social space, and sociability.

Social Presence, Social Space, and Sociability

In educational settings that rely on computer-mediated or technology-mediated communication to facilitate online learning, social presence is considered to be an essential aspect of the learning experience because it affects participation and social interaction, which are both necessary for effective collaboration and knowledge construction (Garrison, 2007; Kreijns et al., 2011). As social interaction occurs, the communicators will form an impression of one another. The process of impression formation determines the emergence of social presence. The sociability of a learning environment is expected to be a predictor of how much social interaction will take place. Sociability is described as the perceived quality of the learning environment to facilitate social interaction (Kreijns et al., 2007; Weidlich & Bastiaens, 2019) and social space is the perceived network of interpersonal relationships among group members (Kreijns et al., 2004a, 2004b; Weidlich & Bastiaens, 2019).

Computer-mediated or technology-mediated learning is the technological means by which information is conveyed and people are linked together (Bower, 2019). Kreijns et al. (2013) suggest that "simply enabling social interaction, therefore is not enough; it must be

stimulated" (p. 230). Kreijns et al. (2013) also postulate that sociability, social space, and social presence influence the social interaction that is needed for both learning and the emergence of a social space. Sociability, therefore, facilitates socioemotional interaction and the emergence of a social space (Kreijns et al., 2013). Within the online learning environment, a social space is created through social relationships and group cohesion (Kreijns & Kirschner, 2001). Weidlich and Bastiaens (2017) suggest that "creating a sociable learning environment is a viable approach to fostering socioemotional aspects that ultimately benefit the quality of the learning experience" (p. 479).

Media Richness Theory

Originating from information processing theory, media richness theory developed by Daft et al. (1987) proposes that the communication efficiency between people is affected by the choice of media and the characteristics of the communication task. Media richness is described as a communication medium's capacity to facilitate the processing of rich information (Daft et al., 1987). Media richness theory was one of the first theories to describe how and why people chose a particular medium to communicate with others in the workplace (Ferry et al., 2001). The theory was developed to help determine when face-to-face or other communication media are appropriate for task completion. Media richness theory proposes that the richer the medium used in the communication, the higher the capacity to transmit rich information; the lower the richness of the communication medium, the lower the capacity to transmit rich information.

A study conducted by Oregon et al. (2018) found a distinct correlation between using rich media technologies and enhancing social presence in course design and instruction on attrition in an online graduate program. Additionally, Campbell (2006) explored the impact of communication apprehension and participation on user perceptions of task and media characteristics in a videoconferencing context. The Campbell (2006) findings indicated that the media richness and social presence aspects of media choice theory are important considerations for videoconferencing users. Therefore, both communication theories of social presence and media richness were applied to this research to better understand the relationship between the communication medium (videoconferencing) and the interactions within the mediated environments (e.g., Zoom).

Method

This research employed a survey approach to make inferences about the relationship between media richness, social presence, social space, and sociability. This cross-sectional study used an electronic self-administered web-based survey to examine the associations of variables by investigating how strongly and in what direction social presence, social space, sociability, and media richness were related. The quantitative data collected from the participants was evaluated using descriptive and inferential statistics to evaluate the research questions and hypotheses.

Applying the communication theories of social presence and media richness, the primary purpose of this cross-sectional study was to explore students' perceptions of social presence, social space, sociability, and media richness in a synchronous videoconferencing learning environment. The communication theories of social presence and media richness were applied in this study to better understand the relationship between the communication medium (videoconferencing) and the interactions within the mediated environments (e.g., Zoom) from a

student's perspective.

Research Questions

The research questions and six null hypotheses underlying this research were:

RQ1: How strongly and in what direction are social presence, social space, sociability, and media richness related in a synchronous videoconferencing learning environment?

H01: Social presence is not related to social space in a synchronous videoconferencing learning environment.

H02: Social presence is not related to sociability in a synchronous videoconferencing learning environment.

H03: Social presence is not related to media richness in a synchronous videoconferencing learning environment.

H04: Social space is not related to sociability in a synchronous videoconferencing learning environment.

H05: Social space is not related to media richness in a synchronous videoconferencing learning environment.

H06: Sociability is not related to media richness in a synchronous videoconferencing learning environment.

RQ2: On average, how often was the student's camera turned on during the class sessions?

RQ3: How important was it to the students to see the faces and hear voices of others?

RQ4: From a list of potential activities in the synchronous videoconferencing environment of Zoom, what did students use in their courses?

Survey Item Construction

This research used four established instruments: the media richness scale, the social presence scale, the social space scale, and the sociability scale. The cross-sectional survey was used to collect demographic data and questions related to perceived media richness, social presence, social space, and sociability. The four existing instruments were combined into one survey that contained 77 questions using a 5-point Likert-type scale. The social presence, social space, sociability, and media richness scales consisted of phrases or statements in which the participants indicated the extent to which the phrase or statement was descriptive of their feelings at the time of taking the survey. The distribution of the survey was administered using Qualtrics survey software. After completing the demographic questions participants were asked eight additional questions that pertained to their use of Zoom in their class meetings. The questions inquired as to how often their Zoom classes met, how long they lasted, and whether the participants were satisfied or dissatisfied with their instructor and student interactions. Participants were also asked to rate their engagement in the Zoom sessions, what activities were included in the class meetings, how often their video was displayed during the Zoom meetings, and if seeing the faces and hearing the voices of others in class was important to them.

The SIPS model developed by Kreijns et al. (2004b) is comprised of the social presence scale, social space scale, and sociability scale and is used as a framework for measuring the social aspects of online learning. The three scales are described by Jochems and Kreijns (2006) as providing "a base for research on the interaction in computer-supported group-based learning" (p. 119). The media richness scale was developed by Ferry et al. (2001) as a means of measuring

the perception of richness that allows researchers the ability to identify characteristics of communication media that are most important for defining richness in practice. The perceived quality of the learning environment to facilitate social interaction was measured by the Kreijns et al. (2007) sociability scale. The Kreijns et al. (2004a) social space scale measured the perceived network of interpersonal relationships between students, and the Kreijns et al. (2020) social presence scale measured the perceived physical realness of the other in the communication. This study used the Ferry et al. (2001) media richness scale to measure students' perceptions of media richness with the use of synchronous videoconferencing as a communication medium in the online learning environment. All of the scales used in this research are published and permission was granted for use by the authors.

The authors of the scales further approved modifications to address the context of the research. For the social presence scale, each question began with asking respondents, "As you're thinking of yourself in class using Zoom, please select a response that best describes how you feel." For the social space scale, each question began with asking respondents, "As you're thinking of yourself in class using Zoom, please select a response that best describes how you feel." For the sociability scale, respondents were asked, "As you're thinking of yourself in class using Zoom, please select a response that best describes how you feel." The survey items with "CSCL environment" in the original scale were replaced with the words "learning environment."

Numerous studies have used and modified the language in the Ferry et al. (2001) media richness scale to fit the communication medium being used within their research studies. For instance, Tseng et al. (2019) used the scale to measure the richness of mobile instant messaging apps in employee communications, and Lee et al. (2009) used the scale to measure the richness of traditional email and avatar email. This study also modified the language in the Ferry et al. (2001) media richness scale to fit the communication medium used (videoconferencing). Therefore, instead of asking "When you are able to express your reactions to others immediately, how long (on average) do you think it takes for them to receive your reactions?" the wording was modified to "When using Zoom, you can send/receive information immediately." "When using Zoom, you can immediately learn what others think about your ideas" was asked in place of "On average, how long does it seem to take for you to learn what others think of your ideas?" And "When using Zoom, you can immediately express your reactions to others" replaced "On average, how long do you feel you have to wait to express your reactions to others?" Additionally, the third construct (personalness) was removed from the Ferry et al. (2001) media richness scale since the Kreijns et al. (2020) social presence scale measured items that were similar in scope.

The reliability of the survey used in this study was measured using Cronbach's alpha. Each of the measures Cronbach's alpha values were within optimal ranges with values that range between 0.7 and 0.9 (Creswell & Creswell, 2017). A summary of the variables, descriptions, items, and Cronbach's alpha for each of the scales used in this study is summarized in Table 1.

Table 1

Variables, Descriptions, Items, and Cronbach's Alpha

Variable	Description	# Items	Cronbach's Alpha	
Media Richness	A communication medium's capacity to facilitate the processing of rich information.	8	Multiple channels Immediacy of feedback	0.83 0.76
Social Presence	The psychological phenomenon that the other is perceived "real" in the communication.	27	Awareness of others Proximity with others	0.85 0.95
Social Space	The perceived network of interpersonal relationships among group members.	20	Positive group behavior Negative group behavior 0.81	0.91
Sociability	The perceived quality of the learning environment to facilitate social interaction.	10		0.94

Participants

After obtaining IRB approval to conduct the research from the university, participant recruitment for this study began and specifically targeted adult students (ages 25+) who were enrolled in the college of education at a midwestern university that used synchronous videoconferencing in their online learning experience. The survey was only distributed in online courses where the instructor was using Zoom. Descriptive statistics were obtained on survey items related to demographic data such as age, ethnicity, gender, student status (graduate), as well as background information about the frequency of use of cameras in Zoom sessions, variety of interactive tools used within Zoom, and the importance of seeing a person's face and hearing a voice. The sample population for this research consisted of 60 graduate students between the ages of 25 to 65+ years old who were currently using Zoom as a communication medium in their online classes from March 17, 2021, to May 18, 2021. The majority of the participants noted their race/ethnicity as White (82%). Table 2 outlines age and gender demographics for this study.

Table 2

Age and Gender Demographics

Age	n	%
25–34	13	21.67
35–44	18	30.00
45–54	25	41.67
55–64	3	5.00
65+	1	1.67
Gender		
Female	39	65.00
Male	21	35.00

Note. Due to rounding errors, percentages may not equal 100%.

Data Analysis

A correlational research design was chosen for this study to describe and measure the nature of the relationship among social presence, social space, sociability, and media richness with synchronous videoconferencing. The rationale for using a correlational cross-sectional study design was because it enabled the researcher to conduct the measures and test relationships within a short amount of time without altering or controlling the environment. The data analysis for this correlational cross-sectional study sought to explore students' perceptions on the social presence, social space, sociability, and media richness scales by investigating how strongly and in what direction they were related in a synchronous videoconferencing learning environment.

Prior to analyzing the raw data, a value or score was added to the data, thereby assigning a numeric value to each response. Any incomplete responses were not included, which led to the 60 completed surveys. The data were assessed for errors and missing data prior to entering it into SPSS. Analysis of the survey data was completed using SPSS data analysis software and Intellectus Statistics online computer software to run descriptive and parametric statistics (Intellectus Statistics, 2021). Factor analyses were previously conducted on the established instruments used in this study, as noted earlier, to assess the construct validity of each of the survey instruments. Cohen's standard was used to evaluate the strength of the relationships. The larger the effect size, the stronger the relationship between the two variables. The Pearson correlation coefficient was used in this study to describe the strength of the association between the variables. To test the assumption of normality, Skewness and Kurtosis were applied to Media Richness, Social Presence, Social Space, and Sociability. Scatterplots were used in this study to graphically display the relationship between the two variables.

Results

The results of the Pearson correlation analysis were used to investigate the research questions. The result of the correlations was examined based on an alpha value of 0.05. A strong, positive correlation was indicated between Social Presence and Social Space (Positive Group Behavior); Social Presence and Sociability; Social Presence and Media Richness; Social Space (Positive Group Behavior) and Sociability; Social Space (Positive Group Behavior) and Media Richness; and Sociability and Media Richness. A moderate, negative correlation was indicated between Social Space (Negative Group Behavior) and Social Presence; Social Space (Negative Group Behavior) and Sociability; and Social Space (Negative Group Behavior) and Media Richness. All null hypotheses for this research were rejected based on the hypotheses tests.

Table 3

Pearson Correlation Results

Combination	*r*p	95% CI	*p*
Social Presence (Awareness)—Social Space (Positive)	0.61	[0.42, 0.75]	< .001
Social Presence (Awareness)—Social Space (Negative)	-0.41	[-0.60, -0.18]	.001
Social Presence (Proximity)—Social Space (Positive)	0.75	[0.61, 0.84]	< .001
Social Presence (Proximity)—Social Space (Negative)	-0.27	[-0.49, -0.02]	.035

Social Presence—Social Space (Positive)	0.73	[0.58, 0.83]	< .001
Social Presence—Social Space (Negative)	-0.36	[-0.56, -0.11]	.005
Social Presence (Awareness)—Sociability	0.65	[0.47, 0.78]	< .001
Social Presence (Proximity)—Sociability	0.83	[0.73, 0.90]	< .001
Social Presence—Sociability	0.79	[0.67, 0.87]	< .001
Social Presence (Awareness)—Media Richness (Multiple)	0.65	[0.47, 0.78]	< .001
Social Presence (Awareness)—Media Richness (Immediacy)	0.55	[0.35, 0.71]	< .001
Social Presence (Proximity)—Media Richness (Multiple)	0.57	[0.37, 0.72]	< .001
Social Presence (Proximity)—Media Richness (Immediacy)	0.52	[0.30, 0.68]	< .001
Social Presence—Media Richness	0.66	[0.48, 0.78]	< .001
Social Space (Positive)—Sociability	0.82	[0.71, 0.89]	< .001
Social Space (Negative)—Sociability	-0.38	[-0.58, -0.14]	.003
Social Space (Positive)—Media Richness (Multiple)	0.44	[0.21, 0.63]	< .001
Social Space (Positive)—Media Richness (Immediacy)	0.57	[0.37, 0.72]	< .001
Social Space (Negative)—Media Richness (Multiple)	-0.41	[-0.60, -0.17]	.001
Social Space (Negative)—Media Richness (Immediacy)	-0.35	[-0.55, -0.10]	.007
Social Space (Positive)—Media Richness	0.55	[0.35, 0.71]	< .001
Social Space (Negative)—Media Richness	-0.41	[-0.60, -0.18]	.001
Sociability—Media Richness (Multiple)	0.56	[0.35, 0.71]	< .001
Sociability—Media Richness (Immediacy)	0.55	[0.34, 0.70]	< .001
Sociability—Media Richness	0.60	[0.41, 0.74]	< .001

Note. $n = 60$.

RQ1: How strongly and in what direction are social presence, social space, sociability, and media richness related in a synchronous videoconferencing learning environment?

H01: Social presence is not related to social space in a synchronous videoconferencing learning environment. The Pearson correlation results among Social Presence (Awareness)—Social Space (Positive Group Behavior) had a large effect size of 0.61 and a $p < .001$; and Social Presence (Proximity) —Social Space (Positive Group Behavior) had a large effect size of 0.75 and a $p < .001$, which indicated there was a strong, positive correlation between the variables. Social Presence (Awareness) and Social Space (Negative Group Behavior) had a moderate effect size of -0.41 and a $p = .001$, which indicated a moderate, negative correlation. Social Presence (Proximity) and Social Space (Negative Group Behavior) had a small effect size of -0.27 and a $p = .035$, which indicated a weak, negative correlation. The null hypothesis was rejected.

H02: Social presence is not related to sociability in a synchronous videoconferencing learning environment. The correlation coefficient between Social Presence (Awareness) and Sociability was 0.65, indicating a large effect size. The correlation coefficient between Social Presence (Proximity) and Sociability was 0.83, indicating a large effect size. This indicated a strong, positive relationship between the Social Presence and Sociability. The null hypothesis was rejected.

H03: Social presence is not related to media richness in a synchronous videoconferencing learning environment. The Pearson correlation results among Social Presence (Awareness)—Media Richness (Multiple Channels) had a large effect size of 0.65 and a $p < .001$; Social Presence (Awareness)—Media Richness (Immediacy Feedback) had a large effect size of 0.55 and a $p < .001$; Social Presence (Proximity)—Media Richness (Multiple Channels) had a large effect size of 0.57, and a $p < .001$; and Social Presence (Proximity)—Media Richness (Immediacy Feedback) had a large effect size of 0.52 and a $p < .001$, which indicated a strong, positive correlation between the variables. This correlation indicates that as Social Presence increases, Media Richness tends to increase. The null hypothesis was rejected.

H04: Social space is not related to sociability in a synchronous videoconferencing learning environment. The Pearson correlation results among Social Space (Positive Group Behavior)—Sociability had a large effect size of 0.82 and a $p < .001$, which indicated a strong, positive correlation. This correlation indicates that as Social Space (Positive Group Behavior) increases, Sociability tends to increase. Social Space (Negative Group Behavior)—Sociability had a moderate effect size of -0.38 and a $p = .003$, which indicated a moderate, negative correlation. This correlation indicates that as Social Space (Negative Group Behavior) increases, Sociability tends to decrease. The null hypothesis was rejected.

H05: Social space is not related to media richness in a synchronous videoconferencing learning environment. The Pearson correlation results among Social Space (Positive)—Media Richness (Multiple Channels) had a moderate effect size of 0.44 and a $p < .001$, which indicated a moderate, positive correlation. Social Space (Positive)—Media Richness (Immediacy Feedback) had a large effect size of 0.57 and a $p < .001$, which indicated a strong, positive correlation. Social Space (Negative Group Behavior)—Media Richness (Multiple Channels) had a moderate effect size of -0.41 and a $p = .001$, which indicated a moderate, negative correlation. Social Space (Negative Group Behavior)—Media Richness (Immediacy Feedback) had a moderate effect size of -0.35 and a $p = .007$, which indicated a moderate, negative correlation. This correlation indicates that as Social Space (Negative Group Behavior) increases, Media Richness tends to decrease. The null hypothesis was rejected.

H06: Sociability is not related to media richness in a synchronous videoconferencing learning environment. The Pearson correlation results among Sociability—Media Richness (Multiple Channels) had a large effect size of 0.56 and a $p < .001$; and Sociability—Media Richness (Immediacy Feedback) had a large effect size of 0.55 and a $p < .001$, which indicated a strong, positive correlation between the variables. This correlation indicates that as Sociability increases, Media Richness tends to increase. The null hypothesis was rejected.

RQ2: On an average, how often was the student's camera turned on during the class sessions?

Most participants met once a week for 1–2 hours. The frequency and duration of the Zoom class sessions consisted of 63% (*n* = 38) who met once a week. However, 35% checked other and stated they met on a different frequency; 4 met 1–2 times a month; 4 met bi-weekly; 2 met 2–3 times per semester; 1 met weekly, with some weeks being only discussion posts and no Zoom video calls; and 1 met five times for class and twice for a group project. Twenty-three percent (*n* = 14) noted meeting 3–4 hours, 27% (*n* = 16) noted meeting 2–3 hours, and 48% (*n* = 29) that had Zoom class sessions that lasted on average 1–2 hours. Only one respondent listed meeting for less than one hour (Table 4).

When asked on average how often they displayed their video during the Zoom meetings, 83% displayed their video during the entire class time (*n* = 50); 5% displayed their video only when speaking (*n* = 3); 2% displayed their video only when in break-out rooms (*n* = 1); 5% displayed their video ½ of the time (*n* = 3), 2% never displayed their video (*n* = 1); and 8% answered *other* (*n* = 5). Of the 8% who answered *other,* 2 respondents indicated that their video is displayed most of the time and will turn it off if there is a distraction at home (kids, dogs, etc.); 1 respondent indicated 98% of the time; 1 indicated 80%+ (not displayed only when not at the computer); and 1 responded with "as needed." Table 5 summarizes the duration of video displayed during Zoom meetings.

Table 4

Frequency of Zoom Course Sessions

Variable	*n*	*%*
Zoom Frequency		
4–6 times a week	1	1.67
Once a week	38	63.33
Other	21	35.00
Zoom Duration		
Less than an hour	1	1.67
1–2 hours	29	48.33
2–3 hours	16	26.67
3–4 hours	14	23.33

Note. Due to rounding errors, percentages may not equal 100%.

Table 5

Video Displayed During Zoom Meetings

Variable	*n*	*%*
Entire class time	50	83.33
1/2 the time	3	5.00
Only when speaking	3	5.00
Only when in break-out rooms	1	1.67
Never	1	1.67
Other	5	8.33

Note. Due to rounding errors, percentages may not equal 100%.

RQ3: How important was it to the students to see the faces and hear voices of others?

Seeing faces and hearing the voices of others in class was extremely to very important to 75% of the respondents (extremely important 40% (*n* = 24), very important 35% (*n* = 21). Eighteen percent (*n* = 11) of the participants felt it was moderately important to see faces and hear the voices of others; 3% (*n* = 2) felt it was slightly important; and 3% (*n* = 2) felt it was not at all important (Table 6). Of the age groups of those who indicated it was extremely important, 8.320.8% (*n* = 5) aged 25–34; 29% (*n* = 7) 35–44; 46% (*n* = 11) 45–54; and 0.04% (*n* = 1) 55–64. Of the 75% who felt seeing the faces and hearing the voices of others in class was extremely to very important, the majority were female (*n* = 29).

Table 6

Seeing the Faces and Hearing the Voices of Others

Variable	*n*	*%*
Not at all important	2	3.33
Slightly important	2	3.33
Moderately important	11	18.33
Very important	21	35.00
Extremely important	24	40.00

Note. Due to rounding errors, percentages may not equal 100%.

RQ4: From a list of potential activities in the synchronous videoconferencing environment of Zoom, what did students use in their courses?

Respondents noted that they participated in a variety of activities in Zoom class sessions. Those with the highest frequency of activities included during the Zoom class meetings consisted of lecture (*n* = 53), group discussion (*n* = 53), screen sharing (*n* = 44), breakout rooms for collaboration (*n* = 39) and guest speakers (*n* = 33). Those noted by fewer students included group projects (*n* = 23, 38%), instant messaging (*n* = 25, 42%), whiteboard (*n* = 5, 8%), polling (*n* = 6, 10%), debates (*n* = 1, 2%), interviews (*n* = 6, 10%), file sharing (*n* = 17, 28%), and annotation and co-annotation (*n* = 2, 3%). See Table 7.

Table 7

Frequency Table for Zoom Activities

Variable	*n*	*%*
Group Discussion	53	88.33
Lecture	53	88.33
Screen Sharing	44	73.33
Breakout Rooms for Collaboration	39	65.00
Instant Messaging	25	41.67
Group Projects	23	38.33
File Sharing	17	28.33
Interviews	6	10.00
Polling	6	10.00

Whiteboard	5	8.33
Annotation and Co-annotation	2	3.33
Debates	1	1.67

Note. Due to rounding errors, percentages may not equal 100%.

Discussion

This study tested variables that have been developed in the fields of communication and computer assisted collaborative learning for their association with student social presence and media richness experiences during the COVID-19 switch to distance learning environments. Consisting of four research questions and six null hypotheses, this research conducted an exploration of graduate students' perceived social presence and media richness of a synchronous videoconferencing learning environment. The research questions for this study were designed to explore students' perceptions on the social presence, social space, sociability, and media richness scales and how synchronous videoconferencing was used in the class sessions.

Social presence has been studied for decades in the online asynchronous environment, but the addition of synchronous learning is new to students and instructors. Social interaction, engagement, and collaborative learning have long been hallmarks in education. The reduction of social interaction was found by Arbaugh (2000) to be a factor that negatively impacted student satisfaction in distance education. The flexibility of the communication medium and the ability to develop an interactive course environment has a larger role in determining student satisfaction than the ease or frequency with which the medium could be used (Arbaugh, 2000). Due to COVID-19, lockdown and social distancing measures, the use of videoconferencing was estimated to have increased from 51% usage in 2019 to an estimated 87% by the end of 2021 (Garrett et al., 2021).

Using the refined social presence core elements developed by Kreijns et al. (2013), the results from this study demonstrated that in the synchronous learning environment graduate students linked social awareness of others and sensing the proximity of others to positive group behavior which leads to higher satisfaction with the media and as social awareness of others and proximity of others increases, negative group behavior tended to decrease. Negative group behavior can be an indicator of low social cohesiveness, which occurs when trust is violated by group members (Kreijns et al., 2004a). With the incorporation of synchronous videoconferencing into courses, instructors can potentially decrease the negative group behavior in the computer assisted learning environments and create a more positive learning experience for students, which increases student satisfaction and engagement (Arbaugh, 2000). Further the majority students expressed that it was extremely important to see faces and hear voices. Low social cohesiveness is an indicator that a sense of community is failing, and affective relationships were not established (Kreijns et al., 2004a). Implications for practice include integrating and using mediated technologies in the online learning environment that incorporate a capability for stimulating meaningful social interactions. When meaningful positive social interactions occur, feelings of isolation and anonymity are reduced, social cohesiveness is increased, and as the results of this study supports negative group behavior is decreased (McInnerney & Roberts, 2004). Arbaugh (2000) found that social interaction impacted student satisfaction. The synchronous videoconferencing learning environment provides a media in which instructors can

stimulate meaningful social interactions and increase student satisfaction and engagement in the course content.

This study further supported the research that as social awareness of others and the sensing of the proximity of others increases so does media richness with the immediacy of feedback and the sense of multiple channels. Media richness "is a measure of a medium's ability to transmit information that will change the receptor's understanding within a given time" (Dunaetz et al., 2015, p. 2). As we can see a person's face, read facial cues, and body language, it enhances the receiver's ability to accurately interpret the spoken message. When just a discussion board is used, these multiple channels in which a person receives information is decreased. Further 75% of participants in this research noted that it was very important to extremely important to see faces and hear voices. Over 80% of the respondents stated that their camera was on the entire course session. From this we note that instructors should encourage students to use their cameras to increase multiple channels in media richness. Clark et al. (2015) found perceptions of social and teaching presence were significantly higher when using video-enabled discussion in both asynchronous and synchronous contexts. Oregon et al. (2018) found a distinct correlation between using rich media technologies and enhancing social presence and retention rates. This is one of the reasons students are drawn to face-to-face courses in addition to the immediate feedback received in real time, versus the delay from a discussion board. With the use of synchronous videoconferencing, instructors can create the social interaction with students to better receive the message and interpret the information. Conradie et al. (2014) found a significant correlation between media richness and student satisfaction. Kuyath and Winter (2006) found the immediacy of a communication medium plays a role in student satisfaction and social presence.

Instructors have long had to deal with negative behavior in a classroom. This research supports the idea that when negative group behavior in the social space arises in the synchronous videoconferencing environment, social presence, and sociability also decreased. Therefore, as negative group behavior increased, the students were less engaged and decreased their immediate feedback and social interactions. Increased social presence of a likable communication partner oftentimes leads to an increase in positive social outcomes. Conversely, increased social presence of a disliked communication partner may lead to negative communication outcomes (Oh et al., 2018). Just as the classroom dynamics must be managed by the instructor, the synchronous videoconferencing environment must be monitored for positive group behavior and collaboration among students. Creating an environment where learners feel welcome and included is important to a successful learning experience in a synchronous videoconferencing class.

This research supports the use of synchronous videoconferencing with distance delivered courses with graduate students. The incorporation of synchronous videoconferencing can assist with the reception of messages through multiple channels (e.g., tone, body language, facial cues) and increase the immediacy of feedback. There are tools within synchronous videoconferencing media program that assist instructors in creating collaborative learning experiences to allow for large group discussions and breakout rooms for small group discussions. Further, by the instructor creating a welcoming atmosphere in the social space, this creates a sense of belonging and increases social interaction between students. With structured instructional approaches, instructors can create collaborative learning activities within small groups further extending the

students interaction in the space. Creating a learning environment of engagement, collaboration and sense of community reduces the feelings of isolation and dissatisfaction with the learning experience. With the incorporation of synchronous videoconferencing into online courses, encouraging students to use their cameras, instructors can increase social presence and media richness. The greater the sociability of an environment, the more social interaction, and the more positive social space created, increases the possibility for students to gain a feeling of relatedness, group cohesiveness, trust, and collaboration with others.

Research Limitations and Future Research Recommendations

This study used a Likert-type scale to gather data. A limitation to using Likert-type scales is that the data will not allow for rich descriptive details that could otherwise be found in qualitative data (Creswell & Creswell, 2017). Recommendations for future studies include examining age and gender differences in their social engagement and social experiences, including how they handle and use technology. Furthermore, cross-referencing the analysis between the descriptive and correlational statistics is also recommended. A mixed-methods or qualitative research design would also enable the researcher to further explore age and gender differences. Adding a question regarding employment status may also help explain engagement level since adult learners often have full-time jobs and have already worked an entire day before attending class, which may affect their classroom engagement levels.

This research did not ask participants if their Zoom course was simultaneously connected to a face-to-face classroom, because during the lockdown and social distancing enforcements during the time period of the research, most courses were not meeting face-to-face. Considering the findings from Rehn et al. (2016) and Charbonneau-Gowdy (2018) indicated that teaching synchronous videoconferencing and face-to-face classes simultaneously led to challenges with developing presence, adding additional clarifying questions is recommended. Incorporating additional questions regarding the delivery method of the participant's Zoom course would enable the researcher the ability to compare social presence of an online-only Zoom course to one that was simultaneously connected with a face-to-face classroom.

Conclusion

Synchronous videoconferencing learning provides students the ability to immediately engage with their peers and instructors with no delays resulting in lowered communication frustration, thereby increasing social presence, social space, and student satisfaction. The capability for immediate social interaction helps students create feelings of group affiliation by increasing participation and engagement, resulting in increased sociability and social presence. The synchronous videoconferencing learning environment provides same-time and same-place interaction for students, which results in higher perceived social presence and media richness, thereby positively impacting student interaction and potential for retention. Videoconferencing enables increased sociability, social presence, and social space (positive group behavior), which helps to create a more effective educational communication exchange between instructor, content, and student.

When introducing new technologies into the learning environment, the helpfulness of different media for satisfying students' psychological and communication needs may also change (Guo et al., 2010). When designing online courses, it is important to consider the different

characteristics of the learner. Creating varied levels of communication and social presence within the online learning environment can help accommodate students' different communication needs. Synchronous videoconferencing provides an interactive course environment for students that enables immediate feedback and the capacity to transmit multiple perspectives and language variety; therefore, increasing student sociability and perceived media richness. Integrating synchronous videoconferencing in the online learning environment not only provides real-time interaction, but it also can reduce feelings of isolation and anonymity and decrease negative group behavior.

Declarations
The authors declare no conflicts of interest in this research.

The authors assert that approval was obtained from an ethics review board (IRB) at Kansas State University.

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Author's Note
To request permission for use of the social presence, social space, and sociability scales, email Dr. Karel Kreijns at karel.kreijns@ou.nl.

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Using Learning Analytics to Understand K–12 Learner Behavior in Online Video-Based Learning

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Abstract
This research investigated the potential of learning analytics (LA) as a tool for identifying and evaluating K–12 student behaviors associated with active learning when using video learning objects within an online learning environment (OLE). The study focused on the application of LA for evaluating K–12 student engagement in video-based learning—an area of inquiry highlighted in literature as important but significantly under-researched. Results determined that the LA method could identify active-learning behaviors and that LA can play a valuable role in providing information on learner activity in autonomous K–12 OLEs. However, LA did not provide a complete picture of learner behavior and viewing strategies, highlighting the importance of a multi-method approach to research on K–12 online learner behaviors. It is anticipated the accessible approach outlined in this study will provide educators with a viable means of using LA techniques to better understand how learners interact with course content and learning objects, greatly assisting the design of online learning programs.

Keywords: learning analytics, ICAP framework, video-based learning, interactive learning environments, active learning

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Introduction

Pre-COVID, online learning was already a growing trend within education, with 90% of universities in the U.S offering some form of online education by 2014 (Bowers and Kumar, 2015). This trend has been accelerated by the advent of COVID-19, with UNESCO (2020) stating that due to the pandemic, one in five students worldwide were unable to attend face-to-face classes. While the COVID-19 situation is now somewhat resolved, a likely lasting impact will be an overall acceleration in the move to online learning (Brown et al., 2022; García-Morales et al., 2021). Some authors are now arguing that online learning is rapidly emerging as the predominant format for students to access higher education, and, as such, it is crucial that the substantial amount of generated data is effectively used by educators to enhance students' learning experiences (e.g., Maloney et al., 2022). In comparison to higher education, K–12 education has been identified as a relatively recent context for the adoption of online learning (Mayer, 2017), and although research into K–12 OLEs is growing, it still has a relatively narrow research base (Martin et al., 2021). Although both tertiary and K–12 institutions are increasing their adoption of online learning, it has been suggested that little is known about learner behavior within these environments (Winne, 2018).

The move to online learning and increased adoption of digital tools and subsequent advances in data quantity and quality had created a relatively new field of research within the learning sciences (Baker et al., 2016). This new field had been termed "learning analytics" (LA), and its aim is to use learner data to develop a greater understanding of learner behavior, particularly in online environments (Verbert et al., 2012). A commonly cited definition of LA comes from the 1st International Conference of Learning Analytics, which defined it as "(T)he measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs" (Siemens and Long, 2011, p. 34). LA has been promoted as a necessary and effective tool for understanding this new teaching and learning paradigm (Pardo, 2014). However, while LA holds undoubted promise for advancing the field of education, early results have been mixed, and there are increasing calls for more learner-centered and teacher-accessible approaches (Kitto et al., 2017).

Responding to the paucity of existing research into online learner behavior in K–12 education, we conducted a study into the effectiveness of LA to identify online learning behaviors. Data were gathered within an OLE that featured courses for year 11 and 12 students in Physics, Chemistry, and Biology, developed by Macquarie University in Australia. The study was designed to specifically examine some of the affordances and limitations of LA as identified in the literature (Ferguson et al., 2019; Maloney et al., 2022; Ochoa, 2022). It applied an innovative LA method to identify learner behaviors and explore for evidence of active learning in the viewing of video objects. LA data were supplemented by a questionnaire that further investigated the students' behaviors—and the motivations for these, as identified in the LA data. The methods used commonly available data provided by a video-hosting service and relatively straightforward mathematical formulae to identify patterns of student engagement with video learning objects, as defined by Chi and Wylie's (2014) ICAP (Interactive, Constructive, Active, Passive) framework. By adopting the ICAP framework to interpret the click-stream data, the study aligned the data analysis method with established learning theory—an approach advocated by other researchers as supporting a more effective pedagogy first design (e.g., Macfadyen et al., 2020). This approach, and the study's accessible LA method, acknowledges the importance of learning design theory and the technical and operational capabilities of education practitioners, to the success of such innovations (Ferguson et al., 2019; Macfadyen et al., 2020; Rosé et al., 2019)

Data were collected and analyzed responding to these research questions:

1. To what extent do students participate in active learning behaviors when engaging with videos in the OLE?
2. To what extent is learning analytics an effective tool for identifying patterns of student behavior associated with active learning when engaging with videos in the OLE?

A Review of Literature

Learning Analytics

LA had been touted as an effective method to identify student engagement and success as well as the quality of learning within OLEs in an efficient and cost-effective manner. This area of research had developed in response to the opportunities and challenges afforded by the vast increase in educational data produced by these new learning environments (Behrens and DiCerbo, 2014). While there has been significant development in the decade since its inception, LA is still described by some as being in a proof-of-concept phase, with limited research supporting its predictive power and little credible evidence of large-scale benefits to learners (e.g., Ferguson et al., 2019; Viberg et al., 2018; Zilvinskis et al., 2017). Despite its potential, Maloney et al. (2022) state that few studies have fully explored the learning data derived from digital environments like LMS (Learning Management Systems). They suggest the limited use of such data for informing teaching and learning practices, including corresponding research that aids educators in designing more informed and targeted resources, hinders the optimization of learning and the environments in which it takes place (Maloney et al., 2022). Moreover, as LA uses more complex modelling techniques such as those generated by machine learning, it becomes difficult for researchers to understand how models generated through this process work, and/or if they would apply to other datasets (Rose et al., 2019).

Recent discussion of some limitations of LA research can be found in the developing field of MMLA (Multimodal Learning Analytics). Described as a subfield of LA, MMLA serves an essential purpose in addressing educational contexts where capturing information beyond computer screen activities is valuable (Ouhaichi et al., 2023). MMLA encompasses the collection and integration of data from multiple sources, enabling a more comprehensive understanding of the various dimensions of learning and learning processes (Giannakos et al., 2022; Ochoa, 2022; Ouhaichi et al., 2023). This expansion is achieved by harnessing advancements in machine learning (ML) and cost-effective sensor technologies, that act as a ‘virtual observer and analyst’ of non-digitized learning activities (Giannakos et al., 2022). This new method acknowledges the risk with LA of oversimplification, or even misunderstanding of the learning process, if the focus is solely placed on a single type of trace data recorded in the logs of digital tools (Ochoa, 2022). This limitation results from the lack of available contextual information, which has been identified by the educational research community as one of the main criticisms of LA (e.g., Ochoa, 2022). The bias towards learning contexts heavily reliant on digital tools in LA can lead to a phenomenon known as the *Streetlight Effect* (Ochoa, 2022). This bias manifests as relying on a particular learning trace—such as accessing materials on the LMS, to infer a learning behavior such as engagement, simply because that data is readily available and without considering if there is a strong theoretical or empirical basis identifying access as a strong predictor of engagement (Ochoa, 2022). MMLA researchers argue the analysis of multimodal data allows for a more comprehensive analysis of learning contexts and provides a more holistic understanding of student engagement (Giannakos et al., 2022; Ochoa, 2022). However, proponents of the sub-

field have also identified potential limits to MMLA's advancement, such as technical complexities associated with implementing multimodal analytic systems and the combination of expertise (e.g., learning scientists, data scientists, and computer scientists) required for MMLA studies (Giannakos et al., 2022; Ochoa, 2022).

Learning Analytics and Video-based Learning

Early studies investigating student behaviors associated with the viewing of video objects include those undertaken by Kim et al. (2014) and McGowan et al. (2016). Kim et al. (2014) used data harvested from 862 video-viewing sessions from a MOOC (Massive Open Online Course) to investigate student engagement. The McGowan et al. (2016) study involved a smaller cohort (80 students); however, it also applied a questionnaire to provide further insight into student viewing behaviors. Both studies analyzed student in-video engagement including rewinding, skipping ahead, and dropping out (exiting a video before completion), which revealed what the authors described as "peaks" and "drop-offs" in the data-visualization. The studies interpreted viewing behaviors such as rewinding, skipping ahead, and dropping out as evidence of disengagement, and argued that with more engaging videos students may stay longer, potentially enhancing learning outcomes. Both studies found that students watched more of a video in their first viewing session, and that in subsequent sessions there was more dropping out and "rewatching" (a section of the video being watched multiple times), which they interpreted as disengagement (Kim et al., 2014; McGowan et al., 2016). Kim et al.'s study concluded there was a relationship between longer videos and higher drop-out rates, which they argued may be due to students' short attention span and/or feeling bored, leading to their recommendation of a "6-minute rule" for video length (Kim et al., 2014). However, countering this, Lodge et al. (2017) argued that the focus on high-level taxonomies (as well as the underdeveloped nature of the research field) has led to a "proliferation of heuristics" (p. 2) in video object design that remain largely untested, pointing to the "6-minute rule" as one example of this. Furthermore, of the studies on video-based learning using randomized or semi-randomized conditions, few have yielded conclusive findings (Lodge et al., 2017).

A more recent study completed by Zhang et al. (2022) built on Kim et al.'s 2014 work. Zhang et al. explored the patterns of attention allocation (accumulation, circulation, and dissipation of collective attention) related to features associated with MOOC video lectures and engagement with videos. Consistent with Kim et al.'s (2014) earlier studies, engagement was also defined by an accumulated count of watching and rewatching. Zhang et al. (2022) similarly identified a negative correlation between video length and the level of learner engagement (although not specifically adhering to the "6-minute rule"), as defined by the percentage of the videos students watched. However, Lagerstrom et al. (2015) investigated many of the same behaviors as Kim et al. and McGowan et al. and reached a different conclusion: that their data did not support a "6-minute rule" for video length to maintain student engagement. They found that although there may be higher dropout rates (the rate at which students leave the viewing session) when viewing individual sessions, students often returned to a video and that when the multiple viewing sessions were combined, the average percentage of a video watched by a student can be close to 90% (Lagerstrom et al., 2015). They argued these results disputed Kim et al.'s earlier "6-minute rule" for optimal video length.

Further studies have used clickstream data to explore the relationship between learner interaction with video objects and academic results (e.g., Chen et al., 2016; Stohr et al., 2019). Chen et al.'s study analysed clickstream data associated with actions such as *playing*, *pausing*, and *seeking*, presenting this information to instructors through a tool called "PeakVisor." An assumption underpinning this tool was that an area with high occurrence of

pausing or backward seeking represented a difficult or confusing segment of the video, although this was not confirmed through participant checking. A similar result was also found by Stohr et al. (2019), although their study did not investigate "in-video" engagement beyond an initial action such as playing, pausing, seeking, or stopping. The majority of these studies, as well as more recent ones (e.g., Maloney et al., 2022; Zhang et al., 2022) have focused on singular analysis of clickstream data, and as such, possibly risk suffering from Ochoa's (2022) "streetlight effect."

A further limitation of many LA studies into video-based learning is that the main measure identified for quantifying engagement has been watch time or the median of normalized engagement time—that is, the percentage of watch time relative to the total video duration (Maloney et al., 2022). However, some authors argue this does not provide a direct measure of viewer engagement (e.g., Chavan and Mitra, 2022; Chen and Thomas, 2020). For example, Chen and Thomas claim it is possible for video viewers to start playing a video but be engaged in a secondary task, simultaneously. Chavan and Mitra (2022) further note that only considering the number of views or watching patterns does not provide insights into the specific motivations behind these actions, which could vary based on factors including perceived importance, confusion, or engagement.

Responding to this, and to provide additional insights into viewer engagement, Chen and Thomas (2020) simulated an OLE within a laboratory setting, where participants viewed lecture videos containing different levels of "within-video" motion. They were then required to rate the engagement levels of the videos and complete recall and knowledge transfer tasks. The study found that there was agreement amongst students that they found "hand drawn" videos more engaging, which the authors state was consistent with earlier studies on video-based learning (e.g., Guo et al., 2014). However, the study did not find significant correlation between high levels of perceived engagement and better recall performance—only a small positive effect for the "low prior knowledge" cohort. In their study, Chavan and Mitra (2022) designed a dashboard that allowed students to voluntarily and in real-time report their cognitive-affective states during video lectures. The collected data was then presented back to instructors via their analytics dashboard (Tcherly). However, as the study focused on the usability of the prototype dashboard for instructors, it provided limited analysis regarding the types of student engagement in video-based learning.

The ICAP Framework

The review of literature to this point has identified few studies providing any analysis of the types of student engagement with video objects beyond simply "view-counts," and none that has adopted a pedagogical framework to help better understand that engagement. However, a study by Dodson et al. (2018) did apply a framework in an attempt to define the type of engagement as captured via click-stream data. The analysis framework through which students' viewing behaviors were identified and defined in Dodson et al.'s study, was the ICAP framework for active learning (Chi and Wylie, 2014). The framework divides and ranks active learning by (sub)modes of engagement labelled "Interactive," "Constructive," "Active," and "Passive" engagement. These terms form the acronym ICAP and are expressed in a hierarchy of I>C>A>P. Chi and Wylie (2014) argue that this hierarchy of engagement corresponds with associated levels of learning, with "Passive" being the lowest and "Interactive" the highest. They refer to this as the ICAP hypothesis (Chi and Wylie, 2014).

The ICAP framework makes assumptions supported by experimental studies and a meta-analysis of existing studies, that the behaviors reflect a learner's underlying cognitive engagement (Chi et al., 2018). Chi and Wylie (2014) specifically identify "pausing," "playing," "fast-forward," and "rewind" as examples of active engagement within video-based learning. Dodson et al. (2018) extended these signifiers by adding browsing, searching,

changing playback speed, and rewatching, while passive engagement was revised to include watching a video linearly, without interaction. Their study also introduced a specially designed video player (ViDeX) that allowed additional behaviors to be executed, such as video-highlighting and note-taking. Dodson et al. (2018) argue that when provided with the right tools, learners will engage in active learning behaviors as defined by the ICAP framework. Their approach is consistent with recommendations that LA methods should have a solid grounding in learning theory (Ferguson et al., 2019; Macfadyen et al., 2020). As Ferguson et al. (2019) commented "Validating analytics would involve clearly linking behaviours and measurable outcomes with pedagogy and with learning benefits and employing an appropriate and robust scientific method." (p. 52).

However, a significant limitation of Dodson et al.'s (2018) study was that trace data was logged from a very small sample comprising only 28 students. They highlighted the need for further studies with larger cohorts before any substantive conclusions might be advanced. Identifying it as a potentially valuable framework for embedding LA research, we adopted the same modified ICAP framework as used in Dodson et al.'s, (2018) work. Our study also applied a similar LA method (with an expanded participant base) but included a questionnaire to better understand students' behaviors as they align with the ICAP framework, including their underlying motivations. To reduce confusion, when specifying a mode within the ICAP framework, it has been capitalized e.g., Interactive, Constructive, Active. However, all modes fall under the umbrella term as evidence of active learning. The modified ICAP framework with identified modes of engagement, associated behaviors, and aligned motivations is presented in Table 1.

In summary, a number of limitations have been identified regarding LA and/or LA as applied to video-based learning. First, there is a dearth of studies completed in K-12 contexts, as well as in video-based learning, more generally. Second, LA has been critiqued for often taking a "black box" approach to its methodology (Rosé et al., 2019) as well as a disconnect existing between analysis and robust pedagogical frameworks (Ferguson et al., 2019; Macfadyen et al., 2020). Third, recent studies have highlighted a potential "streetlight" effect in LA and have recommended incorporating multimodal data into its analysis method (Giannakos et al., 2022; Ochoa, 2022). However, MMLA approaches further exacerbate the technological hurdle and specialized knowledge requirement that currently discourages many educators from using LA methods in their practice.

Table 1

Engagement mode	Definition	Observed behavior	Leaner motivation/intention
Passive	The lowest mode of the ICAP framework and defined by the learner being oriented towards, and receiving information from the learning object or instructor, but not acting on or interacting with the learning object in any way.	Playing the video.	Basic, non-targeted information building.
Active	This mode of engagement can be identified by the learner acting on the learning object in a motoric or physical capacity.	Skipping forward or back within the video. Rewatching sections of video. Pausing the video. Stopping the video.	Information searching. Reviewing, seeking clarification. Reviewing, reflecting, seeking clarification. Identifying that specific information needs have been met.
Constructive	Those behaviors that result in the production of additional outputs or products to the initial learning material, thus a characteristic of this mode is that it is generative.	Taking notes while watching the video. Explaining the video to a classmate. Asking questions.	Translating/extending understanding, linking concepts. Making inferences. Translating/clarifying understanding. Clarifying/extending understanding.
Interactive	The highest mode of engagement, and like constructive, it is generative, but with the additional requirement that the generative output was collaboratively created.	Collaborating with a peer or teacher to take notes or otherwise expand on the content of the video.	Co-constructing, co-clarifying or co-extending understanding.

The Modified ICAP Framework Used in This Study (from Chi and Wylie, 2014)

Research Design

Research ethics

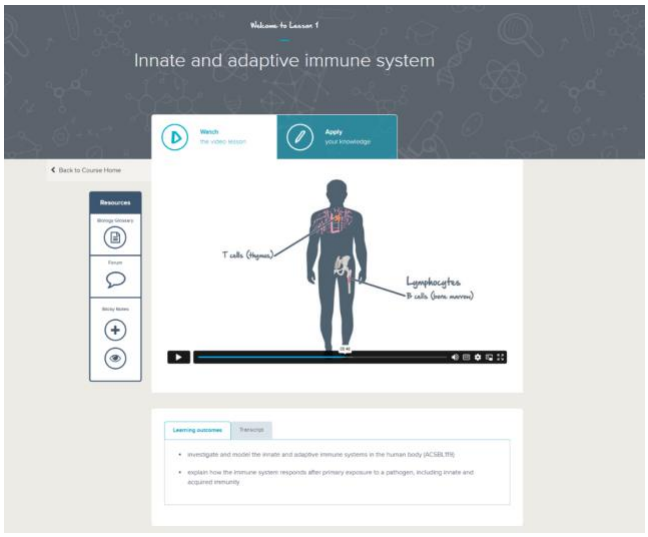
Research ethics clearance was obtained from the Macquarie University before any data were collected (application number: #5201834454739).

The learning environment

The online learning environment (OLE) (Figure 1) in which data for the study were harvested was a learning program called HSC Study Lab, developed by Macquarie University for the purposes of helping improve learning outcomes for students in years 11 and 12 of high school in physics, chemistry, and biology. HSC Study Lab is a custom OLE-developed by the university and all content within the OLE was delivered via pre-recorded video presentations and accompanied by simulated experiments, games and animations, with assessment comprising traditional recall-style quizzes with automated feedback. Course content was developed by experienced teachers in the Australian New South Wales (NSW) high school system and built by learning designers and educational technologists working at Macquarie University. The lesson content aligned with the NSW Higher School Certificate (HSC) curriculum and was designed to support students as they prepare for their end of year 11 and 12 school exams. Students were enrolled for 12-month periods and could access the learning material at any time over that period. HSC Study Lab exists in a digital ecosystem through which learner behavior in the form of trace data can be observed, recorded, and analyzed. Designed around an "anywhere, anytime" learning model, students are completely independent within the environment. As such, it is challenging for course designers to evaluate student learning and interaction with the program content.

Figure 1

The Lesson Page Interface Showing an Animated Video, a Tab to an Assessment Quiz as well as Additional Resources.



Data Methods and Analysis

A video from the OLE was randomly selected from the year 12 biology program and an aggregate of second-by-second user interaction data were analyzed. The video was an animated lecture on the innate and adaptive immune system. It was 9:44 minutes long and the total number of plays at the time of analysis was 870. A decision was made to use a video from the year 12 biology program as it comprised the largest cohort (of the three programs), and as such, constituted the largest possible sample size.

LA Data Capture

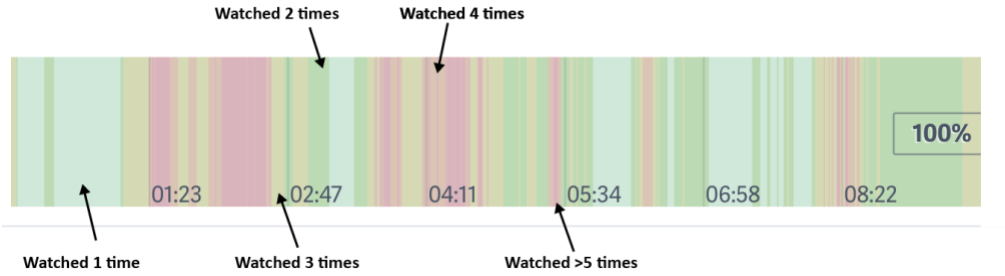
The first stage of LA research is the capture of data (Pardo, 2014). In this study, the main type of data captured were student actions while viewing the video objects in the OLE. The OLE used an external hosting service for streaming videos, and this service allowed the capture and visualization of data associated with watching the video (Figure 2). In Figure 2, the timestamp at the bottom of the bar indicates points of time throughout the video[1], while the figure at the end of the bar records the overall percentage (not necessarily sequential) of the video watched. Finally, the colour of the bar indicates which sections were watched, and how often. The hue of the coloured bands within the bar indicates whether a section was rewatched, with the colour changing in intensity (darker green and then yellows and reds) depending on the number of times that section of the video was watched. The colours within the bar and the number of times that section was watched, is illustrated in Figure 3. The study was limited by the data sets available through the video hosting service; therefore, the analysis was restricted to identifying peaks in viewership caused by students rewatching or skipping sections of the video. Additional behaviors and/or reasons for behaviors could not be identified through click data alone. The addition of a questionnaire was essential for providing more accurate insights into the reasons for students' viewing behaviors.

Figure 2

Visualization of Data on the Viewing Session of Individual Users

[1] The timestamp does not reflect the entire length of the video as indicated by the colored band that begins before the first reading (1:23) and past the final reading (8:22)

Figure 3
Colored Bands Indicating the Number of Times Sections of Video Were Watched



Understanding LA Data

It was possible to identify different modes of active learning in the trace data. For example, rewatching sections of a video, along with pausing, or skipping, are behaviors consistent with Active engagement. Conversely, watching a video without otherwise acting on it corresponds with Passive engagement (Chi and Wylie, 2014). Each video also had a visualization of the aggregate data associated with all viewers and viewing sessions (Figure 4). However, it should be noted that the total number of views is not the same as the total number of viewers, as viewers may rewatch sections of videos multiple times. Peaks in the graph are caused by students rewatching sections of the video, while dips are caused by students dropping out or skipping ahead.

Figure 4
Visualization of the Aggregate Viewer Engagement With the Video

Definition of a Peak

The hosting service provided an aggregated display of student engagement with the video, which was revealed as a series of peaks[2] mapped against the timestamp for the video.

[2] The term "peak," used by Kim et al. (2014) and McGowan et al. (2016), etc. in their studies, was adopted to refer to areas of concentrated collective engagement (generally caused by rewatching).

However, there was a general decrease in viewership across the length of the video caused by user dropout, which tended to mask the significance of the peaks. Therefore, a working definition of a peak that took into consideration this overall trend was needed. When data was transposed to an Excel worksheet and converted to seconds, it was necessary to apply a formula that would account for the general decrease in viewership caused by the dropout rate, as well as reduce the interference generated by hundreds of in-video click interactions. Such an approach is an example of an ad-hoc analysis technique, which has been used successfully in other studies (e.g., Pardo, 2014). N represents the number of students enrolled in the class, and $n(t)$ is the percentage total viewership (V) at time (t). Note that $n(t)$ can be larger than N as students can rewatch sections of the video, and each time a student returns to a time instance t_i, $n(t_i)$ increases by 1. The viewership as a percentage over time is calculated by this formula:

$$V(t) = \frac{n(t)}{N} \times 100\% .$$

A time interval earlier in the video was selected to act as a comparison point (Δt) against which changes in viewership could be identified. This was done to account for the general decrease in viewership over time. The comparison point (Δt) was set at 20_s to identify specific points of interest. The formula for expressing this is

$$\Delta V(t) = V(t) - V(t - \Delta t)$$

As there were almost continual changes in viewing percentages, a measure for meaningful change was required. A trigger (represented as δ) was therefore created that would call a peak only when an increase in viewership was above a given percentage. The trigger for calling a peak was a 5% increase in viewership, which meant that if there was a 5% increase in viewership over any 20-second timeframe, a peak was called. Under these conditions, a peak is defined as

$$\Delta V(t_i) \geq \delta$$

Questionnaire

To enhance interpretive validity, a web-based questionnaire was developed and sent to the year 12 students enrolled in the biology program. The questions and results can be found in Appendices A and B. Year 12 students were selected as they were likely to have had more experience in the program overall and possibly greater familiarity with the format and style of the videos. The questionnaire was emailed to students and 106 responses were received. While the total number of students enrolled in the biology program at the time of the study was 8,142, given enrolment was purchased in 12-month subscriptions and the subject itself can be taken anytime by a student over that time period; thus, it is difficult to know how many students were actively participating in the OLE at the time the questionnaire was sent out. However, despite the relatively small number of respondents, given the extent of agreement between respondents, we were able to calculate high confidence intervals for the results (see Appendices A and B).

The purpose of the questionnaire was, in the first instance, to triangulate the findings of the LA method as well as evaluate inferences that learner intentions behind identified behaviors conformed with active learning (as defined by the ICAP framework). This was needed because for learner activity to represent active learning, there must be a corresponding intent on the part of the learner (Bonwell and Eison, 1991; Chi and Wylie, 2014; Scardamalia and Bereiter, 2006). An additional purpose for the questionnaire was to identify non-program-based engagement with the video-based lessons, such as note-taking or discussing the videos with classmates and teachers. The analysis of trace data allowed the researchers to identify patterns of behavior that could be categorized as passive or active (including all submodes, as defined by the framework), while the questionnaire augmented

these findings by asking participants to report on those behaviors. For example, as it is possible within the trace data to identify rewatching of sections of the video, a question specifically asked participants to confirm that they participated in that behavior. If the participants responded in the affirmative, then there is support that the patterns of behavior identified in the trace data are an accurate reflection of learner behaviors. Furthermore, as it is not enough that the behaviors conform to active learning—the intention or motivation behind the behaviors also needed to align with the observed (and reported) behavior. Therefore, additional questions were designed to elicit responses that provided more information about the motivations behind the behavior. The questionnaire comprised12 questions and were categorised as relating to either the "environment," "observable behavior," or "motivation/intention." The first three questions related to environment and were used to establish the context for learning (online and as individuals) while the responses to the following questions were categorised under "observable behavior" or "motivation/intention" and were further coded against the framework and mapped to the specific submodes of engagement within active learning.

Coding decisions were based on alignment of student responses with ICAP submodes and then independently blind-checked for accuracy by the coauthor. For example, item 10 asked participants whether while watching a video, they skip back to rewatch parts of it. This behavior was identified by the LA method and according to the ICAP framework as indicative of Active engagement. Participants were then asked for the reasons why they rewatched the video. A univariate analysis was completed with students reporting as participating in the behavior (or not), along with a general frequency. This relationship between observed behavior and viewer motivation is illustrated in Table 2.

Table 2
Category and Coding of Response Against ICAP Framework

Focus	Observable Behavior	Reported Learner Motivation/Intention	ICAP Code
5	Stopping the video	Found what I needed	Active

Results for all questionnaire items are presented in Appendices A and B. Appendix A summarizes questionnaire results for items categorized under "environment" and "observable behavior" and aligned with the submodes of the ICAP framework, while Appendix B does the same for "motivation/intention." In both Appendices, columns 1 and 2 record the primary category and item, column 3 the students' responses (options and short answer), and columns 4 and 5 the response count and alignment with the ICAP framework. By using the questionnaire, it was possible to more accurately determine student viewing behaviors within the OLE, including whether their underlying (and invisible to the LA method) motivations also aligned with active learning as defined by the framework.

Results

Aggregate Data

Aggregate data were also harvested from the video that had been viewed 870 times. This provided a relatively large sample size, which increased the validity of conclusions about patterns of engagement. Once data were entered into a spreadsheet, the graph shown in Figure 5 was generated. It was evident that there was a large initial viewership, a relatively

even (and steep) drop-off until around the two-hundred-second mark, and then a series of peaks and troughs until the five-hundred-second mark, before another steep drop-off, ending with below 50% viewership. These peaks were caused by an aggregate of collective engagement, generally caused by rewatching of the video by individual students, so although there was a decline in overall viewership caused by the dropout rate, this was countered by students rewatching specific sections of the video multiple times.

The formula was then applied, which allowed for a comparison of "peakiness" (height and width of peak) between data points. The data was then re-graphed and a visualization created (Figure 6). Along with the visualization, the formula revealed a total of six peaks at 152, 222, 263, 332, 382, and 449 seconds, with an average increase in height over the twenty-second timeframe of 9% and an average width equal to 15.83 seconds of video.

Figure 5

Percentage of Viewership Over Time

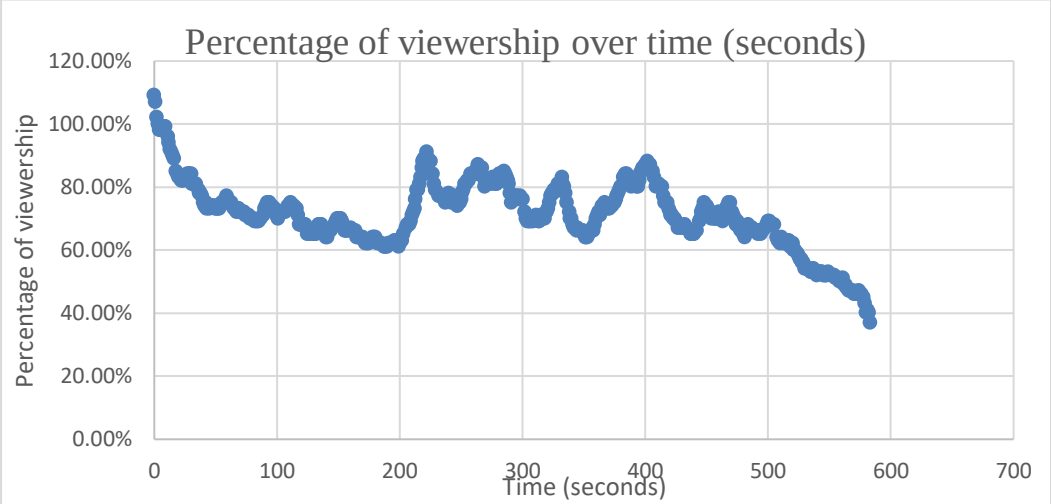
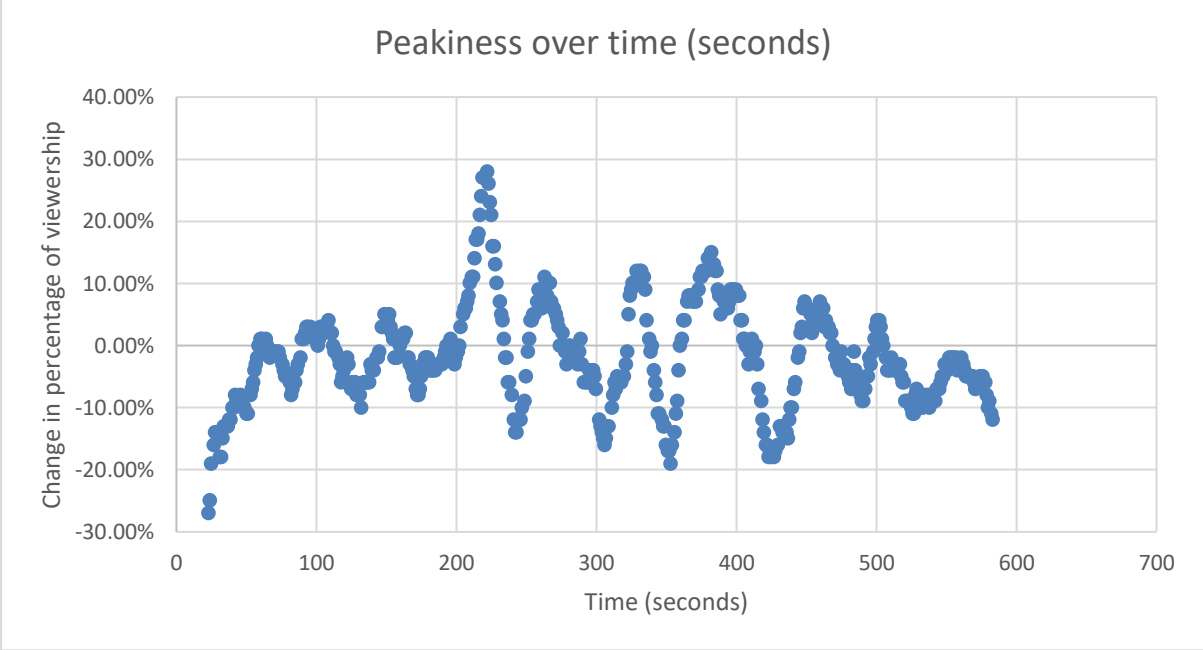


Figure 6

Graph Illustrating "Peakiness" of Data Over Time



In the aggregate analysis, the peaks in the visualization (Figure 6) indicate multiple students rewatched specific sections of the video, which is evidence of Active engagement. As illustrated in Figure 6 the largest peak came at the 222-second mark and was an increase of 28% over the given timeframe. Further peaks occurred at 52, 263, 332, 382, and 449 seconds. This suggests that there was content within those sections of the video that students felt particularly engaged with. Whether that was due to interest, confusion, or difficulty of the subject matter could not be identified by the LA method alone. What was clear, however, was that there was non-random student engagement with the video in the form of rewatching specific sections. This analysis indicated patterns of behavior that aligned with Active engagement.

Individual Viewing Data

The video-hosting site provided visualizations of individual viewing sessions as illustrated in Figures 7 and 8. When analyzing individual viewing sessions and mapping the data against the ICAP framework, it was possible to identify different viewer behavior patterns. For example, Figure 7 reveals patterns of behavior aligned with Passive engagement, while Figure 8 reveals patterns of behavior aligned with Active engagement.

Figure 7

Visualization Indicating 100% of Video Watched but With No Interaction

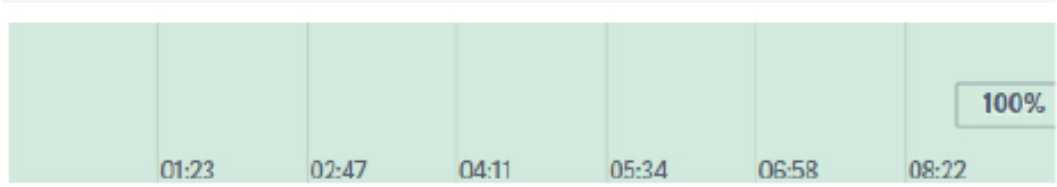


Figure 8

Visualization Illustrating 85% of Video Watched With Colored Bands Indicating a Pattern of Rewatching

By combining these data visualizations with individual IP addresses, it was possible to conduct a secondary analysis of some individual viewing sessions. By using the unique IP address to link separate (individual) viewing sessions and then analyzing the viewing behaviors in totality, it was possible to identify that students were returning to a video and completing it over multiple viewing sessions. For example, in the first pairing of viewing sessions (Figure 9a) a student started viewing the video, rewatched sections earlier on, and then rewatched sections from approximately three-minutes to six-minutes multiple times, before leaving the video around the eight-minute mark. In the second session the student returned to the video twenty days later when they skipped over the first three minutes of video, which was the same three minutes they showed limited engagement with in the first session. Then there is little to no rewatching of the video, and this time the video was completed. It could be reasonably concluded that the student found the content between the

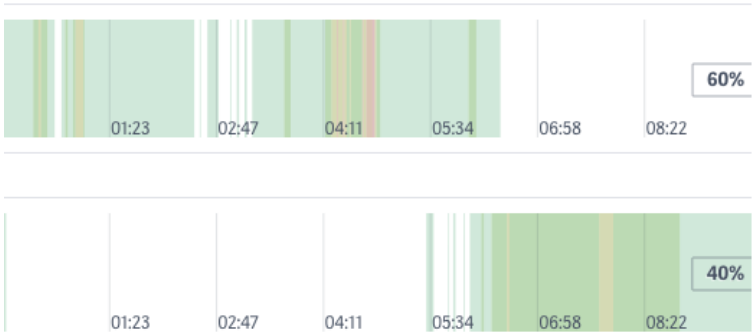
three and six-minute mark of most interest or relevance, and then revisited it twenty days later for a refresher, jumping directly to the section they found most relevant. The second pairing (Figure 9b) also indicates a student returned to and completed the video over multiple sessions. This student started the video and watched until around the six-minute mark before dropping out. In this session, they appeared very active as they rewatched multiple sections, and even skipped over some sections. Then they re-entered the video the next day, skipped ahead until they reached approximately when the previous session had ended and watched the video until completion, again rewatching a large section and smaller sections multiple times.

Figure 9

Two Examples of Pairings of Two Viewing Sessions With Common IP Addresses

a.

b.



Discussion

This section discusses the results in relation to the research questions. This is followed by a general discussion of the findings with reference to other research on ICAP and active learning in OLEs.

1. To what extent do students participate in active learning behaviors when engaging with videos in the OLE?

Results from this study provide general support for earlier summarized arguments that students may participate in active learning behaviors when interacting with video objects in OLEs. Aggregate LA data clearly indicated many students rewatched specific sections of the video, in some cases multiple times, which is evidence of active engagement (Figure 9). Furthermore, the applied formula revealed a series of peaks within the data. From the clustering and size of these peaks, it could be defensibly concluded that there was content within those sections that students particularly engaged with. More significantly, the analysis revealed patterns of behavior that aligned with Active engagement as defined by the ICAP framework, with questionnaire results supporting the tentative conclusions derived from the LA method. Students reported that they did participate in the behaviors identified, and further, their actions were non-random, deliberate, and consistent with the definition of active learning. For example, the most cited reason for leaving a video was that the student had found what they needed, which is an example of learner intention/motivation that aligns with Active engagement (Table 1). Moreover, the mean of results from the questionnaire revealed 96% of respondents always or sometimes participated in active-learning behaviors, including taking notes, discussing with a peer, and/or rewatching sections of video. Questionnaire item 10 addressed the behavior of rewatching, which was also identified by the LA method. The results confirmed initial interpretations from the LA method, with students responding that they always (30.4%) or sometimes (66.7%) participate in rewatching behavior.

2. To what extent is learning analytics an effective tool for identifying patterns of student behavior associated with active learning when engaging with videos in the OLE?

When considering the second question, it was important to evaluate which alternative modes of active learning the questionnaire revealed that were not identifiable by the LA method. For example, in item 7 the students were asked, “do you take notes while watching the video?” with 96% of respondents either answering “yes” or “sometimes.” While this behavior aligns with a Constructive mode of active learning, it could not be determined using the LA method alone. This was due to the behavior occurring within other learning tools (e.g., a notebook or computer) that sat outside of the OLE and therefore did not create trace data in the video logs. Other questionnaire items indicated that all but one of the students pause to take notes while watching the video, while in item 9 where participants recorded whether they discussed the content of the videos with others, 59.8% indicated that they do. Neither behavior considered higher order engagement in the ICAP framework was identifiable by LA in the video log data.

In other instances, the questionnaire revealed alignment between LA-identified behavior and its underlying motivation, as illustrated by responses to items 11 and 11B. For example, 72.8% responded that they rewatched sections of a video because it was either confusing (57.6%) or interesting (15.2%)—behaviors strongly aligned with motivations indicating Active engagement. Of those who answered “other,” responses to the follow up item “Please detail” revealed further Active motivations, as well as some Constructive motivations. In fact, 100% of respondents indicated an Active motivation for the behavior including, for example, that they would take notes, which has been aligned with Constructive learner intentions such as translating and linking concepts (Chi and Wylie, 2014). No participants reported “video error” or other technical reasons that were unrelated to active-learning motivations as a reason for rewatching a section of the video.

The ICAP Framework

Literature indicates studies that did not use the ICAP framework for identifying active learning often interpreted behaviors quite differently to those that did. For example, both

McGowan et al. (2016) and Kim et al. (2014) concluded that skipping ahead indicates disengagement, while the ICAP framework suggests that the behavior is indicative of active learning. Studies that only used an LA method were limited in that they could only infer student intentions behind the observed behaviors (e.g., Kim et al., 2014, Lagerstrom et al., 2015, Zhang et al., 2022). By adopting the ICAP framework the study revealed limitations with LA as a method whereby it was effective at identifying lower order (within the ICAP framework) forms of engagement (Active) but unable to identify Constructive and Interactive engagement, which were both revealed by the questionnaire. This finding supports the conclusions of other authors regarding the limitations of LA as the sole method for identifying engagement (Chavan and Mitra, 2022; Chen and Thomas, 2020, Giannakos et al., 2022; Ochoa, 2022).

Dodson et al.'s. (2018) study also investigated behaviors such as skipping ahead and by supplementing LA data with a questionnaire, they were able to identify the student motivation behind the behavior. For example, students reported that they would often look for—specifically slides within the video, and then use a note-taking tool to record the information they needed (Dodson et al., 2018). The current study also found significant agreement between the responses to the questionnaire, the behaviors, and their underlying motivations. By supplementing the LA method with a questionnaire, this study has further developed understanding of student intentions when interacting with video objects and found that there is substantial alignment between trace data revealed using the LA method and the attributes of active learning defined by the ICAP framework. This highlights the importance of LA research adopting a solid theoretical referent to build more accurate understandings of the purposes and motivations behind patterns of learner engagement, as revealed by LA data (Macfadyen et al., 2020, Ferguson et al., 2019).

In conceptualizing these outcomes, the ICAP framework provided a valuable lens through which to evaluate data collected by the LA method. Earlier research (e.g., Giannakos et al., 2015) identified improved learning outcomes associated with active learning behaviors like rewatching, so it is encouraging that 97% of students responded that they engaged in such behavior at least some of the time. When analyzing the motivations behind the behaviors, most responses indicated students did this to improve clarity or understanding. This finding might suggest the subject content is not being clearly explained and/or is beyond the level of the student—knowledge which could be used to inform improvements in the design or presentation of the video content. Interestingly, within literature, analysis of dropping-out behavior or exiting a video is contentious, with some researchers interpreting the cause as low engagement on the part of the student (e.g., Kim et al., 2014; McGowan et al., 2016; Zhang et al., 2022). Kim et al. (2014). Zhang et al.'s (2022) studies further found that there was a relationship between video length and dropout rates, and, according to Kim et al. (2014), that students "might feel bored due to (a) shorter attention span or experience more interruption" (p. 3). This finding led Kim et al. to recommend limiting the length of videos to six minutes. However, this recommendation was not backed up by other data that could verify LA-derived interpretations, such as that which could be gathered via participant checking. The present study achieved this by using a questionnaire to specifically investigate these assumptions. Indeed, the questionnaire suggested alternative motivations for such behaviors.

Likewise, the secondary analysis of individual viewing sessions by their individual IP addresses (Figure 7a and b) revealed students frequently watched a video across multiple sessions. This conclusion of the questionnaire also aligns with Lagerstrom et al.'s (2015) work, as 74% of respondents reported that they often returned to a video after exiting, before completion. This reveals an interesting area for potential future research.

Limitations and Further Studies

As this is a new area of study there was little guidance within the research as to what could be considered a meaningful or significant peak in terms of viewer engagement. This was ultimately decided by the width of the resulting peaks, but further analysis against multiple videos is required to add validity to this method. For example, initially 10 seconds earlier in the video was selected as the comparison point, which produced more peaks but the average width (the duration of viewing for each peak) was only 6.4 seconds. Increasing this timeframe to 20 seconds resulted in fewer peaks but the average duration (or width) of each peak increased to 15.83 seconds. This study selected the longer timeframe of 20 seconds, but further comparison across multiple videos is required to establish a more universally applicable baseline for significant events.

Although two data methods were used in this study adding validity to its findings, it is acknowledged that the size and scope of the study was limited. This provides an opportunity to apply its methods in new contexts and/or to larger datasets. Furthermore, the questionnaire was specifically designed to better understand and validate the behaviors and motivations as captured by the applied LA method, as well as test the assumptions of the ICAP framework. However, we acknowledge that although free text responses were permitted, these responses were limited to focusing principally on these behaviors and its interpretive framework. While doing this was consistent with the study's design, it is acknowledged that it could limit the range and depth of possible responses or hinder identification of other possibly relevant information. Future studies applying similar LA methods and interpretive frameworks could be strengthened by conducting in-depth interviews and/or focus groups matching engagement data to individuals, which could yield a wider range of possible responses and potentially identify new areas for inquiry.

Conclusion

This study focused on an under-researched and emerging area of inquiry (McGowan et al., 2016; Maloney et al., 2022; Viberg et al., 2018), seeking to build more accurate knowledge about the type and quality of student engagement with video objects in OLEs. This was achieved by adopting the ICAP framework for determining active learning and using a questionnaire that was able to identify student motivations behind the in-video clicks. This supported interrogation of previously inconclusive interpretations of student behaviors when interacting with video learning objects, with findings tending to support the earlier studies of Dodson et al. (2018) and Lagerstrom et al. (2015). The results also question earlier assumptions that video-based lessons often place students in the role of passive learners (Giannakos et al., 2015). Furthermore, it achieved this by using readily available services and techniques to make this type of data analysis more accessible to educators. The data collection method was essentially an "out-of-the-box" service offered by the video host (not dissimilar to YouTube analytics), and our method of analysis was a relatively straightforward mathematical formula.

Our study, therefore, offers an accessible strategy for educators who may not have the specialized expertise required for more complicated tools and techniques, which has been identified as a limiting factor on LA and, more recently, on MMLA research (Ferguson et al., 2019; Giannakos et al., 2022; Ochoa, 2022). Secondly, these results provide general support for LA as an effective method for identifying patterns of behavior associated with active learning when using video objects. Supporting this, the questionnaire verified many of the interpretations made from LA data, with most students confirming that they did participate in

the behaviors identified by the LA method, and that they did so for reasons consistent with active learning.

As a tool for identifying active learning with video objects, results from this study suggest that LA has an important role to play and is greatly strengthened when mapped to a well-researched pedagogical model like the ICAP framework. Finally, while it was clear that the LA method could identify rewatching and that this behavior was possibly associated with Active engagement, without the questionnaire several additional active learning behaviors would not have been substantiated. This highlights a potential limitation with LA, also identified by those involved in the emerging subfield of MMLA, whereby the focus on digitized trace data alone can lead to oversimplification of findings or misunderstandings (Giannakos et al., 2022; Ochoa, 2022; Ouhaichi et al., 2023).

Declaration of Competing Interests

The authors declare that they have no competing interests.

Ethics

Ethics approval for this work was granted by the Macquarie University Human Research Ethics Committee (application #5201834454739).

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Appendix A

Responses to Environment Questions Used to Establish Learner Context

Focus	Item	Response count or sample	Count
1	Where do you watch the video-based lessons?	Home School Other	77 27 2
1A	Other. Please detail - free text	At school Library	1 1
2	Do you watch the video-based lessons on your own or with others?	On my own With others	92 14
3	If 'yes' who do you watch the video-based lessons with?	Classmate Teacher Other. Please detail	9 2 3

Responses to Behavior Questions Coded Against ICAP Framework

Focus	Item	Response count or sample	Count	ICAP Alignment	% "Active" responses	95% CI
4	When you start a video how often do you finish it?	Always Usually Sometimes Never	42 44 15 4	N/A N/A N/A N/A		
6	Do you return to finish the video later (yes, no)?	Yes Sometimes No	15 32 13	N/A N/A N/A		
7	Do you take notes while watching the video (yes, no, sometimes)?	Yes Sometimes No	47 48 8	Constructive Constructive Passive	96.12%	0.8527, 0.9659

8	Do you pause the video to take notes (yes, no)?	Yes Sometimes No	74 19 1	Constructive Constructive Passive	98.94%	0.9422, 0.9997
9	Do you discuss the content of the video lessons with another person (yes, no)?	Yes Sometimes No	24 37 41	Interactive Interactive Passive	59.80%	0.4963, 0.6939
10	While watching a video do you skip back to ‘re-watch’ parts of it?	Sometimes Always Never	68 31 3	Active Active Passive	97.06%	0.9164, 0.9939
12	When watching videos which strategy/s applies best to you (multiple responses allowed)	Watch everything at once Take notes while watching Watch the video with a classmate Search the video for 'important points' Other. Please detail	26 77 8 43 6	Passive Constructive N/A Active N/A	N/A (multiple responses allowed)	

Appendix B

Responses to Motivation Questions Coded Against ICAP Framework

Focus	Item	Response	Count	ICAP Alignment	% "Active" responses	95% CI
5	Under what circumstances do you 'stop' the video?	I found what I needed	39	Active	*83.33%	0.7148, 0.9171
		It is boring	10	Passive		
		It is too difficult	4	Active		
		Other. Please detail	7	N/A		
5B	Other. Please detail - Free response	All of the above	1	Active		
		I find out it isn't relevant.	1	Active		
		I found the information that I needed, and the rest of the video	1	Active		
		Contained information that I already knew so I stopped watching	1	Active		
		Sometimes certain concepts aren't explained in great depth, such as how to interpret the graphs for NMR and mass spectroscopy, so I pause the video and watch other youtube videos to understand it or look it up online, after I learn I resume the video	1	Active		
			1	Constructive		
		Sometimes the detail within the content is lacking	1	Active		
		When writing down notes				
		Sometimes it's boring or the detail is not always stated/ relevant				
11	Why do you re-watch the videos?	It was confusing	53	Active	*100.00%	0.9607, 1.0000
		It was interesting	14	Active		
		Other. Please detail	25	N/A		
11B	Other. Please detail - Free response	Clarity and understanding	1	Active		
		For clarity, or to ensure I understand.	1	Active		
		If it is a complex topic it helps to rewatch it to cement it in my brain	1	Active		
		It was a lot to write down so I had to go back a rewatch so I could understand it more	1	Constructive		
		Make notes	1	Constructive		
			1	Active		

		May have been a concept I didn't understand fully the first time, or just for revision purposes.	1	Constructive		
		Note taking/better information retention	1	Constructive		
		So I can write what they said	1	Constructive		
		Taking notes or if the content is interesting or confusing				
		Taking notes, too fast				
		The first time to get a preliminary understanding of the overarching concept, then a second time to make sure that I have a deep understanding of everything that was said	1	Active		
		The videos often have text, and they aren't on the screen for very long so we watch it once to process the vid, then a second time to write down notes while pausing.	1	Constructive		
		There are times when the information is given out too quickly, so I need to re-watch particular parts to understand them better.	1	Active		
		There was something I needed to take notes on.	1	Active		
		They just spoke too fast for me to get all the info down, so I need to listen to it again to ensure I don't miss anything important.	1	Active		
		To ensure students they get a broad understanding of the topic	1	Active		
		To relearn content I forgot	1	Constructive		
		To take notes and solidify my understanding	1	Active		
		Because I needed to relook over the information	1	Active		
		Sometimes it’s confusing	1	Constructive		
		The detail was skimmed over/ not written down	1	Active		
		To double check information	1	Constructive		
		To ensure I have written the correct information for my notes	1	Active		
		Watching it more than once is helpful	1	Active		
		You always miss something when it has been told				

Note. * The percentage of Active responses in Appendix B include the responses to the follow-up “Other” question, “Please Detail” i.e., 83.33% is the total number of Active responses for both focus 5 and its follow-up, focus 5B.

Parent's Perceptions of Online Learning during COVID-19 Pandemic: The Road Ahead

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Abstract
This study explored parents' perceptions pertaining to online learning in the state of Qatar during COVID-19 pandemic. Six hundred and eighty-eight parents were surveyed, and data was analyzed statistically using SPSS 28.0. Findings suggest that parents perceived online learning positively only when a set of conditions coexisted, including parental readiness, school support, and abundance of online resources. Moreover, parents viewed in-person learning to be of higher quality than remote learning, believing that academic progress and well-being were stymied through online learning. Moreover, parents suggested a road map for leveraging the quality of online learning, which sheds light on the importance of a solution that is family-centered, accounting for parental multitasking; apprehending economic and social pressures; responding to the cultural context; and securing student well-being.

Keywords: online learning, distance learning, blended learning, parents' perceptions, school improvement

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Introduction

COVID-19 has altered the face of education globally, impacting the lives of students, their teachers, and their families. UNESCO (2020) estimated that over 90% of students in 200 countries rapidly transitioned from physical schools to online distance learning without access to sports or social events in March 2020. In reality, the pandemic put 1.6 billion learners, along a large number of teachers and educators, behind screens. Information and communication technology became the essential element in the learning process, without which learning would have been interrupted (Ghamrawi et al., 2020; Ghamrawi, 2022). Schools found themselves urged to move from face-to-face teaching to distance learning, which forced schools into new learning processes filled with complexities and limitations (Mailizar et al., 2020; Rasmitadila, 2020).

Moreover, the lack of experienced teachers with online teaching techniques was one of the major challenges they confronted during the pandemic (Bao, 2020). In fact, they were dubious about distance learning in general and the effectiveness of online assessment particularly (Karthik et al., 2015). Likewise, as in the case of teachers, the lack of technical infrastructure at home, dearth of human interaction, and costly internet connection augmented their struggle with online learning (Bao, 2020).

Research revealed that school closure, the lack of equipment to participate in distance learning, difficulties in accessing online materials from home, and isolation at home for a long time had great impact on the mental and physical well-being of students (Apriyanti, 2020). No one was prepared for this, including schools, administrators, educators, students, and parents.

As such, the stress exerted on teachers and students overburdened parents, as their involvement in their children's daily education became essential. Findings from previous studies during COVID-19 have shown that the daily life routines and functioning of parents have changed, and their involvement in their children's learning has markedly increased (Toran et al., 2021; Viner et al., 2020). In fact, parents who were either unemployed or working remotely from home expected to play a pivotal role in the education of their children (Cusinato et al., 2020).

Despite the wealth of research studies that addressed students (Daniel, 2020), teachers (Huang et al., 2022), and education in general (Schleicher, 2020), fewer research studies addressed parents' experiences in responding to online learning needs of their children during the pandemic (Chen et al., 2022). The majority of the published work addressing parents during COVID-19 focused on the struggle of parents as caregivers for children with learning disabilities (Cahapay, 2020), or their struggle to secure the infrastructure needed to start online learning for their children (Ghamrawi et al., 2020). Yet, few studies elicited parents' opinions addressing their perceptions pertaining to their overall personal experience with online learning. This is particularly what this study aims to explore.

Literature review

Education disruption by COVID-19

The global spread of COVID-19 worldwide affected all countries and territories, influencing every aspect of human lives. The first case of COVID-19 was detected in December 2019 in Wuhan, China. Consequently, and in order to contain the pandemic spread, countries around the globe put in place lockdown measures, urging people to stay at home in order to flatten the infection curve and control the transmission of the disease

(Pokhrel et al., 2021). All educational entities, including universities, colleges, training institutes, and higher education facilities were fully closed in most countries. Education systems worldwide had to react fast, with very little time to make optimal decisions, with no other options other than adopting distance learning to mitigate the crisis (Dreesen et al., 2020; Looi, 2022). Few countries tried using the radio or television as an educational tool (Dreesen et al., 2020).

As a result, education witnessed a paradigm shift in the delivery model of teaching and learning and adopted various online platforms (Ghamrawi et al., 2020). Online learning and distance education became a panacea during the pandemic (Looi, 2022). This transition from traditional face-to-face learning to online learning was very challenging for teachers, students, and parents (Espino-Diaz et al., 2020). In fact, countries faced massive and various challenges, such as internet access, the availability of digital devices, availability of e-learning materials, the availability of parental support for students, and teachers' readiness (Ghamrawi et al., 2020; Besser et al., 2022; Lin and Yeh, 2022; Looi, 2022). Despite these challenges, distance and online learning became the significant education savior for educational communities in most countries (Soland, 2020).

Distance learning and its terminologies

The progressive advancement of education technology and its associated fields and tools led to the use of different terminologies pertaining to distance learning by practitioners and researchers. The use of online learning, virtual learning, e-learning, distance learning, blended learning and other terms have been used interchangeably. Ghamrawi et al. (2020) addressed the differences among these terms, as shown in Table 1.

Table 1

Terminologies of Remote Learning

Name	**Description**				
	Mandatory Features				
	Technology	Real Time	Internet	Classroom	Anywhere
Online Learning	X	X	X		X
Virtual Learning	X		X		X
E-Learning	X		X		X
Distance Learning	X		X		X
Blended Learning	X		X	X	X

Source: Ghamrawi, 2020

Table 1 clarifies the common features amongst the different terminologies that are used to describe the different forms of distance learning. The commonalities shown in the table above explain clearly why people use these terminologies interchangeably.

Impact on students

During the crisis, students were unable to go to school, which is generally recognized as being integral for children to acquire skills, have fun, and socialize. While relatively a short period in school supports this, a relatively short period of missed school leaves an impact on children's skill development and well-being (Hoffman et al., 2020). Several studies suggest that students' well-being during the pandemic was at high risk (Flack et al., 2020). In fact, many concepts were addressed in the literature more than ever, such as isolation, dropout, sense of purpose, belonging, mindfulness, social-emotional learning, and emotional safety (Dudovitz et al., 2022; Flack et al., 2020; Soneson et al., 2022; Squires et al., 2022).

While assessment remains an integral part of any learning process, conducting internal (at the school level) and external (at the national/country level) assessments were canceled or postponed during the pandemic. One potential alternative for the cancelled assessments was to use "predicted grades" by teachers, which Murphy and Wyness (2020) criticized as being imprecise. As a result, some countries decided to shift their examination system from offline to online. This divergence in students' online assessments caused caution and uncertainty among teachers, students, and parents; further, the approach to adopting online examination varied from one country to another. It was mainly a function of the context's convenience, the know-how of educators, and compatibility of learners. Checking plagiarism of online assessments was hard, and consequently the reliability of the assessments was problematic (Pokhrel et al., 2021).

Impact on teachers

The COVID-19 pandemic required radical changes in teaching practices (Reimers and Schleicher, 2020). In fact, teachers were not prepared to make a paradigm shift in their daily routines (Loot, 2022). In fact, prior to the pandemic, a study conducted in 2018 across all countries participating in the Program for Student International Assessment (PISA), showed that teachers lacked the relevant instructional and technical skills to use digital devices inside classrooms (OECD, 2020b). Moreover, the study distinguished between teachers' digital skills based on the socio-economic statuses of the countries they came from, suggesting that teachers' pedagogical and technical skills from higher socio-economic countries were considerably higher than those of low socio-economic countries (OECD, 2020b). In fact, online teaching witnessed additional complications in disadvantaged communities where a huge number of students were left behind, due to the lack of internet and computer devices (OECD, 2022a, 2022b).

During COVID-19, teachers handled unprecedented workloads. In fact, while online learning required them to acquire new skills and develop new learning materials, they also had to take care of their families, which increased their overall stress and impacted negatively on their well-being (Hong et al., 2021). Some teachers had to offer care to family members who had fallen ill, or had to mourn the death of family members, friends, or colleagues (Jalongo, 2021).

All these factors and others resulting from the pandemic and its compulsory lockdown impacted the quality of online learning, which was not always deemed good (Nugroho et al., 2021). For example, parents in many European countries reported their dissatisfaction with the poor quality of online learning offered to their children (Thorell et al., 2021). Consequently, many teachers faced complex situations and received negative feedback from their students and parents. In short, the pandemic era was a hassle to teachers, who had to face massive challenges, which intensified their stress and even caused burnout (Pressley, 2021).

Impacts on parents

As in the case of teachers and students, COVID-19 overburdened parents and caregivers. Parents were struggling to manage their time, seeking a balance between their work, the supervision of their children, and their daily house chores (Michelson et al., 2021). Some countries, such as China, Italy, Spain, and Guatemala provided online pedagogical

support to parents and caregivers, supporting them in the education of their children during confinement (Chang et al., 2020).

Nonetheless, confinement increased the risk of trauma, immobility, and detachment and led to a loss of the sense of time and security (Feeney and Fitzgerald, 2022). Challenges were further exacerbated in the case of low-income parents, who had pre-existing health problems or families having children with disabilities or with special needs, who required special attention and care (Fontanesi et al., 2020). Also, the pandemic amplified the qualms of parents pertaining to the effect of desocialization on their children's health (Feeney and Fitzgerald, 2022). In the midst of this, parents were overwhelmed with the management of the learning of their children at home. This was happening in the absence of any governmental support in many countries (Beckmann, 2021).

Methodology

Research Design

This study was guided by Morse's (1991) convergent mixed methods design, whereby quantitative and qualitative data are collected simultaneously on the same topic to better understand the researched problem. As such, the study benefits from the strengths of both research paradigms (Patton, 1990) and supports in developing a deeper and comprehensive understanding of the phenomenon being explored (Creswell and Clark, 2017). As such, a survey instrument was designed bearing 29 closed questions and 1 open-ended question.

The study was guided by the following research questions:

(1) What are parents' perceptions pertaining the provision of online learning in the State of Qatar during COVID-19 pandemic?
(2) What factors contribute to improved parents' experiences with online learning in case of future learning disruptions?

Research Instrument

An online survey was developed and conducted by the Social and Economic Survey Research Institute (SESRI) at Qatar University. It consisted of four sections (A, B, C, & D) that included 29 closed questions, besides one open-ended question, allowing parents to suggest how the provision of online learning can be improved in case of future learning disruptions. Section A collected socio-demographic information and included 14 items. Section B included 10 items that elicited parents' experiences with online education. Moreover, section C included three items that tapped on the different challenges that confronted parents during online education in terms of balancing their various duties. In addition, section D requested parents to suggest the most preferred learning modes for their children. Finally, the survey included one open-ended question pertaining to the factors that would improve parents' experiences with online learning. The survey, developed by SESRI's research team, was validated by two external experts and was piloted on a group of respondents (N = 24) that were not part of the study.

Sampling and Data Analysis

The sample was a non-probability random sample; it targeted Qatari and non-Qatari parents, as well as government and non-government schools. Data was collected online via the SESRI's Qualtrics web-based survey tool. Participants were asked to e-sign a consent form attached to the survey. The sample size of 688 parents were selected randomly.

Data derived from closed-ended items were analyzed using the Statistical Package for Social Sciences (SPSS 28.0) for Windows. Descriptive statistics were used to describe and summarize the characteristics and properties of the data collected. Percentages were calculated for each item of the survey instrument. Bivariate analysis was used to assess the parents' perceptions against online learning. On the other hand, qualitative data derived from the open-ended question was analyzed using theme-based analysis.

Results

Socio-demographics

The sample of the study consisted of 688 parents divided between 632 (91.9%) females and 56 (8.1%) males, with an average age of 37.25 ± 6.32 years (Table 2). The majority of the parents surveyed were non-Qataris (92.7%). Among those 22.3% had been living in Qatar for more than 2 to 5 years, and 27.6% had been living in Qatar for more than 10 years. As for marital status, data showed that 95.6% of the parents were married, 2.3% were divorced, and 2% were separated.

In addition, 52% of the sample were employed and 79.4% of their spouses were employed. Finally, 45.6% of the sample had graduated with a university degree, 38.1% had master's or PhD degrees, and 16.3% had a diploma or secondary degrees.

Table 2

Sociodemographic Characteristics of Sample

		Frequency	Percent
Gender	Male	56	8.1
	Female	632	91.9
Nationality	Qataris	50	7.3
	Non-Qataris	638	92.7
How Long	Less than one year	6	0.9
	More than one year to two years	50	7.9
	More than two years to five years	142	22.3
	More than five years to ten years	232	36.5
	More than ten years to twenty years	158	24.8
	More than twenty years	18	2.8
	All my life/I was born in Qatar	30	4.7
Age	Mean (SD)	37.25 (6.32)	
	Min. to Max.	29 to 59	
Marital Status	Married	658	95.6
	Separated	14	2.0
	Divorced	16	2.3
Employment Status	Unemployed	330	48.0
	Employed	358	52.0
Spouse Employment Status	Unemployed	142	20.6
	Employed	546	79.4
Educational Level	Secondary or less	20	2.9
	Diploma (After secondary but no university)	92	13.4
	University Graduate/BA/BCOM/BSc	314	45.6

	Master's Degree	222	32.3
	PhD	40	5.8
Spouse Educational Level	Secondary or less	22	3.2
	Diploma (After secondary but no university)	94	13.7
	University Graduate/BA/BCOM/BSc	296	43.0
	Master's Degree	246	35.8
	PhD	296	43.0

On the other hand, Table 3 presents data pertaining the educational characteristics of children. In fact, 39.8% of parents had one child enrolled in school, 44.8% had two, and 15.3% had three or more enrollees. Furthermore, 71.5% of the children were enrolled in government schools, 23.27% were enrolled in international schools and 5.23% were enrolled in other schools (community schools and schools run by the embassies).

As far as the preferences of mode of learning by parents is concerned, data showed that 67.7% of parents favored blended learning; 20.9% preferred online learning only; 6.4% favored in-school learning; and 4.9% preferred different learning approaches. Moreover, 91.9% of parents contended that they followed up on their children's education, while 8.1% depended on private tutors in one or more of the subjects taught to their children.

Table 3

Educational Characteristics of the Children

		Frequency	Percent
Number of Children in School	One only	274	39.8
	Two	308	44.8
	Three	74	10.8
	More than three	30	4.4
	I don't have children registered in school	2	0.3
School Type	Government schools	492	71.5
	International schools	160	23.27
	Other schools (community/embassy schools, others..)	36	5.23
Current mode of learning	In-school learning only	44	6.4
	Online learning only	144	20.9
	Blended learning: A mix of in-school and online learning	466	67.7
	Different learning systems for different children	34	4.9
Family role	I do the follow-up with my child/ren education	406	59.0
	My spouse does the follow-up with our child/ren education	32	4.7
	My spouse and I do the follow-up with our child/ren education	194	28.2
	We have a tutor doing the follow-up with the child/ren regarding one of the school subjects	30	4.4
	We have a tutor doing the follow-up with the child/ren regarding most of the school subjects	8	1.2
	We have a tutor/s doing the follow-up with the child/ren regarding all school subjects	6	0.9
	Not applicable	12	1.7

Parents' experiences with online learning

The study researched parents' opinion pertaining to how their children's schools coped with online learning. The results are presented in Table 4: 73.9% of parents conveyed that schools coped well; 18% were neutral; and 8.1% suggested that schools' coping skills with remote learning were poor.

In the same line, 30.8% of parents stated that their communication with schools during the pandemic was very easy, 35.8% said somewhat easy, and 19.8% said it was somewhat hard to very hard. Parallel to that, the communication between parents and teachers during the pandemic was very easy for 34.6% of the parents; somewhat easy for 33.4% of parents; and was somewhat hard to very hard for 15.7% of parents.

Moreover, 22.1% of parents described school support to be very satisfactory, 38.4% thought it was satisfactory, and 21.2% believed it was not satisfactory. In fact, from the 688 surveyed parents, only 32.3% confirmed that their children's teachers contacted them to check on student workload. Likewise, 12.2% of parents stated that the follow-up provided by teachers during school closures was very satisfactory, 43.6% suggested that it was not satisfactory, and 19.2% believed it was not satisfactory.

Nevertheless, 60.5% of parents contended that the required educational resources for the online provision were made available during the schools' closure; yet it was not available for 39.5% of parents. Furthermore, 77.9% of parents were satisfied with the steps taken by schools to prevent the spread of COVID-19. Lastly, 11.9% of parents thought that their children were able to adapt very well to online learning; 32.8% thought that their children were able to adapt well; while 38.4% of parents stated that their children were unable to cope well.

Table 4

Experiences With Education Disruption Due To COVID-19

		Frequency	Percent
School cope with emergency remote education	The school coped very well	222	32.3
	The school coped well	286	41.6
	Neutral	124	18.0
	The school did not cope well	40	5.8
	The school did not cope well at all	16	2.3
Communication Parent and School	The communication was very easy	212	30.8
	The communication was somewhat easy	246	35.8
	Neutral	94	13.7
	The communication was somewhat hard	112	16.3
	The communication was very hard	24	3.5
Communication Parent and Teachers	The communication was very easy	238	34.6
	The communication was somewhat easy	230	33.4
	Neutral	112	16.3
	The communication was somewhat hard	82	11.9
	The communication was very hard	26	3.8
School support	The support is very satisfactory	152	22.1
	The support is satisfactory	264	38.4
	Neutral	126	18.3

	The support is not satisfactory	106	15.4
	The support is not satisfactory at all	40	5.8
Workload	Yes, my child's teacher contacted us to check the amount of work	222	32.3
	No, my child's teacher did not contact us to check the amount of work	466	67.7
Educational resources for online learning	I had too many resources available	92	13.4
	I had just the right number of resources available	324	47.1
	I had few resources available	238	34.6
	I had no resources at all	34	4.9
Follow-up of school and teachers	Very satisfactory	84	12.2
	Satisfactory	300	43.6
	Neutral	172	25.0
	Not satisfactory	104	15.1
	Not satisfactory at all	28	4.1
School's steps to prevent covid	Very satisfied	232	33.7
	Satisfied	304	44.2
	Neutral	106	15.4
	Dissatisfied	36	5.2
	Very dissatisfied	10	1.5
Children cope with online	My child/ren coped very well	82	11.9
	My child/ren coped well	226	32.8
	Neutral	116	16.9
	My child/ren did not cope well	198	28.8
	My child/ren did not cope well at all	66	9.6

On the other hand, data suggests that in-school learning was still the most preferable mode of learning for parents (79.4%), which was followed by blended learning (10.8%), online learning (4.9%), homeschooling (1.5%), and finally "different learning system for different children" (3.5%).

Challenges confronting parents and children during online learning

The unexpected shift from in-person to online learning imposed massive challenges on parents, as well as children. Table 5 presents these challenges. First, the challenges that parents faced during online learning were tested against 12 items measured using a five-point Likert scale ranging from 1 = "Not challenging at all" to 5 = "Very challenging."

Data showed that the highest four scored challenges were: (1) parents feel overwhelmed (average score 4.29 ± 0.99 over 5); (2) balancing parent's employment demands and child learning needs (average score 4.21 ± 1.11 over 5); (3) children's motivation specifically related to online learning (average score 4.14 ± 1.03 over 5); and (4) balancing requirements of different children's school work (average score 4.03 ± 1.16 over 5).

A score was computed to assess each of the challenges faced by parents, and then these scores were added to calculate the average score. The validation of this score was done using Cronbach's alpha $\alpha = 0.814$ (> 0.7) meaning that the items addressing challenges faced

by parents fitted well together. The average score of challenges faced by parents was 39.69 ± 8.65 over 60, with a minimum of 12 over 65 and a maximum of 60 over 60.

The challenges that children faced during online learning were explored via five items measured on a five-point Likert scale varying from 1 "Not challenging at all" to 5 "Very challenging." As such, "Having too much screen time" was the highest scored challenge (average score 4.54 ± 0.83 over 5); followed by "Maintaining social connection and friendships" (average score 4.26 ± 1.10 over 5); and then "Maintaining mental health" (average score 3.95 ± 1.15 over 5). A score was computed to assess the overall challenges for children and the scores of the five items were added all together. The validation of this score was done using Cronbach's alpha α =0.774 (> 0.7). The average score of challenges faced by children was 19.45 ± 4.20 over 25, with a minimum of 5 over 25 and a maximum of 25 over 25.

Table 5

Parents and Children's Challenges with Online Learning

	Not challenging at all	Somewhat not challenging	Neutral	Somewhat Challenging	Very challenging	Mean (SD)
Parents challenges						
Balancing parent's employment demands and child learning needs	32 (4.7%)	42 (6.1%)	50 (7.3%)	192 (27.9%)	372 (54.1%)	4.21 (1.11)
Balancing requirements of different children's schoolwork	38 (5.5%)	52 (7.6%)	68 (9.9%)	222 (32.3%)	308 (44.8%)	4.03 (1.16)
Parents feel overwhelmed	18 (2.6%)	30 (4.4%)	70 (10.2%)	186 (27.0%)	384 (55.8%)	4.29 (0.99)
Child/ren's motivation specifically related to online learning	22 (3.2%)	46 (6.7%)	54 (7.8%)	256 (37.2%)	310 (45.1%)	4.14 (1.03)
Child/ren's motivation towards learning in general	76 (11.0%)	152 (22.1%)	108 (15.7%)	170 (24.7%)	182 (26.5%)	3.33 (1.36)
Access to technology hardware for online learning	190 (27.6%)	144 (20.9%)	106 (15.4%)	138 (20.1%)	110 (16.0%)	2.76 (1.45)
Internet quality	196 (28.5%)	176 (25.6%)	102 (14.8%)	136 (19.8%)	78 (11.3%)	2.60 (1.37)
Access to online educational resources provided by the school	160 (23.3%)	216 (31.4%)	134 (19.5%)	112 (16.3%)	66 (9.6%)	2.58 (1.27)
Teaching skills and level of parent's knowledge	132 (19.2%)	142 (20.6%)	124 (18.0%)	170 (24.7%)	120 (17.4%)	3.01 (1.39)
Parent's interest in using technology	200 (29.1%)	164 (23.8%)	154 (22.4%)	110 (16.0%)	60 (8.7%)	2.51 (1.29)
Parents-Teacher communication	174 (25.3%)	160 (23.3%)	146 (21.2%)	138 (20.1%)	70 (10.2%)	2.67 (1.32)
Child/ren acquisition of the required learning outcomes and skills	48 (7.0%)	112 (16.3%)	122 (17.7%)	216 (31.4%)	190 (27.6%)	3.56 (1.24)
Challenges faced by Parents	Mean (SD) = 39.69 (8.65)			Min.–Max.: 12–60		
Children challenges						
My child/ren adjusted quickly to online learning	74 (10.8%)	108 (15.7%)	86 (12.5%)	232 (33.7%)	188 (27.3%)	3.51 (1.33)
My child/ren adjusted quickly to blended learning	84 (12.2%)	158 (23.0%)	118 (17.2%)	198 (28.8%)	130 (18.9%)	3.19 (1.31)
Maintaining their mental health	28 (4.1%)	74 (10.8%)	86 (12.5%)	218 (31.7%)	282 (41.0%)	3.95 (1.15)
Maintaining social connection and friendships	22 (3.2%)	58 (8.4%)	40 (5.8%)	168 (24.4%)	400 (58.1%)	4.26 (1.10)
Having too much screen time	10 (1.5%)	18 (2.6%)	36 (5.2%)	150 (21.8%)	474 (68.9%)	4.54 (0.83)
Challenges faced by Children	Mean (SD) = 19.45 (4.20)			Min.–Max.: 5–25		

Parents' perceptions towards online learning

How parents perceived online learning was assessed using nine items measured using a four-point Likert scale, varying from 1 "Strongly Disagree" to 4 "Strongly Agree." Table 6 suggests that the highest three scored perceptions were: "The online learning is suitable for children without needing parents' supervision" (average score 3.23 ± 0.93 over 4), followed by "the blended learning is easy to deal with (average score 2.95 ± 0.83 over 4), and finally "the shift between traditional learning to online learning has been done smoothly" (average score 2.76 ± 0.89 over 4).

On the opposite side, the lowest three scored perceptions were "schools need to focus more on innovative ways of learning" (average score 1.84 ± 0.74 over 4); followed by "parents need to be more involved in their child's education" (average score 2.22 ± 0.85 over 4); and then "online learning gave new perspective to education (average score 2.36 ± 0.85 over 4).

Table 6

Parent's Perceptions Toward Online Learning

	Strongly Disagree	Disagree	Agree	Strongly Agree	Mean (SD)
The shift between traditional learning to online learning has been done smoothly	40 (5.8%)	250 (36.3%)	230 (33.4%)	168 (24.4%)	2.76 (0.89)
The online learning is suitable for children without needing parents' supervision	48 (7.0%)	92 (13.4%)	204 (29.7%)	344 (50.0%)	3.23 (0.93)
The blended learning is easy to deal with	18 (2.6%)	197 (28.6%)	271 (39.4%)	202 (29.4%)	2.95 (0.83)
Schools need to focus more on independent learning	104 (15.1%)	306 (44.5%)	186 (27.0%)	92 (13.4%)	2.39 (0.90)
Parents need to be more involved in their child's education	126 (18.3%)	342 (49.7%)	160 (23.3%)	60 (8.7%)	2.22 (0.85)
You were able to adjust to online learning quickly	46 (6.7%)	294 (42.7%)	240 (34.9%)	108 (15.7%)	2.60 (0.83)
You were able to adjust to blended learning quickly	56 (8.1%)	342 (49.7%)	194 (28.2%)	96 (14.0%)	2.48 (0.83)
Online learning gave new perspective to education	80 (11.6%)	366 (53.2%)	156 (22.7%)	86 (12.5%)	2.36 (0.85)
Schools need to focus more on innovative ways of learning	228 (33.1%)	364 (52.9%)	72 (10.5%)	24 (3.5%)	1.84 (0.74)

To assess the overall parents' perception towards online learning, the scores of the nine items were added up into one score. This score was validated in the study population using Cronbach's alpha $\alpha = 0.736$ (> 0.7). The average score of parents' perception towards online learning was 22.16 ± 4.33 over 36, with a median score of 22 over 36, a minimum of 10 over 36, and a maximum of 34 over 36 (Table 7).

Table 7

Score of Parents' Perception Toward Online Learning

Parents' Perception	
Analyzed N	688
Mean	22.16
Median	22.00
Std. Deviation	4.335

Minimum		10
Maximum		34
Percentiles	25	20.00
	50	22.00
	75	25.00

Correlation between parents' perceptions of online learning and the challenges faced by parents and children

Table 8 suggests that parents' perceptions of online learning was negatively associated with the challenges they faced using online learning ($p < 0.001$) with $r = -0.447$; meaning that online learning is perceived negatively by parents who were unable to overcome challenges. Similarly, testing the correlation between parents' perceptions of online learning and that of their children's ($p < 0.001$) showed that parents of children who suffered during online learning, exhibited low perceptions with $r = -0.552$.

Table 8

Correlation Between Perception and Challenges

		Parent's Perception	Challenges faced by Parents	Challenges faced by Children
Parents' Perception	Pearson Correlation	1	-0.447	-0.552
	P value		**<0.001**	**<0.001**
	N	688	688	688
Challenges faced by Parents	Pearson Correlation	-0.447	1	0.608
	Pvalue	**<0.001**		**<0.001**
	N	688	688	688
Challenges faced by Children	Pearson Correlation	-0.552	0.608	1
	P value	**<0.001**	**<0.001**	
	N	688	688	688

Note. Pearson Correlation test was used in the analysis. Bold = statistically significant correlation set at 5%.

Leveraging the Quality of the Provision of Online Learning

As stated earlier, the survey included one open-ended question: what factors could improve your experience with online learning in the future? Responses were analyzed thematically, and findings are presented in Table 9. For ethical reasons, participants will be denoted using the formula Px, where x stands for the number given for the survey.

Table 9

Themes Emerging From the Open-ended Item

Themes	***Approximate % of Responses****
Choosing a user-friendly platform	95%
Ensuring leaning is interactive	92%
Securing peer collaboration	67%
Fitting age level characteristics	84%
Providing a comprehensive curriculum (PE, Arts, etc.)	76%
Differentiation of learning	53%
Avoiding screen fatigue	90%
Offering remedial learning opportunities	83%
Catering for student well-being	81%
Revising assessment and evaluation protocols	72%
Accounting for Privacy of homes when used	71%

*Note. *Rounded figures*

As Table 9 suggests, parents believed that online learning is best facilitated when a user-friendly platform is in place.

> *Do not speak of any functional online learning if the platform you are using keeps on freezing or breaking down (P412).*

Moreover, parents suggested that efforts should be made to render future online learning interactive, believing that one of the key problems in their past-experience during COVID-19 related to the lack of student-teacher interactivity. In addition, it should allow for peer collaborative work on virtual projects.

> *Schools should offer learning that allow our children to interact with teachers, by allowing time for asking questions, indulge in discussions, and express themselves (P71).*
> *Online learning should continue to give students the opportunity to work with each other collaboratively (P113).*

That is to say, as many participants enunciated, online learning should be responsive to the age level of children and should provide learning opportunities accordingly.

> *Our children can sit and listen to a teacher who is delivering the same way a TV news anchor delivers. Children are children, be that in school or behind screens, and an effective online provision should account for that (P287).*

One way to achieve that would be the adoption of a comprehensive curriculum that does not exclude the subjects that are mostly liked by children such as physical education, arts, drama, etc. Moreover, parents hinted on differentiating learning without naming it, suggesting that children should not all be given the same tasks, but rather tasks that fitted their abilities and interests.

> *I think a key failure has been the exclusion of the subjects that kids mostly liked. Online learning can and should include Arts, sports and all the subjects that energize children (P11).*
> *Online learning should offer children different tasks and learning opportunities based on their strengths and weaknesses, as well as their interests (P402).*

In the same vein, parents thought that online experience could be improved by ensuring children are given the right balance between rest and screen time to avoid screen fatigue.

> *It ached my heart when I saw my son sleeping behind screen. This is not learning, this is torture. Children should be given enough breaks (P364).*

In addition, parents suggested academic remedial programs to accompany online learning as well as programs that caters for students' social and emotional well-being.

> *Online learning should include a component help in identifying and supporting struggling students in the various subjects (P133).*
> *Online learning should provide social and emotional support for children (P215).*

Furthermore, parents thought that online learning should be able to carry out student assessment and evaluation fairly and easily.

> *I suggest improving assessment and learning and making it professional, true and allow children learn how to improve (P324).*

Finally, parents were keen to mention the importance of not violating the privacy of their homes through online learning. As such, many suggested teaching children the appropriate methods of opening cameras, while maintaining privacy.

> *I think one reason for the failure of online learning is closing cameras to protect privacies, but I think what needs to be done is teaching kids how to open cameras while maintaining privacy such as those pictures they put behind [virtual backgrounds], or choosing corners, etc. (P98).*

Discussion

This study explored parents' perceptions pertaining online learning in the state of Qatar during COVID-19 pandemic. Findings suggest that parents believed that online

learning was highly challenging, yet they were able to respond to it efficiently, and were satisfied the way schools and teachers communicated with them during the pandemic. Furthermore, parents believed that their children were able to cope with the sudden shift from in-person to online learning. All these findings come in line with Ghamrawi et al. (2020) and Ghamrawi (2022) suggesting that despite the gross challenge incurred on them, parents were left with no option but to respond with all effort to support the learning of their children during online mode.

The study suggests that the challenges reported by parents in online learning were massive because they had to seek the right balance between their jobs, home duties, and catering for their children's learning. They had to motivate kids to learn online, allocate the appropriate digital devices, and ensure high quality internet of internet at home, given that with all their children were going online simultaneously. These findings come in parallel to the literature that suggests that parents encountered problems stemming from the availability of appropriate devices, the access to online resources, and the internet quality (Besser et al., 2022; Ghamrawi, 2022; Ghamrawi et al., 2020; Lin & Yeh, 2022; Looi (2022).

In the same vein, parents believed that shifting from traditional to online and blended learning was not easy at all. Children took time to adapt and reported that online learning might have affected them their mental health, due to isolation and disconnection from peers; a finding that comes parallel to Hoffman et al. (2020) who suggested that online learning left deep effects on students in terms of socializing and developing new skills.

Moreover, parents preferred in-school learning because they thought online and blended learning models added stress and pressure, making it difficult to balance their lives. This converges with Michelson et al. (2021), who elaborated that parents were struggling in balancing between their jobs and the supervision that online learning required.

On the other hand, this study suggested several ideas for improving the provision of online learning, as perceived by parents. Some of these findings came parallel to the literature, while others were additions to it. In fact, parents suggested choosing a user-friendly platform (as in Ghamrawi, 2022), ensuring learning is interactive, securing peer collaboration, fitting age-level characteristics, providing a comprehensive curriculum (PE, arts, etc.), differentiation of learning, avoiding screen fatigue (as in Feeney & Fitzgerald, 2022; Flack et al., 2020), offering remedial learning opportunities, catering to student well-being (as in Hoffman et al., 2020; Hong et al., 2021), revising assessment and evaluation protocols (as in Murphy & Wyness, 2020; Pokhrel et al. 2021), and accounting for privacy of homes.

Conclusion

This study explored the parents' perceptions pertaining to online learning during the pandemic. It went beyond depicting what went well and what went wrong to draw a road map for leveraging the quality of online learning, should any learning disruption take place in the future. Findings illuminate the social context behind what might appear as a school challenge on a surface level. It is imperative for policymakers to understand that online learning is not only about using technology to engage in learning from home. It should offer a holistic approach, providing a family-centered solution accounting for the multitasking that is expected from parents, and apprehending economic and social pressures incurred on them.

Moreover, policymakers should understand that online learning should provide for student well-being. Behind screens, students are prone to anxiety, depression, and isolation.

Furthermore, online learning should be culturally responsive to norms and values of a given context. For example, while opening cameras is an international recommendation, it was considered a violation of privacy for parents in Qatar. Policymakers should ensure that solutions support a balance between parents' values around technology use and the desired vision for online learning.

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Assuring Academic Integrity of Online Testing in Fundamentals of Accounting Courses

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Abstract
Demand for online courses continues to grow. To remain competitive, higher education institutions must accede to this demand while ensuring that academic rigor and integrity are maintained. The authors teach introductory Fundamentals of Financial and Managerial Accounting courses online. Previously, there was no proctoring of the exams. Prior experience teaching these courses led the professors to suspect a high likelihood that academic integrity on these tests was low and that cheating was high. To address academic integrity concerns, the professors utilized a remote proctoring service employing a lockdown browser with screen and webcam monitoring. The program monitors the students remotely, recording sound, video and the information appearing on the students' screens. The videos are reviewed for detectable instances of breach of academic integrity prior to releasing the grades. Data was collected and analyzed for the average exam scores prior to and after the implementation of the remote proctoring software. The data analysis reveals a significant difference in the two sets of scores, with the average exam scores after the implementation of the remote proctoring being significantly lower than the ones before implementation. These results indicate that concern about academic integrity in online test-taking in the accounting curriculum is valid.

Keywords: Academic dishonesty, online courses, proctored versus non-proctored exams, cheating

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Online education became a requirement when the 2020 COVID-19 pandemic impacted traditional learning all over the world. Noorbehbahani et al. (2022) report the pandemic forced 1.5 billion students and 63 million educators to the online learning environment. Even before the pandemic, the popularity of online courses was increasing as students wished to complete their higher education in a time and manner most convenient for them as individuals. To remain competitive, higher education institutions have acceded to this demand. As a result, they face difficulties in ensuring that the academic rigor and academic integrity established in traditional face-to-face courses are maintained in the online environment.

There is a vast amount of literature regarding academic cheating, academic misconduct, and academic integrity. In much of this literature, the terms are often intertwined. The various studies have focused on concepts such as the cheaters' personality and characteristics, motivating factors for cheating, methods of cheating, and detection and prevention methods.

Giluk and Postlethwaite (2015) conducted a meta-analytic review of the relationship of the Big Five personality factors to academic dishonesty. The five-factor model (Big Five) is one of the dominant models of personality (Digman, 1990.) The factors included are neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. This model has been used to predict academic performance (Poropat, 2009). Conscientiousness and agreeableness were, as expected, negatively related to academic dishonesty, and had the strongest relationships of the five factors. The other three factors, neuroticism, extraversion, and openness to experience were all positively related to academic dishonesty. However, they did not have the level of relationship shown with conscientiousness and agreeableness, even though previous studies had mainly given attention to extraversion and stability (vs. neuroticism which exhibits emotional instability, irritability, depression, and other negative effects) (Williams et al., 2010). These personality factors exist and present a concern about academic dishonesty whether exams are in person or online and whether proctored or not.

Many different motivations are cited by students as reasons for cheating. Studies indicate that academic misconduct at universities has been on the rise for years (Turner & Beemsterboer, 2003; Marsden et al., 2005) and that misconduct is significantly even higher during exams and assessment tests (Desalegn & Berhan, 2014). Students are, in fact, more motivated to cheat when there are higher stakes (graded) assessments (Farland & Childs-Dean, 2021). Some reasons that students cite for cheating are greed for high scores, what their peers think of them, and lack of understanding about the university polices regarding cheating (Passow et al., 2006). Radwan et al. (2022) posit that students cheat in general for three reasons: fear of failure, a desire to take risks, and a lack of concern about their cheating being detected. Academic cheating is found in universities and other levels of education throughout the world (Iqbal et al., 2021).

There are a seemingly endless number of methods that students employ to cheat. The three main cheating methods observed by Ozgen et al. (2021) while using computer metrics were using another person, device, or absence. Cheating practices include copying and pasting, plagiarizing, looking at another student's work, making up data, using unauthorized materials, and a plethora of other means (Ercegovac & Richardson, 2004; Błachnio & Weremko, 2011).

Fortunately, there are methods for detection and prevention of cheating. Some detection methods use computer technologies that identify head and neck movements (Malhotra et al., 2021), facial expressions (Ghizlane et al., 2019), and posture (Nishchal et al., 2020) that suggest cheating. Online exam proctoring, using live proctors and/or video and audio which is reviewed later is a useful tool for detection of cheating. One author posits that using proctoring may give students fewer or no opportunities for academic dishonesty (Reisenwitz, 2020). Assuming that holds true, online proctoring of exams also serves as a method for prevention of cheating. Based on a review of literature on cheating in online exams from 2010 to 2021, Noorbehbahani et al. (2022) categorize cheating prevention in two ways: before-exam prevention and during-exam prevention. Beforehand prevention includes exam design, authentication of students, clustering students into groups and lowering cheating motivation. During-exam prevention includes cheat-resistant systems such as browser lockdown (Chua & Lumapas, 2019) and other methods such as cutting down on bribery of proctors by using random assignment of proctors right before exams (Kigwana & Venter, 2016) and using online proctoring of exams.

The focus of this study is on ensuring that academic integrity is maintained in the online environment. The study worked to achieve this goal by adding remote proctoring to the design of the online assessments to help in both detecting and preventing cheating. Prior experience teaching the Fundamentals of Financial and Managerial Accounting courses led the authors to suspect a high likelihood that academic integrity on the exams in the classes was low and that cheating was high. To address these academic integrity concerns, a remote proctoring service was utilized, employing a lockdown browser with screen and webcam monitoring. The authors compared student exam performance in the same learning modality (online), with no changes in the course structure or content. The only change in the assessment design was the inclusion of webcam-based online proctoring of the exams. This inclusion revealed significant differences in exam scores when compared to scores with no proctoring, large enough to imply that cheating had been occurring prior to the proctoring requirement. The contribution of this research is that it adds to the body of literature by emphasizing the necessity of adding proctoring as a component of the design of online exams.

Literature Review

Unethical behavior such as fraud, deception, and cheating have been reported amongst the greatest challenges faced by individuals and society alike (Shalvi et al., 2015). In academia, academic dishonesty has been and continues to be of real concern. In a recent survey conducted by Wiley of over 2,800 instructors in the United States and Canada, a reported 77% of instructors believed that students are more apt to cheat in online courses than in traditional face-to-face courses (Carrasco, 2022). In an analysis of over three million tests, conducted by ProctorU, cheating, or attempts to cheat, were found in 7.2% of higher education assessments (Williams, 2022). This is a reported increase of over 14 times prior to the pandemic (Williams, 2022).

Disregarding any academic code of conduct previously signed, student perception that cheating is acceptable—especially in non-proctored environments—is high. Several studies have shown that students feel it is easier to cheat in the online environment and thus they are more likely to resort to cheating in online courses. In a survey of 141 students, 118 reported that cheating in online examinations was an issue (Berkey & Halfond, 2015) while 88 out of 121 students in another survey felt it was much easier to cheat in online courses compared to

traditional courses (King et al., 2009). Watson and Sottile (2010) surveyed 635 students and discovered that the students reported a much higher likelihood (greater than four times) of cheating in the online environment versus a face-to-face setting. The reason may be because students attributed the absence of exam proctoring to the belief that the teacher was not serious in prohibiting outside resources (Dyer et al., 2020). Therefore, Newton (2021) maintained the decision to not utilize assessment proctoring in online courses sends the students the message that the course is not as serious or valuable as traditional, face-to-face courses and the assessment's integrity is not that important, otherwise proctoring would be in place to protect it. This is consistent with Harmon et al.'s (2010) conclusion that the main factor that mediates cheating, according to students, was the inclusion of proctoring.

There are multiple cheating methodologies, and a number of students have used several methods of cheating while working on earning their degrees (Josien & Broderick, 2013). Online cheating often occurs in the form of utilizing forbidden items to complete assignments. These items include textbooks, notes, and offline and online electronic resources (Fontaine et al., 2020; Holden et al., 2021) and having others in the room with them during the exam (Williams, 2022). Corrigan-Gibbs et al. (2015) reported that cheating largely occurred in the online environment as the students utilized the Internet to look up the answers to examination questions. In the online environment, impersonation is also a threat to academic integrity. By sharing one's academic account credentials with another, someone other than the student is allowed to complete the work (Dobrovska, 2017). The sharing of credentials is a form of "contract cheating," which is using a third party to help a student complete their work and submitting it as if they prepared it themselves (Quality Assurance Agency, 2017). This is a large challenge to safeguarding assessment security (Gamage et al., 2020).

Even though the academic situation changed during Covid-19 resulting in much more online assessment, academic integrity and assessment security are "still indispensable in the higher education sector" (Gamage et al., 2020). Allowing cheating to go unchecked is a threat to higher education. It makes it very difficult for colleges and universities to properly conduct assurance of learning, devalues the student's education and degree, making their diploma essentially worthless (Bergmans et al., 2021; Williams, 2022). The impact of cheating in the online environment on students' education is concerning to many instructors. Seventy-four percent of instructors surveyed had concerns that cheating severely impacts students' learning and 52% feared this leaves the students underprepared for their future careers (Carrasco, 2022).

The exam design is the highest contributing factor motivating students to cheat on exams (Noorbehbahani et al., 2022). Poorly designed exams providing the same or similar true/false or multiple-choice questions for each student, along with the ease of locating test bank solutions, incentivizes cheating (Noorbehbahani et al., 2022). Additionally, exams that are overly complex and irrelevant to the course materials covered can also motivate students to cheat (Srikanth & Asmatulu, 2014).

Liken to the Fraud Triangle elements of Opportunity, Pressure (Motivation) and Rationalization (Cressey, 1973), all three must be perceived to be present for a student to be able to cheat on an exam. The perceived notion of opportunity + pressure + rationalization = an increased risk for such behavior (Metts, 2021). Academic misconduct often occurs when

opportunities are present, but surveillance is obsolete or minimal (Faucher & Caves, 2009). While the motivation and rationalization compelling a student to cheat lies solely with the student, the examiner controls the opportunity element. Hence, the examiner should do what they can to remove or lessen the opportunity to cheat. The use of online proctoring, whether human or automated, can assist examiners with this endeavor. In fact, research has shown that the average score on an online examination can drop close to a letter grade when proctoring or monitoring is used (Newton, 2021). Thus, proctoring online test-taking can assist in promoting academic integrity. It creates accountability similar to traditional face-to-face courses (Newton, 2021). Live proctoring of online test-taking can help detect and stop cheating as it is happening. However, it is expensive and not always available. An alternative to live proctoring is the use of proctoring software that requires a webcam. Using a webcam, the student's testing environment can be continuously monitored to ensure forbidden materials are not in the room. The student can also be required to show a picture ID that will provide evidence that the student taking the exam is the student enrolled in the course.

There have been multiple studies comparing student exam performance with proctored and non-proctored exams in the online environment whose findings suggest cheating was occurring in the latter. Daffin and Jones (2018) compared scores with students enrolled in online psychology courses at Washington State University. Using a sample of close to 1,700 students over the Spring 2015 to Spring 2016 terms, the authors discovered that exam performance was 10-20% better in the non-proctored environment than when administered in a proctored setting (Daffin & Jones, 2018). Both Alessio et al. (2017) and Fask et al. (2014) studies revealed similar findings. Alessio et al. (2017) had compared the exam scores for an online medical terminology course at Miami University while Fask et al. (2014) compared elementary statistics exam scores for students attending a private university in the northeastern region of the United States. Elevated exam scores were once again present in the non-proctored setting as compared to the proctored setting. Dendir and Maxwell (2020) also found significant differences in student performance scores between proctored and non-proctored exams given in an online course. They compared the examination scores of students enrolled in multiple sections in one or both of principles of microeconomics and geography of North America at a comprehensive midsized public university in the United States. Keeping their course structure, content, and assessments the same, the authors introduced online proctoring of assessments. The results revealed an average reduction of 16 percentage points across the six exams (three economics and three geography) when the exams were proctored. Hylton et al. (2016) also discovered an increase in examination scores for students taking non-proctored exams in online courses. The authors randomly assigned students to complete their exams either in a non-proctored setting or a webcam-based proctored setting. Not only did they find that the students who took the exam in the non-proctored environment had elevated exam scores, the students in the non-proctored setting also took a much longer time to finish their exam which they attributed to students looking up answers. All the aforementioned authors attributed the reduction in proctored exam scores and elevated scores in non-proctored exams to cheating and thus, determined that web-cam monitoring was an effective deterrent to mitigate cheating in an online course (Alessio et al., 2017; Dendir & Maxwell, 2020; Fask et al., 2014; Hylton et al., 2016).

The Hechinger Report (2020) revealed that proctors reviewing the video recordings of an exam in a pre-med chemistry class at a well-known mid-Atlantic university discovered that the

same person had taken exams for at least a dozen students at seven universities. There was a spreadsheet on his wall, which was caught on camera, that showed student names, schedules, and login credentials and passwords for him to use for websites that would "feed" him answers. The video proctoring and review of these exams thus documented these multiple incidents of contract cheating. The report further shared that students at some universities, during the COVID lockdowns, were given extra time to complete their exams online (with no proctoring) and students were setting up video conferences to share answers. Software that locks the students' browser is helpful but doesn't stop schemes such as video conferencing. Proctoring (live or video review at a later date) helps with detecting cheating and the report cited one professor at Purdue as saying, "You cannot give an exam if it is not proctored." They also cited Scott McFarland, CEO of ProctorU: "We can only imagine what the rate of inappropriate testing activity is when no one is watching."

Methods

Participants

The participants for this study included undergraduate business majors enrolled in online, 7-week, Fundamentals of Accounting courses during the Spring 2020 and Spring 2021 terms. Both the Fundamentals of Financial Accounting and Fundamentals of Managerial Accounting courses were included in the study. There were 67 students initially enrolled in the Spring 2020 Fundamental Financial Accounting course and 65 enrolled in the Spring 2021 offering. Forty-two students were initially enrolled in the Spring 2020 Fundamental Managerial course and 47 were enrolled in the Spring 2021 course. Students enrolled in these courses may have been either part-time or full-time students. As the courses were 100% online, it is important to note that the demographics for online students are often different from those of traditional, F2F students coming straight from high school. While some of the students in the course may have been traditional students, it is likely that many were non-traditional students (older, working adults possibly with families and maybe attending school on a part-time or full-time basis). Additionally, different genders, ages and ethnicities were most likely present, but were not collected for inclusion in this study. Both the Fundamentals of Accounting courses satisfy a portion of the business core required for all business majors at the university, whether accounting, finance, general business, management, or marketing.

Materials

The only instruments used in this study were the course exams, consisting of three exams covering three chapters each and one comprehensive final exam covering all the chapters in the course. In both the Fundamentals of Financial and Fundamentals of Managerial classes, the first three exams were each worth 100 points. The final exam in Fundamentals of Financial Accounting was worth 100 points while the final exam in Fundamentals of Managerial Accounting was worth 150 points. Most of the exams were in true/false and multiple-choice question format with a few short application problems. The course structure and content of the online exams remained constant in the classes of both professors, whether non-proctored or proctored.

Procedure

All Fundamental of Accounting courses involved in this study were taught in the Blackboard learning platform, integrated with the partner content platform, and taught by both authors of this paper. The classes were 100% online and thus, all instruction, coursework—including exams—were online. The exams were open for a period (over several days) allowing students to take the exams at a time most convenient for them. Prior to the use of proprietary proctoring software, which only became available from the publisher and integrated with the partner content platform in 2021, the exams were non-proctored. When the proprietary proctoring software became available for use with partner content platform in Spring 2021, it was subsequently incorporated for all exams in the two courses.

With or without proctoring, students were advised that except for a 3 x 5 card with formulas, blank scratch paper, pen/pencil and a basic calculator, no notes, books, or other outside help of any kind (e.g., people or internet) were allowed. Before the use of the proprietary proctoring software, the students were completely on an honor system to abide by the rules. The proctoring software used for all the exams utilizes lockdown browsing and videotapes the students as they take the exams. The proctoring software provided the instructor with a report that alerts them to various levels of suspicious activity. The videos for each student were available for the professors to review for rule violations. At the end of the non-proctored and proctored semesters, only the data related to the exams were downloaded. The student names were omitted, and the data were analyzed for any significant difference using SPSS.

Analysis

An independent samples *t*-test was used to examine the differences in student performance on the non-proctored and proctored exams in both courses. The *t*-test was conducted for all the exams in the courses. The mean scores on the exams that were non-proctored in one semester were compared with the scores of the exams that were proctored in another semester. There were 67 students initially enrolled in the Spring 2020 Fundamental Financial Accounting course and 65 enrolled in the Spring 2021 offering. Forty-two students were initially enrolled in the Spring 2020 Fundamental of Managerial Accounting course and 47 were enrolled in the Spring 2021 course. The change in the number of students taking the different exams may indicate those who did not take one or more exams or dropped the course between exams. As mentioned previously, the exam content remained the same across both semesters. The only variability was the addition of online proctoring and a different set of students taking the exams. The authors believed that cheating was occurring on the non-proctored exams and thus hypothesized that student performance would significantly decrease when the exams became proctored.

Results

Student performance was examined for non-proctored and proctored exams in the online Fundamentals of Accounting courses during the Spring 2020 and Spring 2021 semesters. Figures 1 and 2, respectively, show the average exam scores for all three-chapter exams and the final exam for the Fundamentals Financial Accounting course and Fundamentals of Managerial Accounting course. The average exam scores in both courses decreased for all proctored exams with significant decreases seen in Exam #1, #3 and the final for Fundamentals of Financial

Accounting (Figure 1 below) and for all four exams in Fundamentals of Managerial Accounting (Figure 2 below).

Figure 1
Fundamentals of Financial Accounting Average Exam Scores Comparison

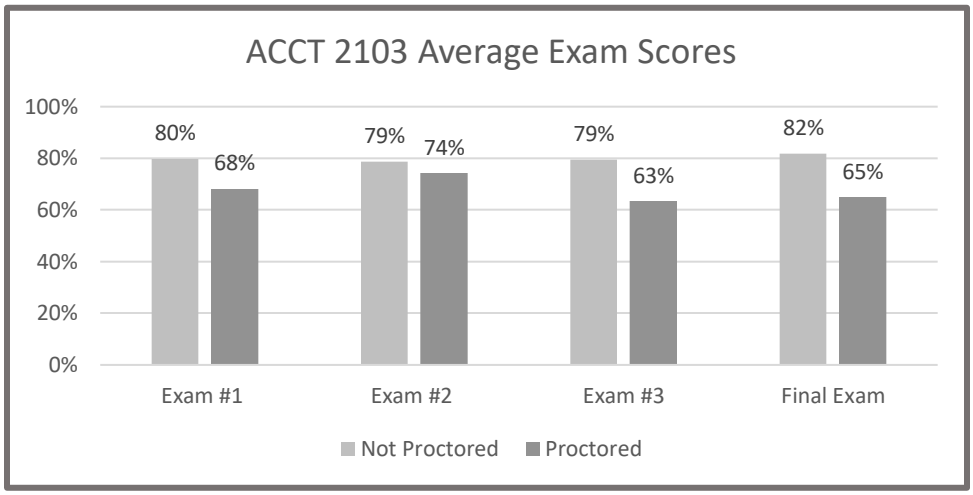
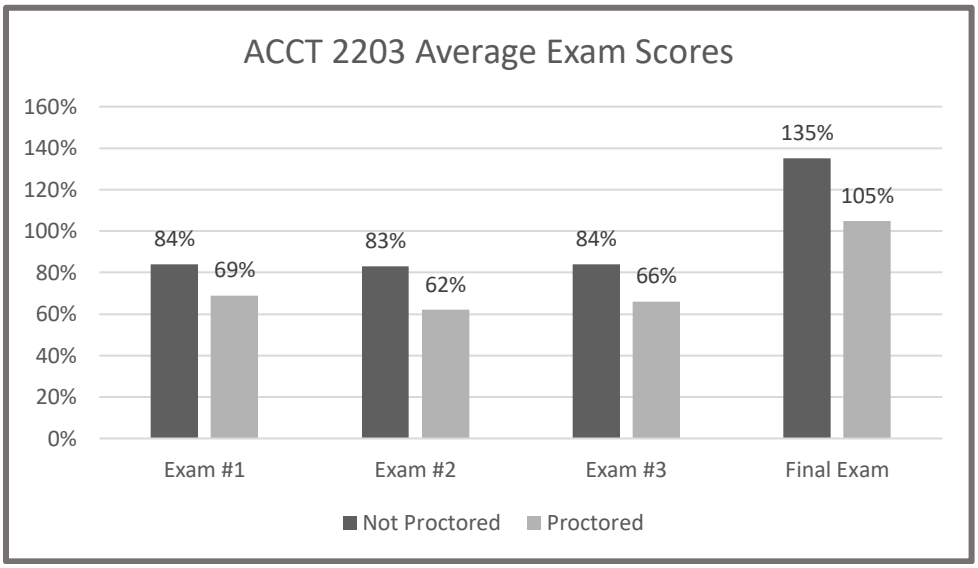


Figure 2
Fundamentals of Managerial Accounting Average Exam Scores Comparison



An independent sample *t-test* was conducted to compare the scores earned on all three-chapter exams and the final exam when the exams were not proctored with those when they were proctored. The samples statistics and the differences in the mean scores for the exams in Fundamentals of Financial Accounting and Fundamentals of Managerial Accounting are shown in Tables 1 and 2 below. As highlighted in Figures 1 and 2 (above), the results for both courses were significantly lower on the proctored exams than on the non-proctored exams.

Table 1
Fundamentals of Financial Accounting Independent T-test Sample Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
Exam_1_Tests	Not Proctored	67	79.93	13.435	1.641
_Scores	Proctored	65	68.23	14.006	1.737
Exam_2_Tests	Not Proctored	65	78.69	14.931	1.852
_Scores	Proctored	63	74.27	13.585	1.712
Exam_3_Tests	Not Proctored	57	79.56	15.257	2.021
_Scores	Proctored	58	63.43	17.804	2.338
Final_Exam_	Not Proctored	59	81.78	11.010	1.433
Tests_Scores	Proctored	62	65.10	13.849	1.759

Table 2
Fundamentals of Managerial Accounting Independent T-test Sample Statistics

	Condition	N	Mean	Std. Deviation	Std. Error Mean
Exam_1_Tests	Not Proctored	42	83.48	12.468	1.924
_Scores	Proctored	47	69.09	15.150	2.210
Exam_2_Tests	Not Proctored	42	83.00	11.910	1.838
_Scores	Proctored	42	61.93	14.729	2.273
Exam_3_Tests	Not Proctored	40	83.85	11.575	1.830
_Scores	Proctored	41	65.88	14.297	2.233
Final_Exam_	Not Proctored	41	135.22	11.279	1.762
Tests_Scores	Proctored	41	105.54	24.568	3.837

The independent samples test results for Fundamentals of Financial Accounting and Fundamentals of Managerial Accounting, shown in Tables 3 and 4 below, reveal there was a statistically significant difference (p-value is less than 0.05) in the exam scores for all but Exam #2 in the Fundamentals of Financial Accounting course between the proctored and non-proctored exams.

Table 3
Fundamentals of Financial Accounting Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Exam_1_Tests_Scores	Equal varianceassumed	.234	.630	4.896	130	.000	11.695	2.388	6.969	16.420
	Equal variances not assumed			4.893	129.327	.000	11.695	2.390	6.966	16.423
Exam_2_Tests_Scores	Equal variances assumed	.101	.751	1.751	126	.082	4.422	2.525	-.575	9.420
	Equal variances not assumed			1.754	125.505	.082	4.422	2.522	-.568	9.413
Exam_3_Tests_Scores	Equal variances assumed	2.510	.116	5.213	113	.000	16.130	3.094	10.000	22.261
	Equal variances not assumed			5.220	110.954	.000	16.130	3.090	10.007	22.254
Final_Exam_Tests_Scores	Equal variances assumed	6.555	.012	7.312	119	.000	16.683	2.282	12.165	21.201
	Equal variances not assumed			7.353	115.397	.000	16.683	2.269	12.189	21.177

Table 4

Fundamentals of Managerial Accounting Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Exam_1_Tests_Scores	Equal variances assumed	5.928	.017	4.859	87	.000	14.392	2.962	8.504	20.279
	Equal variances not assumed			4.912	86.441	.000	14.392	2.930	8.568	20.216
Exam_2_Tests_Scores	Equal variances assumed	4.716	.033	7.209	82	.000	21.071	2.923	15.257	26.886
	Equal variances not assumed			7.209	78.559	.000	21.071	2.923	15.253	26.890
Exam_3_Tests_Scores	Equal variances assumed	1.732	.192	6.209	79	.000	17.972	2.895	12.210	23.733
	Equal variances not assumed			6.225	76.422	.000	17.972	2.887	12.222	23.721
Final_Exam_Tests_Scores	Equal variances assumed	26.718	.000	7.031	80	.000	29.683	4.222	21.281	38.085
	Equal variances not assumed			7.031	56.145	.000	29.683	4.222	21.226	38.140

Discussion

General

Academic integrity is important to higher education. Academic dishonesty threatens higher education as it makes assurance of learning more difficult, jeopardizes accreditations, devalues students' education and degree, making their diploma essentially worthless (Bergmans et al., 2021; Williams, 2022). Student cheating impacts learning and leaves students underprepared for their future (Carrasco, 2022). When opportunities to cheat are present and surveillance is obsolete or minimal, academic dishonesty transpires (Faucher & Caves, 2009). In the absence of any exam proctoring, students believe that it is okay to cheat because the instructor was not serious about the prohibition of outside resources (Dryer et al., 2020). To demonstrate the importance of assessment integrity and to assist in removing the opportunity to cheat, online webcam-based proctoring of examinations should be implemented.

Main Findings

While the Spring 2020 semester was characteristically different from any other semester given the worldwide lockdown due to the COVID-19 pandemic, the Fundamentals of Accounting courses used in this study had been previously taught 100% online and in a 7-week format prior to the COVID-19 pandemic that forced all learning to move to the online environment. Additionally, the 2020 course offering of Fundamental Financial Accounting was completed prior to the COVID-19 worldwide lockdown as the course started in early January 2020 and finished the last week of February 2020. As subsequent courses have also had the same results, there appears to be no significant differences between the groups of students that would have dramatically impacted the results.

Prior experience in teaching the introductory Fundamentals of Accounting courses led the instructors to suspect a high likelihood that cheating was occurring within the online examinations. However, prior to the Spring 2021 semester, there was not a monitoring software compatible with the learning management system and partner content utilized in the courses. When the monitoring software became available within the partner content platform for the Spring 2021 term, the instructors incorporated the use of this proctoring software for exams to help deter and prevent the suspected cheating.

The software is embedded within the partner content platform. Using a webcam, the software monitors students taking exams. While the instructors preferred live proctoring, live proctoring by the proprietary software within the partner content platform was not an option at the time of the study. However, the webcam records the student's testing environment and actions while taking the exams. After the examination period, the software provides the recordings along with reports that flag suspicious activity for the instructors to review. Since the examination content, examination settings (e.g., use of algorithmic questions) and materials permitted for use during the exams were the same under non-proctored and proctored testing, the only design variant was the use of the proctoring software.

The results of this study reveal evident and significant grade disparities between the proctored and non-proctored exam scores. These results are consistent with previous research where student scores on the proctored exams were significantly lower than the student scores on

non-proctored exams (Alessio et al., 2017; Daffin & Jones, 2018; Dendir & Maxwell, 2020; Fask et al., 2014; Hylton et al., 2016; Peterson, 2019; Reisenwitz, 2020). The Fundamentals of Financial Accounting course saw an average grade reduction of 12 points across the four exams while the Fundamentals of Managerial Accounting course observed an average reduction of 21 points.

Absent any monitoring, Kennedy et al. (2000) maintain cheating is much easier for students in online courses. The findings of the current study suggest that cheating was most likely occurring in the non-proctored exam environment as evident by the reduction of scores equivalent to one letter grade in Fundamentals of Financial and a two letter grade drop in Fundamentals of Managerial. The authors acknowledge that there may be other explanations in addition to cheating for the notable differences in the non-proctored and proctored exam scores, such as an increase in test anxiety, which can be associated with the proctoring environment's webcam and recording requirements due to privacy concerns (Fask et al., 2014). However, the lower exam scores on the proctored exams versus the non-proctored exams continued throughout all exams in both the consecutive classes, past when anxiety over using the proctoring software would be expected to have dissipated. Thus, the authors believe this indicates that a lack of academic integrity exists for many students when they are not monitored while taking exams (Faucher & Caves, 2009).

Limitations

It is important to consider the potential limitations to the generalizability of the results of this study. First, our focus was on students taking online, 7-week accelerated accounting courses without any comparison to traditional, face-to-face (F2F) accounting courses. Secondly, the demographics of students enrolled in online courses can differ largely from those enrolled in F2F courses. Non-traditional students are often older, likely working adults with small children, and may be attending school on a part-time or full-time basis.

Conflicts of Interest and Human Subjects Research

The authors are not aware of any conflicts of interest in this study. Additionally, no informed consent was provided or necessary as our research did not require Institutional Review Board (IRB) approval. According to our institutions' IRB exemption list, our research was exempt because it involved the study of the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Future Research Ideas

Recommendations for future research are to replicate the study in other accounting courses as well as in other disciplines in and outside the business school. Additionally, this study used a video recording proctoring service. It would be interesting to see any differences between when live proctoring is used or the use of lockdown software without the use of video monitoring. Finally, future studies could look at the exam performance in courses with exam proctoring that allow the use of notes or other resources.

Conclusion

Students enrolled in the online Fundamentals of Financial Accounting or Fundamentals of Managerial Accounting courses with required proctored exams scored much lower on the exams than students enrolled in the same courses with no exam proctoring requirement. Students

in Fundamentals of Financial Accounting scored, on average, 12 points lower while students in Fundamentals of Managerial Accounting scored an average 21 points lower across all exams. Thus, the inclusion of monitoring software significantly negatively impacted the exam scores. A lack of academic integrity (cheating) is a strong explanation for the difference in proctored exam scores versus non-proctored exam scores in an online testing environment. Therefore, webcam monitoring appears to have been an effective deterrent to cheating in online courses, consistent with the findings of Alessio et al. (2017), Dendir Maxwell (2020), Fask et al. (2014) and Hylton et al. (2016).

Allowing cheating to go unchecked is a threat to higher education. Academic dishonesty makes it difficult for institutions to properly conduct assurance of learning and devalues the students' education and their degrees, making their diplomas essentially worthless (Bergmans et al., 2021; Williams, 2022). As the demand for online education continues to surge, educators must take measures to help ensure that cheating is curtailed, and academic integrity is maintained in online teaching. The use of proctoring software can help in this endeavor to deter and prevent cheating in the online environment. The results of this study reveal the positive impact that the use of proctoring software can have on reducing the opportunity to cheat thus assuring higher academic integrity in online courses.

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Instructor Leadership in Online Learning: Predictive Relationships Between Servant Leadership and the Community of Inquiry Framework

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Abstract
Instructor leadership is widely recognized as essential for facilitating meaningful online learning in higher education. While previous studies have applied organizational leadership theories to the study of instructor leadership, fewer studies have investigated online instructor leadership. This predictive correlational study detailed the associations between the Community of Inquiry (CoI) framework and servant leadership (SL) theory and employed multiple regression analyses to investigate the predictive relationships of seven SL dimensions on the three CoI presences. Survey data were gathered from 148 graduate students enrolled in online courses in education, communication, and engineering master's degree programs using the CoI Survey (Arbaugh et al., 2008) and the SL-28 (Liden et al., 2008). The findings revealed a significant positive correlation between the instruments. The predictive model as a whole explained 66% of the variance in students' perceptions of a CoI. Three SL predictor variables demonstrated the most influence: helping subordinates grow and succeed, conceptual skills, and creating value for the community. Additional analyses at the CoI subscale level revealed that the SL variables accounted for 73% of the variance in teaching presence, 55% of the variance in cognitive presence, and 31% of the variance in social presence. Implications and limitations are discussed and recommendations are proposed to implement online instructor SL.

Keywords: Community of inquiry, instructor leadership, servant leadership

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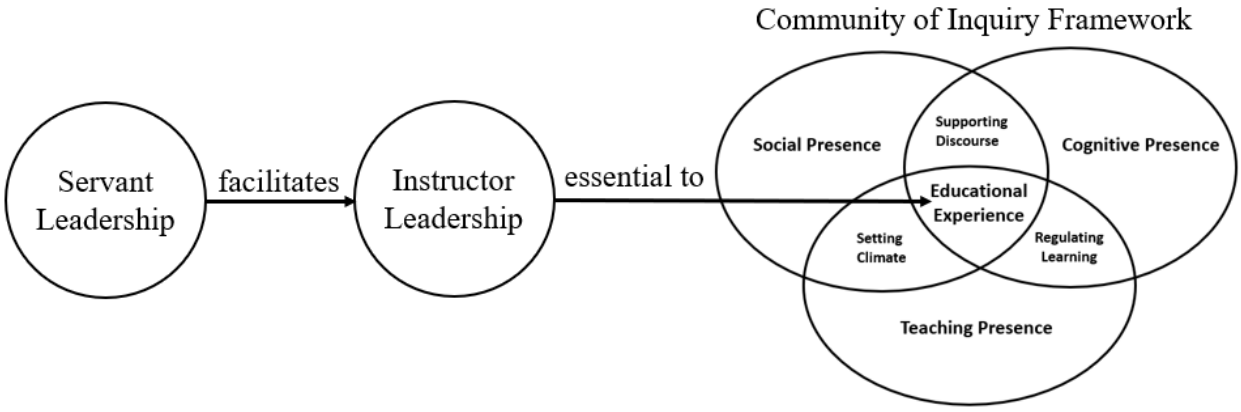
The Community of Inquiry (CoI) framework (Garrison et al., 2000) is the most referenced and empirically supported model for investigating higher education online learning (HEOL) (Valverde-Berrocoso et al., 2020). Since the framework's inception, instructor leadership has become recognized as crucial to meaningful online educational experiences (Alotebi et al., 2018; Garrison, 2017; Garrison & Cleveland-Innes, 2005; Szeto, 2015; Xin, 2012), yet there is a lack of clarity about what online instructor leadership entails (Szeto, 2015; Xin, 2012). This study proposes that organizational leadership theories can help elucidate the construct of online instructor leadership and offer insights relevant for the theory and practice of online instruction. Leadership theories have been conceptually and empirically aligned with positive outcomes in higher education teaching and learning (Balwant, 2016; Bolkan & Goodboy, 2009; Chory & McCroskey, 1999; Kondrasuk & Bernard, 2013; Noland & Richards, 2015, 2014; Pounder, 2009), but fewer studies have investigated such theories in the context of online learning (Alotebi, 2018).

Studies have investigated the characteristics and behaviors of effective online instructors (Arbaugh et al., 2010; Author, 2015; Sheridan & Kelly, 2010, Veseley et al., 2007), and while leadership has not been the focus of these studies, the proposed characteristics and behaviors align with values-based organizational leadership theories such as servant leadership (SL) (Liden et al., 2008; van Dierendonck, 2011; Winston & Fields, 2015; Yukl, 2013). Given the significance of instructor leadership within the CoI framework, this study seeks to investigate relationships between instructor SL and the CoI framework, specifically the degree to which students' perceptions of their instructors' SL behaviors in an online graduate-level course contributed to students' perceptions of a CoI. The results offer valuable insights for research and practice in online learning, as the dynamics of online instructor leadership remain under-investigated (Xin, 2012). Figure 1 shows the proposed relationships among the constructs.

Figure 1

Relationships Among Servant Leadership, Instructor Leadership, and The CoI Framework



Note. The Community of Inquiry Framework image is adapted from "E-Learning in the 21st Century: *A Community of Inquiry Framework for Research and Practice (3rd ed.)*," by D. R. Garrison, 2017, Routledge.

Literature Review

The following sections provide an overview of the Community of Inquiry (CoI) framework, instructor leadership, servant leadership (SL) theory and the instruments used in this study. The review highlights intersections among the constructs, supporting the rationale for this study.

Instructor Leadership and the Community of Inquiry Framework

The CoI framework was proposed by Garrison et al. (2000) as a process model for understanding critical elements of deep and meaningful educational experiences in higher education (HE) online settings (Garrison et al., 2010). Guided by a collaborative-constructivist perspective (Arbaugh et al., 2008), the authors defined three interrelated elements—cognitive presence (CP), social presence (SP), and teaching presence (TP)—which dynamically evolve as instructors and students actively participate in and share responsibility for the learning community (Garrison et al., 2010).

Cognitive Presence

Cognitive presence (CP) constructs meaning through sustained communication, achieved through four categories of experience: triggering event, exploration, integration, and resolution (Garrison et al., 2000). Participants in a CoI progress through the categories in a deliberate cycle of inquiry, with critical thinking as the desired outcome (Garrison et al., 2010). In subsequent studies analyzing discussion transcripts, however, Garrison et al. (2001) and others (e.g., Rourke & Kanuka, 2009) found learners often did not progress to advanced phases and thus recognized the importance of the instructor's teaching presence in achieving high levels of CP. In a study comparing students' cognitive engagement in four online graduate courses, Garrison and Cleveland-Innes (2005) specified instructor leadership as an essential component to facilitate CP: "Students must be provided structure and leadership to become engaged and responsible for approaching learning in a deep manner" (p. 144).

Social Presence

Social presence (SP) is "the ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by way of projecting their individual personalities" (Arbaugh et al., 2008, p. 134). Social presence consists of three indicators: emotional expression, open communication, and group cohesion (Garrison et al., 2000). An important role of the instructor is to facilitate a shared learning experience by modeling, encouraging, and practicing SP in an engaging, responsive, respectful, challenging, and supportive online environment (Garrison et al., 2000). Similarly, SL is founded on the expectation that leaders facilitate followers' development through processes of social exchange, in which leaders and followers provide reciprocal support and social learning, whereby leaders model and followers emulate key behaviors leading to increased trust, positive attitudes, and a mutually supportive environment (Eva et al., 2019; Winston & Fields, 2015). The social construction of knowledge at the core of the CoI framework (Arbaugh et al., 2008) and the association of SL with social learning theories support the connections between the constructs.

Teaching Presence

Teaching presence, proposed as the "binding element" (Garrison et al., 2000, p. 96) in a CoI, influences development of CP and SP to achieve intended educational outcomes. The dimensions of TP include design, facilitation, and direction of cognitive and social processes (Garrison et al., 2000). While leadership is not formally indicated as a construct, Garrison and Arbaugh (2007) stated interaction and discourse in a CoI require "structure (design) and leadership (facilitation and direction)" (p. 164), and a significant body of research supports close associations between TP and instructor leadership (Garrison, 2017; Garrison & Cleveland-Innes, 2005; Shea et al., 2010; Szeto, 2015; Xin, 2012; Zhang et al., 2022; Zhao & Sullivan, 2017). In fact, TP has been interpreted as "effective instructional leadership" (Szeto, 2015, p. 192). However, as Xin (2012) noted, while design, facilitation, and direction are important aspects of online instruction, "the core dynamics of online leadership requires further specification" (para. 39).

Servant Leadership Theory and Higher Education Instruction

Instructor Leadership

Leadership is a phenomenon that has defied singular definition. A common understanding, however, is that leadership is a process of intentional influence that guides, structures, and facilitates group interactions (Yukl, 2013). Balwant (2016), adapting Yukl's (2013) definition, defined instructor leadership as *"a process whereby instructors exert intentional influence over students to guide, structure, and facilitate activities and relationships"* [emphasis in original] (p. 21). Similarly, Garrison et al. (2000) described TP in a CoI as the instructor's influence over students' activity by proactively guiding interactions and managing structural concerns of the course while facilitating an educational transaction. Thus, the essential characteristics of leadership are evident in TP.

The past two decades of research in HE instructional practice has increasingly focused on instructor leadership (Balwant, 2016), conceptualizing the classroom as a "quasi-organization with the teacher as leader and students as followers" (Pounder, 2009, p. 318) and investigating leadership behaviors and student outcomes through the lens of organizational leadership theories (Noland & Richards, 2015). While organizational and educational contexts differ (e.g., degree of distance, relationship duration, and student consumerism) (Balwant, 2016), decades of research have affirmed the legitimacy of applying leadership theories to the study of HE settings (Baba & Ace, 1989; Chory & McCroskey, 1999; Dawson et al., 1972).

Servant Leadership Theory

According to van Dierendonck (2011), "leadership studies have clearly moved away from a strong focus on, most notably, transformational leadership toward a stronger emphasis on a shared, relational, and global perspective where especially the interaction between leader and follower are key elements" (p. 1229). More than any other leadership theory, SL emphasizes the needs and development of followers (van Dierendonck, 2011). Servant leadership is a values-based approach to leadership, originally conceptualized by Greenleaf (1970/2008), in which leaders prioritize the needs, goals, development, and well-being of followers, leading to outcomes such as increased engagement, satisfaction, and effective performance (Eva et al., 2019). Eva et al. (2019) defined SL as: "*an (1) other-oriented approach to leadership (2)*

manifested through one-on-one prioritizing of follower individual needs and interests, (3) and outward reorienting of their concern for self towards concern for others within the organization and the larger community" [emphasis in original] (p. 114).

In their systematic review of SL, Eva et al. (2019) evaluated 270 studies published between 2008 and 2018 and noted the theoretical frameworks employed in SL studies have primarily focused on social interaction theories such as social exchange theory, social learning theory, and social identity theory (Eva et al., 2019). Scholars have noted, for example, that the process of social exchange impacts followers' perceptions and actions: "Servant leadership is initiated by the behaviors of a leader; and is transmitted by followers reciprocating the leader behaviors" (Winston & Fields, 2015, p. 415). Such theoretical frameworks align with the collaborative-constructivist foundation of the CoI framework, with social construction of knowledge at its core. Thus, if instructor leadership is essential to meaningful educational experiences, and the CoI framework and SL behaviors can both be interpreted through social interaction theories, SL should be positively associated with cognitive, social, and teaching presences in a CoI.

Servant Leadership and Higher Education

Research has demonstrated conceptual and empirical connections between SL and HE learning environments. Buchen (1998), for example, noted instructor SL represents a "democratic circle of common inquiry" (p. 132) in which students and instructors are collaborators, resonant with Greenleaf's (1970/2008) concept of the leader as *primus inter pares*, or first among equals. This notion is consistent with the concept of all members of a CoI contributing to the core presences (Garrison et al., 2000), as SL acknowledges "in certain situations where the needs and the strengths required are different, someone else steps forth to become the first among equals…the knowledge base is shared not parceled out to insure control" (Buchen, 1998, pp. 132-133). Barbuto (2000) also offered a conceptual connection, explaining that leadership style should be aligned with leaders' and followers' developmental stages. The author's proposed pedagogical model identified SL as the most appropriate leadership theory to achieve higher-order learning outcomes. With the development of higher-order, critical thinking as the focal outcome in a CoI (Garrison et al., 2000), SL seems an appropriate model for instructor leadership in HEOL.

Studies have also offered empirical evidence supporting positive associations between instructor SL behaviors and student outcomes. In Drury's (2005) study, a sample of 87 undergraduate students associated higher levels of SL behaviors with their most effective professors. Noland and Richards (2015) surveyed 434 undergraduate students in an introductory communications course and found positive associations between instructor SL and students' learning and engagement. Finally, Sahawneh and Benuto (2018), in one of the few peer-reviewed studies of SL and online learning, reported a strong positive correlation between SL and student satisfaction among online community college students. In sum, given the substantial yet minimally investigated connections between SL and HEOL, this study offers valuable insights for the theory and practice of HEOL.

Relevance of Survey Instruments

The Community of Inquiry Survey

The CoI survey was developed to operationalize and investigate interrelationships among the three presences proposed in the CoI framework (Arbaugh et al., 2008). While more than 100 studies have supported its reliability and validity (Stenbom, 2018), others have suggested potential improvements (e.g., Arbaugh et al., 2008; Kozan & Richardson, 2014). Results of the initial study indicated the potential of a fourth presence, for example, and, although inconclusive, factor loadings demonstrated TP was perceived as two rather than three indicators: (a) design and organization, and (b) facilitation and direct instruction (Arbaugh et al., 2008). Importantly, Garrison and Arbaugh (2007) labeled facilitation and direction as instructor leadership, although the construct was not further elaborated upon (Szeto, 2015). Thus, instructor leadership may be a critical, yet under-investigated construct in the CoI framework.

The Servant Leadership SL-28 Scale

Many survey instruments have been developed to measure SL behaviors (Eva et al., 2019; van Dierendonck, 2011). Eva et al. (2019) evaluated 16 and recommended three, including Liden et al.'s (2008) long-form (SL-28) instrument. Eva et al. (2019) noted the instrument is particularly useful for "community-related outcome variables, or if the research model includes aspects of organizational or cognitive-based competencies" (p. 116). Given the CoI framework's focus on community and cognitive development, the authors deemed the SL-28 the most relevant measure of instructor SL in HEOL. The SL-28 is one of the most widely used measures in empirical studies of SL (Xu et al., 2020) and has previously been used in educational settings (e.g., Noland & Richards, 2015). Table 1 details the dimensions and definitions of Liden et al.'s (2008) SL model and the definitions adapted for HE.

Table 1

Liden et al.'s (2008) Dimensions of Servant Leadership Adapted to Higher Education

Servant Leadership Dimensions (Liden et al., 2008)	**Servant Leadership Definitions (Liden et al., 2008, p. 162)**	**SL Definitions Adapted to Higher Education (Noland & Richards, 2015, p. 17)**
Emotional healing	"The act of showing sensitivity to others' personal concerns."	"Expressing concern for student well-being and completeness and support during times of struggle."
Creating value for the community	"A conscious, genuine concern for helping the community."	Recognizing "the interdependence of the community and student."
Conceptual skills	"Possessing the knowledge of the organization and tasks at hand so as to be in a position to effectively support and assist others, especially immediate followers."	"Balancing classroom management, instruction, and vision tasks while assisting students in achieving success."
Empowering	"Encouraging and facilitating others, especially immediate followers, in identifying and solving problems, as well as determining when and how to complete work tasks."	"Validating the intrinsic value of the student and helping them generate personal power to succeed."

Helping subordinates grow and succeed	"Demonstrating genuine concern for others' career growth and development by providing support and mentoring."	Providing "opportunities for students to engage a personal challenge and develop as a result."
Putting subordinates first	"Using actions and words to make it clear to others (especially immediate followers) that satisfying their work needs is a priority."	"Emphasizing student development above all other goals and elevating student welfare above self."
Behaving ethically	"Interacting openly, fairly, and honestly with others."	"Embodying honesty and integrity in interactions and serving as a role model for students."

Summary and Research Questions

In summary, the review of relevant literature supports significant associations between the CoI framework and SL theory. Specifically:

- Developing high levels of critical thinking associated with CP requires instructor leadership.
- Instructor facilitation of SP aligns with social theories proposed as foundational to SL.
- There are significant associations between TP and instructor leadership.
- Research supports the application of organizational leadership theory to the HE context.
- SL is conceptually and empirically aligned with student outcomes associated with HEOL.
- Liden et al.'s (2008) SL survey is recommended for studies investigating community outcomes and cognitive competencies.

Given the significant alignments between SL theory and the CoI framework, the following research questions were proposed to guide this study. In an online graduate level course:

1. How do students' perceptions of their instructors' servant leadership behaviors correlate with students' perceptions of the Community of Inquiry dimensions?
2. To what extent do students' perceptions of each servant leadership subscale (emotional healing, creating value for the community, conceptual skills, empowering, helping subordinates grow and succeed, putting subordinates first, and behaving ethically) contribute to students' cumulative perceptions of a Community of Inquiry?
3. To what extent do students' perceptions of each servant leadership subscale contribute to students' perceptions of cognitive presence?
4. To what extent do students' perceptions of each servant leadership subscale contribute to students' perceptions of social presence?
5. To what extent do students' perceptions of each servant leadership subscale contribute to students' perceptions of teaching presence?

Methods

This quantitative study used a predictive correlational design to investigate potential relationships between students' perceptions of instructors' servant leadership (SL) and Community of Inquiry (CoI) in online graduate-level courses. Liden et al.'s (2008) SL-28 and its seven subscales were predictor variables, and the CoI Survey (Arbaugh et al., 2008) and its three subscales were criterion variables. The researchers employed four separate standard multiple

linear regression analyses to discover how each predictor variable contributed to students' perceptions of the CoI as a whole and to each subscale individually.

Context and Participants

Subjects were recruited from a large, midwestern university during the fall 2021 and spring 2022 academic terms. Following IRB approval, the researchers contacted administrators of online graduate degree programs in multiple colleges. Three college of education programs, one college of liberal arts program, and three college of engineering programs participated. All programs were designed with intensive eight-week-long courses, with students typically taking two successive courses each academic semester.

The program administrators emailed their respective students an invitation to participate in the survey, informing them of the expected duration (15-20 minutes). To encourage participation, students were invited to register for a random drawing for one of seven $70 gift cards. Of the 1,438 total students, 148 survey responses were submitted, resulting in a ten percent response rate. One incomplete response and six outliers were removed from the data set, resulting in a sample of 141 subjects, including 55 college of education, 38 liberal arts, and 48 engineering students. Most subjects were white (79%), female (70%) and between the ages of 25 and 34 (60%). The survey asked respondents to think of the instructor in one online course they are currently taking as they responded to the survey questions. Subjects identified an equal representation of male (49%) and female (49%) instructors. Subjects had a mix of experiences with online courses, with 33% having completed one to four, 30.5% five to eight, and 35.5% nine or more courses.

Instruments

The SL-28 (Liden et al., 2008) is a 28-item survey that measures seven subscales of servant leadership on a seven-point scale (1 = strongly disagree to 7 = strongly agree). Confirmatory factor analysis supported the validity of the scale, and hierarchical linear modeling demonstrated its ability to explain variance beyond other leadership theories. The researchers received permission from Dr. Robert C. Liden to use a modified version of the survey, which included slight wording variations to conform to the educational setting (e.g., "instructor" in place of "manager").

The CoI Survey (Arbaugh et al., 2008) consists of 34 items that measure three subscales of an online educational experience on a five-point scale (1 = strongly disagree to 5 = strongly agree). Principal component analysis supported the reliability of the three-factor model. Internal consistency was also supported at .94 for TP, .91 for SP, and .95 for CP (Arbaugh et al., 2008).

The two instruments were combined into one survey, with a separate section for each. Participants were also asked demographic and informational questions. While this resulted in a relatively long survey (70 questions), the questions were straightforward, and the separate sections provided a logical break to lessen the potential of survey fatigue.

Data Analysis

The SL-28 and the CoI Survey were developed with different response scales (seven point and five point, respectively). To maintain reliability and validity of the original instruments, each section of the survey used the original scales. However, to analyze survey responses, while not reducing the discrimination of the SL-28 seven-point scale, response data from the CoI survey were converted from a five-point to a seven-point scale using linear interpolation (IBM SPSS Statistics, 2020).

Given the absence of published studies investigating the correlation between SL and the COI framework, the researchers were unable to determine an *a priori* estimate of the association between the constructs to determine the necessary sample size. Thus, G*Power (Faul et al., 2009) was used to conduct a post hoc analysis of achieved power. The positive, strong correlation between the mean SL-28 and COI ratings ($r(138) = .79$, $p < .001$) indicates a shared variance 62%. G*Power results indicated that the study sample size of 141 participants resulted in 93% power ($\alpha = .001$, two-tailed). Therefore, the sample size was deemed sufficient for the analysis.

The data met assumptions of multiple linear regression (Hair, Jr. et al., 2010), including acceptable tolerance levels (> .20) and VIF values (< 5.0), assumptions of independent errors (TP Durbin-Watson value = 2.14; SP Durbin-Watson value = 1.97; CP Durbin-Watson value = 2.09), approximately normally distributed errors, homogeneity of variance and linearity, and non-zero variances and standard residuals (< 3.0). The researchers identified six outliers using univariate and bivariate observations and Mahalanobis distance (D^2, $p < .001$). Data were analyzed using descriptive statistics, Pearson bivariate correlation, and standard multiple linear regression.

Results

Descriptive Statistics

Participant ratings were averaged for the SL-28 and CoI subscales, following standard practice for each instrument. Cronbach's alpha reliability coefficient was .96 for the CoI survey and .96 for the SL-28, indicating internal consistency among each survey's items and reliability of each survey in measuring CoI and SL, respectively. Internal consistency among each of the SL-28 subscales was primarily above alpha level .80, with the exception of the empowering subscale ($\alpha = .60$). However, each subscale consists of only four items, Cronbach's alpha has a positive relationship to the number of items in a scale, and decreased values are acceptable in exploratory studies (Hair, Jr. et al., 2010). Given these conditions, the researchers deemed .60 as an acceptable alpha level. Each of the CoI subscales demonstrated excellent internal consistency with alpha levels above .90.

Research Question One

Research question one asked: How do students' perceptions of their instructors' servant leadership behaviors correlate with students' perceptions of a Community of Inquiry? The correlation between the composite means of respondents' ratings of the SL-28 ($M = 5.17$, $SD = .93$) and the CoI Survey ($M = 5.56$, $SD = .88$) was strong and significant, $r(138) = .79$, $p < .001$. Table 2 presents descriptive statistics and Pearson correlations among the subscales of each instrument. While correlations were significant across all SL-28 and CoI Survey subscales, the strength of correlations varied, with TP demonstrating moderate to strong, CP demonstrating moderate, and SP demonstrating weak to moderate correlations.

Table 2

Means, Standard Deviations, and Correlations Among SL-28 and CoI Survey Subscales

Variable (*n* = 141)	Mean (SD)	1	2	3	4	5	6	7	8	9	10
EH (1)	4.29 (1.42)	–									
CVC (2)	4.70 (1.08)	.78***	–								
CS (3)	5.55 (1.13)	.62***	.61***	–							
EMP (4)	5.43 (.92)	.47***	.50***	.61***	–						
HSGS (5)	5.44 (1.13)	.75***	.71***	.74***	.55***	–					
PSF (6)	4.90 (1.20)	.74***	.73***	.67***	.56***	.81***	–				
EB (7)	5.86 (.88)	.63***	.67***	.66***	.50***	.76***	.70***	–			
TP (8)	5.67 (1.04)	.63***	.65***	.76***	.53***	.82***	.73***	.68***	–		
SP (9)	5.25 (1.09)	.52***	.49***	.36***	.31***	.49***	.44***	.37***	.51***	–	
CP (10)	5.67 (.91)	.52***	.60***	.69***	.46***	.66***	.57***	.58***	.80***	.60***	–

****p <.001*

Abbreviations: EH, emotional healing; CVC, creating value for the community; CS, conceptual skills; EMP, empowering; HSGS, helping subordinates grow and succeed; PSF, putting subordinates first; EB, ethical behavior; TP, teaching presence; SP, social presence; CP, cognitive presence.

Research Question Two

The second research question asked: To what extent do students' perceptions of each of the servant leadership subscales contribute to students' perceptions of a Community of Inquiry? The researchers used standard multiple linear regression modeling to investigate effects of the predictor variables (SL-28 subscales) on subjects' cumulative CoI ratings. The multiple regression coefficient model indicates the average change in the criterion variable given a one unit increase in the predictor variable (Hair, Jr., et al., 2010) and in this study is expressed as: CoI′ = 1.758 – .006 (EH) + .163 (CVC) + .213 (CS) + .006 (EMP) + .318 (HSGS) + .021 (PSF) + .003 (EB), where CoI = community of inquiry, EH = emotional healing, CVC = creating value for the community, CS = conceptual skills, EMP = empowering, HSGS = helping subordinates grow and succeed, PSF = putting subordinates first, and EB = ethical behavior.

In this model, the three most influential predictor variables were HSGS, CS, and CVC, which indicated a one unit increase in the predictor variable would result in an increase of .318 (HSGS), .213 (CS), and .163 (CVC) in subjects' CoI ratings. The prediction model was statistically significant, $F(7, 133) = 36.56$, $p < .001$, $R^2 = .66$ and explained 66% of the variance in students' perceptions of a CoI (Table 3).

Table 3

Regression Coefficients for Predicting CoI Presences in Select Online Graduate Level Courses

Variable	B	95% CI	β	t	p
Constant	1.758	[1.067, 2.449]		5.03	<.001
EH	-.006	[-.119, .106]	-.010	-.11	.912
CVC	.163	[.018, .308]	.199	2.22	.028
CS	.213	[.084, .341]	.271	3.27	.001
EMP	.006	[-.121, .132]	.006	.09	.928
HSGS	.318	[.150, .486]	.406	3.75	<.001
PSF	.021	[-.120, .161]	.028	.30	.769
EB	.003	[-.162, .169]	.003	.04	.968

Note. R^2_{adj} = .64 (N = 140, p < .001). CI = confidence interval for B.
Abbreviations: EH, emotional healing; CVC, creating value for the community; CS, conceptual skills; EMP, empowering; HSGS, helping subordinates grow and succeed; PSF, putting subordinates first; EB, ethical behavior; TP, teaching presence; SP, social presence; CP, cognitive presence.

Research Questions Three, Four, and Five

The final three research questions asked: To what extent do students' perceptions of each of the servant leadership subscales contribute to students' perceptions of (a) cognitive presence, (b) social presence, and (c) teaching presence? To understand how each of the predictor variables influenced the CoI subscales, the researchers ran three additional multiple regression tests.

All regression models were significant but showed differences in which predictor variables influenced each of the CoI subscales. The overall regression model for CP was significant, F (7, 133) = 23.22, $p < .001$, $R^2 = .55$. Taken as a set, the SL predictors accounted for 55% of the variance in CP. Three individual SL-28 dimensions in the model were significant positive predictors of students' perceptions of CP: conceptual skills ($t = 4.45$, $p < .001$), creating value for the community ($t = 2.43$, $p = .017$), and helping subordinates grow and succeed ($t = 2.22$, $p = .028$).

The overall regression model for SP was also significant, F (7, 133) = 8.45, $p < .001$, $R^2 = .31$. Taken as a set, the SL predictors accounted for 31% of the variance in SP. One individual SL-28 dimension in the model was a significant positive predictor of students' perceptions of SP: emotional healing ($t = 1.99$, $p = .049$).

Finally, the overall regression model for TP was significant, F (7, 133) = 51.42, $p < .001$, $R^2 = .73$. Taken as a set, the SL predictors accounted for 73% of the variance in TP. Two individual SL-28 dimensions were significant positive predictors of students' perceptions of TP: conceptual skills ($t = 4.16$, $p < .001$) and helping subordinates grow and succeed ($t = 4.98$, $p < .001$).

Discussion

This study detailed significant conceptual and empirical connections among the Community of Inquiry (CoI) framework (Garrison et al., 2000), instructor leadership, leadership theory, and higher education online learning (HEOL). Among leadership theories, servant

leadership (SL) is particularly relevant to HEOL. Specifically, the dimensions of Liden et al.'s (2008) SL theory are markedly aligned with the CoI framework.

The purpose of the study was to investigate relationships between Liden et al.'s (2008) seven dimensions of SL, the CoI framework as a whole, and its three dimensions individually. Understanding the relationships contributes to understanding the under-investigated construct of instructor leadership in higher education online learning (Xin, 2012), the relationships between SL and the CoI framework, and what instructor SL behaviors are most impactful for achieving the meaningful educational outcomes associated with a CoI in HEOL. The final section of the discussion includes practical guidance for instructors interested in implementing SL in their online courses.

Positive Relationships Between Servant Leadership and the Community of Inquiry

The first research question investigated the relationship between students' perceptions of their instructor's SL and their perceptions of a CoI. Results revealed a significant and positive correlation between the CoI Survey (Arbaugh et al., 2008) and the SL-28 (Liden et al., 2008). This finding offers empirical data to support the contention that instructor leadership is essential to a CoI (Alotebi et al., 2018; Garrison, 2017; Garrison & Cleveland-Innes, 2005; Szeto, 2015; Xin, 2012) and affirms that SL is applicable to the study of instructor leadership in the context of HEOL.

Relationships at the subscale level provided additional insights. All seven SL subscales showed significant correlations with each of the CoI subscales but with varying strengths—moderate to strong with TP, moderate with CP, and weak to moderate with SP. The strongest association with TP is consistent with Garrison et al.'s (2000) seminal CoI work that proposed TP as the binding element of the educational experience and the significant body of research that has closely associated TP with instructor leadership behaviors (Garrison, 2017; Garrison & Cleveland-Innes, 2005; Shea et al., 2010; Szeto, 2015; Xin, 2012; Zhang et al., 2022; Zhao & Sullivan, 2017). The weak to moderate association between SP and SL was a surprising finding, given the alignment of both constructs with social theories. One explanation may be that social influences in organizational settings develop over long-term, physically-present relationships, and these influences are harder to distinguish in a short-term, online educational setting with physical and psychological distance (Balwant, 2016). Thus, in practice, instructors may need to focus more intentionally on the quality of interactions to facilitate optimal leadership presence (Garrison & Cleveland-Innes, 2005).

Servant Leadership Variables' Influence on Perceptions of a Community of Inquiry

Research question two investigated how each SL dimension contributed to students' cumulative perceptions of a CoI. The regression model revealed three predictor variables had the most influence: (1) helping subordinates grow and succeed, (2) conceptual skills, and (3) creating value for the community. Thus, the higher participants' sense of these three SL dimensions, the higher their sense of a CoI. This finding is not surprising, as together these three dimensions can be interpreted as the core tasks of an instructor in a CoI: An instructor must balance course and pedagogical elements (conceptual skills) to facilitate students' development (helping subordinates grow and succeed) within a collaborative learning community (creating

value for the community). These three dimensions may be conceived of as *functional dimensions of instructor SL* that are expected outcomes of the teaching and learning process in a CoI.

The dimensions that had weaker influence (emotional healing, empowering, ethical behavior, and putting subordinates first) may be related to the recognition that leadership in an instructional setting differs from leadership in an organizational setting (Balwant, 2016). Emotional healing, empowering, ethical behavior, and putting subordinates first could reasonably be viewed as *relational dimensions of instructor SL* that develop over time and, without concerted effort, may not easily be perceived in an eight-week, online course. The distance, duration, and temporary nature of instructor-student relationships are different from leader-follower relationships in many organizational settings (Balwant, 2016). This study provides some clarity to Balwant's (2016) contention that "leader behaviors that necessitate a long-term relationship are not likely to be applicable to a HEI [higher education institution] course context" (p. 23). While the relational dimensions of instructor SL were not the most influential relative to a CoI, each dimension demonstrated significant, positive correlations with the individual CoI elements. Thus, an instructor may choose to focus on the most influential SL dimensions for functional impact, but using behaviors across all dimensions may strengthen the relational nature of instructor-student interactions and enhance meaningful educational experiences in a CoI.

Conceptualizing the SL dimensions in this study's regression model as functional and relational also leads to an intriguing question: Are the results representative of SL, or could they be explained by other leadership models? Significant research has established the relevance of transformational leadership to HE teaching (Balwant, 2016; Bolkan & Goodboy, 2009; Kondrasuk & Bernard, 2013; Noland & Richards, 2014; Pounder, 2009). However, functional leadership and relational leadership are two other perspectives of leadership also worthy of consideration. Briefly, functional leadership involves the integration of task, team, and individual in achieving desired outcomes (Adair, 2009), while relational leadership focuses on "*the relational dynamics of leading and organizing* [emphasis in original]" (Uhl-Bien, 2006, p. 667). Investigating other leadership theories may offer additional insights to help facilitate the theory and practice of online instructor leadership.

Finally, the weaker influences of SL relational dimensions may be a function of the study design, as the sample included a mix of disciplines—education, liberal arts, and engineering. Much research in online learning has focused on participants' perceptions absent considerations of course content effects (Arbaugh et al., 2010). Richardson et al. (2012), for example, noted the dynamics of online learning may be discipline specific. In their study, the researchers concluded hard disciplines, such as engineering, focused on the design and presentation of content and less on application, which led to lower perceptions of social and cognitive presences, while perceptions of teaching presence remained consistent across disciplines. While this study did not evaluate discipline-specific results, 34% of participants were engineering students, thus this may have reduced overall perceptions of SP and CP, yet had little impact on TP. While a full review of the impact of different leadership theories and discipline-specific influences is beyond the scope of this paper, given the results of this study, these considerations may offer alternative perspectives relative to instructor leadership in a CoI.

Servant Leadership Dimensions That Predict Community of Inquiry Subscales

Research questions three, four, and five investigated the relative importance of the predictor variables (SL dimensions) to each of the criterion variables (CoI dimensions). This level of analysis provided a different perspective, as it investigated the extent to which SL dimensions predicted each of the CoI dimensions individually, rather than the CoI as a whole. Results demonstrated SL dimensions had the most influence on teaching presence (TP), with the SL predictors accounting for more than 73% of the variance in TP. Two dimensions of SL were significant positive predictors of TP—conceptual skills and helping followers grow and succeed. Conceptual skills involve the leader's knowledge of the organization and tasks needed to provide followers with effective assistance, while helping them grow and succeed involves providing followers with support and mentoring (Liden et al., 2008). These results resonate with the proposition of a two-factor model of TP, including design and organization and facilitation and direct instruction (Arbaugh et al., 2008). A servant leader's conceptual skills may align with the course design and organization, while ways in which the instructor helps learners grow and succeed may be related to the pedagogical elements of facilitation and direct instruction as the course progresses.

The SL dimensions had a substantial impact on CP as well, with the SL predictors accounting for 55% of the variance in CP. The two SL dimensions that were significant positive predictors for TP (conceptual skills and helping subordinates grow and succeed) were also significant positive predictors for CP. CoI research has conceptualized TP as necessary to achieve the critical thinking central to CP (Garrison et al., 2010; Garrison & Arbaugh, 2007). Thus, the two shared SL dimensions may represent an instructor's leadership in regulating learning, which lies at the intersection between TP and CP (Garrison, 2017).

A third SL dimension, creating value for the community, was also a significant positive predictor of and uniquely associated with CP. Questions from the SL-28 relative to this dimension are related to the instructor helping others and encouraging students to do the same (Liden et al., 2008). Others have also noted the importance of servant leaders developing helping behaviors among followers (Parris & Peachey, 2013). In a CoI, students are likely to interpret helping behaviors relative to their learning needs. For example, Xu et al. (2013) noted in collaborative online learning, an important role of the instructor is to promote a culture of help seeking, which can positively influence learning, engagement, and achievement. These ideas are in line with Noland and Richards's (2015) emphasis on interdependence as the predominant way in which servant teachers create value for the community.

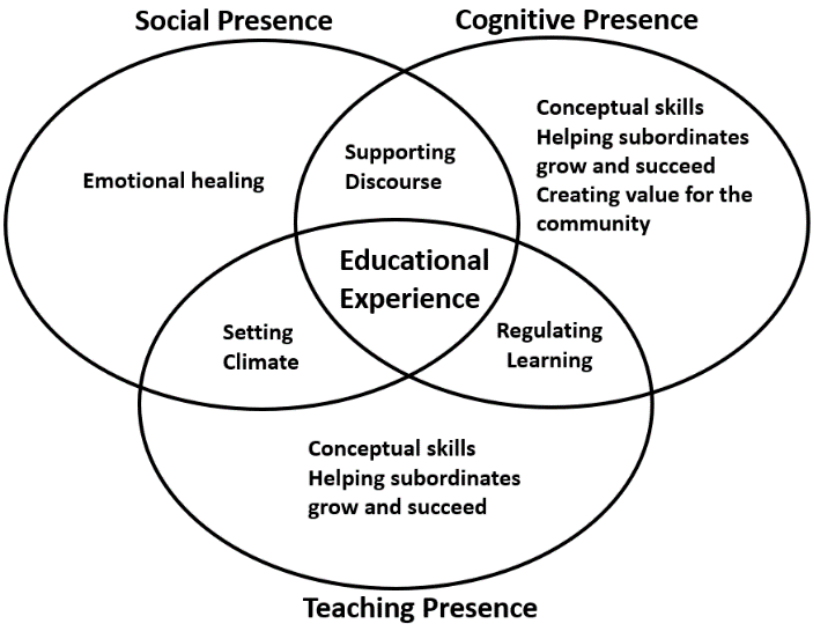
The final regression model indicated SL predictors accounted for 31% of the variance in SP. While only one SL dimension, emotional healing, was a positive predictor for SP, the definition of the dimension is conceptually relevant as it involves sensitivity to followers' personal concerns (Liden at al., 2008). This finding is consistent with research into effective behaviors of online instructors, including responsiveness to students' needs (Arbaugh et al., 2010; Sheridan & Kelly, 2010) and demonstrating empathy (Sheridan & Kelly, 2010).

While the regression model using participants' cumulative CoI perceptions as the criterion variable revealed three influential SL dimensions (helping subordinates grow and succeed, conceptual skills, and creating value for the community), using the CoI presences as

individual criterion variables helped surface the presences upon which the SL dimensions have the most influence. The analyses also revealed that emotional healing, while not influential in the overall regression model, had substantial influence on SP. Figure 2 shows the instructor SL dimensions that had significant impact within the context of the CoI framework.

Figure 2

Dimensions of Servant Leadership That Contribute to a Community of Inquiry



Recommended Instructor Servant Leadership Behaviors

Given the significant, positive relationships among SL dimensions and the CoI presences and the substantial influences of the SL dimensions on CP, SP and TP, instructors may benefit from recommendations for applying SL in a HEOL setting. Table 4 recommends instructor SL behaviors aligned with Liden et al.'s (2008) seven SL dimensions and effective online instructor behaviors.

Table 4

Dimensions of Servant Leadership Aligned With Instructor Behaviors in Online Learning

Servant Leadership Dimensions (Liden et al., 2008)	Instructor Servant Leadership Behaviors	Instructor Behaviors in Online Learning
Emotional healing	• Actively listen to students' needs.[a] • Provide input to help students resolve problems.[b]	• Demonstrate empathy.[d] • Elicit shared personal viewpoints and experiences.[e]
Creating value for the community	• Address the social importance of individuals' group contributions.[b] • Encourage interdependence.[c]	• Demonstrate active involvement in discourse.[f]

		• Promote student engagement and participation.[f] • Create a rich setting for collaboration.[e]
Conceptual skills	• Integrate students' learning within academic and social contexts.[b] • Demonstrate a multidimensional perspective regarding causes and consequences of problems.[a] • Scaffold learning and create conditions to help benefit learners' work, life, and the broader community.[b]	• Model behaviors and interactions.[e] • Summarize ideas and offer alternative perspectives.[f] • Provide scaffolding to help students make sense of course and field concepts.[f]
Empowering	• Encourage students to believe they can and will achieve their goals.[b] • Involve students as co-creators of knowledge.[a] • Inspire students to dream big dreams.[b]	• Empower students to take ownership.[f] • Provide time for discussion and interaction.[e] • Encourage student success beyond the course.[f]
Helping subordinates grow and succeed	• Encourage students to ask questions without fear of judgement.[b] • Identify and utilize teachable moments.[b] • Offer opportunities for students' self-evaluation and reflection.[a]	• Provide direction to ideas and prompts to encourage critical thinking.[f] • Share helpful resources.[f] • Support, model, and clarify.[e, f]
Putting subordinates first	• Align your success with students' success.[b] • Alter pedagogical approaches to meet students' needs.[c] • Model flexibility to accommodate students' schedules.[a]	• Elicit feedback from students.[f] • Be responsive to students' needs.[d] • Be willing and available to support students as needed.[f]
Behaving ethically	• Demonstrate personal values of benevolence, integrity, and competency.[a] • Consider how actions and words impact others and encourage students to do the same.[a] • Explain course policies and procedures to help students understand their importance to the learning community.[a]	• Create an appropriate climate.[f] • Provide students with honest feedback.[e] • Follow through with promises made to students.[d]

Note. [a]Kondrasuk and Bernard (2013); [b]Setliff (2014); [c]Noland and Richards (2015); [d]Sheridan and Kelly (2010); [e]Vesely et al. (2007); [f]Richardson et al., (2015)

Limitations and Future Research

This study investigated relationships between the Community of Inquiry (CoI) framework and servant leadership (SL) theory with a sample of 141 graduate students in one institutions' eight-week, online courses across multiple disciplines. Results may not be generalizable to different populations, including other educational levels, course formats and durations, disciplines, and geographies. Research studies using different populations are needed to examine differences in outcomes to develop deeper understandings of the associations found in this study. While the sample size for this study was deemed sufficient for the research methodology, studies using larger sample sizes would also help confirm the results.

The instrument used in the study combined two separate instruments into one survey, resulting in a 70-item scale. While the researchers took steps to maximize participation and minimize survey fatigue, data quality due to survey fatigue is always possible with longer surveys, although with potentially small effect sizes (Galesic & Bosnjak, 2009). In addition, this study defined SL relationships using one instrument, Liden et al.'s (2008) SL-28. Servant leadership is an evolving theory and many dimensions and instruments have been proposed to measure the construct. Using different instruments with different dimensions may offer additional insights into the relationships between SL and the CoI framework. Results also indicated the possibility that other leadership theories may explain instructor leadership in a CoI. Researchers are encouraged to apply different leadership theories to the study of instructor leadership in a CoI to help advance the understanding of this under-researched concept. Such investigations can help develop research and practice in online learning, resulting in evidence-based pedagogical practices to facilitate the meaningful educational experiences at the core of a CoI. Finally, while literature supports conceptual and empirical alignments between the two constructs, investigating social interaction theories may offer theoretical insights into associations between the constructs.

Conclusion

Instructor leadership is recognized as an essential element of a CoI. In the past two decades, researchers have shown increasing interest in SL (Eva et al., 2019), instructor leadership (Balwant, 2016), and instructor behaviors in HEOL (Author, 2015; Sheridan & Kelly, 2010; Vesely et al., 2007). While previous studies investigating effective online instructor behaviors have not done so through the lens of servant leadership theory, the resultant behaviors are aligned with those of a servant leader (Author, 2015; Sheridan & Kelly, 2010; Vesely et al., 2007). This study provides a refined lens through which to consider what the role of an instructor is and can be in online learning.

Instructor leadership in a CoI is most often associated with teaching presence (TP) (Garrison, 2017; Garrison & Cleveland-Innes, 2005; Shea et al., 2010; Szeto, 2015; Xin, 2012; Zhang et al., 2022; Zhao & Sullivan, 2017), but the intersection of TP with social presence (SP) and cognitive presence (CP) indicates instructor leadership should influence those elements as well. This study demonstrated alignment between SL and the CoI framework and offered new insights, demonstrating that instructor leadership, interpreted through the lens of SL, can be observed across TP, CP, and SP. The results are significant, as extant literature does not offer clarity about the dimensions of and operationalization of instructor leadership in a CoI (Szeto, 2015; Xin, 2018), and little guidance exists regarding the practical applications of SL dimensions

(Coetzer et al., 2017). The results of this study help answer Xin's (2012) call for further specification of the core dynamics of online leadership, offering evidence that SL is a valid theoretical framework worthy of future investigation and detailing specific instructor SL behaviors that may have a positive impact on the meaningful educational experience at the core of a CoI in HEOL.

Declarations

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

The authors assert that approval was obtained from an ethics review board (IRB) at Purdue University.

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What It Takes to Teach in a Fully Online Learning Environment: Provisional Views from a Developing Country

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Abstract
The present study was undertaken to obtain a clearer picture of teachers' online instructional delivery and identify difficulties that might require intervention. Specifically, the following research questions are addressed: (1) What are teachers' practices to promote learning in a fully online learning space? (2) What challenges do teachers experience during the fully online learning sessions? This study involved interviews with 17 teachers from nine higher education institutions in the Philippines, a developing country. Using a descriptive case approach, results indicated that teachers promoted flexibility and interaction, facilitated learning processes, and fostered an affective learning climate as much as they could. While most teachers practice flexibility, the data also showed some rigidity in their practices. Findings also suggested the critical role of technology in facilitating learning processes and stimulating class interactions. However, these teachers faced several challenges related to technological sufficiency, learner-related factors, teaching delivery and assessment, technological complexity, and self-regulation, among others. Their varying experiences were linked to unique contexts brought about by several factors, namely available tools, institutional policies, pedagogical goals, and learner-related factors. Implications for classroom practices, policy making, teacher training, and future research are discussed.

Keywords: Online learning, higher education, education technology, teaching practices, teacher agency

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Teachers and their teaching approaches play a critical role in the success of the online and blended learning. Prior to the COVID-19 pandemic, research suggested that teachers in the online and blended space encountered a variety of teaching challenges, including dealing with unfamiliar technology, incorporating flexibility, stimulating interaction, facilitating students' learning processes, and fostering an affective learning climate (Boelens et al., 2017; Rasheed et al., 2020). Much of this research focused on colleges and universities in the U.S. or other high-resource countries with robust technological and educational infrastructures. Unlike highly developed areas, low-resource contexts confront unique concerns about availability of learning materials, internet connectivity, content development, and learning technologies (Andersson, 2008; Barteit et al., 2020). Such is the case in the Philippines where poor internet connectivity and a lack of technological resources prevent some teachers from implementing synchronous online learning activities and providing real-time feedback (Barrot & Fernando, 2023). Another major stumbling block to successful online learning and teaching in low-resource contexts is acquiring, maintaining, and sustaining technological resources. These challenges lead to poorly equipped traditional or virtual classrooms (Aung & Khaing, 2015).

Recently, educational systems across the globe faced a health crisis which forced them to shift to online learning across the full spectrum of educational levels. In the case of the Philippines, all higher education institutions shifted to emergency remote teaching during the pandemic. Such a transition demands recalibrated policies, protocols, and curricula, upskilling of technical staff, and acquisition of new systems and infrastructures (Donitsa-Schmidt & Ramot, 2020). This circumstance is unique as the pandemic could aggravate the challenges that teachers experienced during online learning due to restrictions in mobility and health protocols (Kapasia et al., 2020). Given today's uncertainties, it is vital to gain a nuanced understanding of teaching practices in an online learning environment.

Situated within the context of a developing country, the current study explores college teachers' experiences navigating fully online learning space across various subject areas. In addition, this study examines how their experiences varied and what factors may explain these differences. Specifically, the following research questions are addressed: (1) What are teachers' practices to promote learning in a fully online learning space? (2) What challenges do teachers experience during the fully online learning sessions?

Literature Review

Factors That Shape Online Learning

The success of an online learning environment has been attributed to several factors at three levels within higher education: institutional (orientation, infrastructure, policies, and protocols), instructor (content knowledge, pedagogical skills, and technical skills), and student (behaviour, psychosocial state, proficiency, aptitude, and motivation) (Barrot et al., 2021; Muljana & Luo, 2019). Institutional factors are considered essential factors in the success of online learning. As several studies have shown, student support and orientation (Aversa & MacCall, 2013), technological support (Parkes et al., 2015), and resource sharing (Shaw et al., 2016) affected students' online learning experience. The influence of institutional factors became evident when educational institutions across the globe were compelled to migrate to fully online learning because of the threats of COVID-19. Schools adopted learning technologies and

infrastructures, trained teachers and staff for a shift to online learning, and established emergency teaching protocols (Donitsa-Schmidt & Ramot, 2020).

At the student level, several student-related factors have been reported to shape online learning. These include behavioural characteristics, demographic variables, and other personal variables (Muljana & Luo, 2019). Some studies have shown that self-efficacy, self-determination, time management, and metacognition contributed to sustaining student retention and academic achievement (Gomez, 2013; Lee et al., 2013). In the same way, age, academic standing, and gender may also influence student performance in an online learning space. For instance, Xu and Jaggars (2013) found that males, younger students, and students with lower academic performance struggled more than others in adapting to online courses. Cochran et al. (2014) echoed the same findings within the context of predicting retention in online courses. However, they found that males were more likely to withdraw than females only in certain cases.

Finally at the instructor level, this alternative learning space provides valuable opportunities for efficient teaching and learning and offers teachers a variety of technologies to expand their teaching repertoire, such as online-based assessment and interactive learning activities (Barrot & Acomular, 2022; Price & Kirkwood, 2014). Online learning technologies may enable teachers to be more self-reflective about their current practices, improve their digital competencies, and better understand 21st century learners or digital natives (Barrot & Acomular, 2022; Turugare & Rudhumbu, 2020). Singh and Thurman (2019) also reported four pedagogical functions that teachers perform within an online learning environment: creating the learning process, concretizing students' ideas, supporting students in developing their conceptual understanding, and structuring and summarizing students' understanding of certain concepts. Moreover, Moorhouse and Wong (2021) found that teachers' pedagogical and technological development passed through three phases in an online teaching environment: the reactive phase (teachers not recognising the need to engage in active online teaching), the experimentation phase (teachers proactively exploring online teaching approaches), and the stabilisation phase (teachers experimenting with different approaches and technologies and engaging in professional development activities). However, one issue that teachers confront is how to make the most of the available online platforms and tools due to technological insufficiency and complexity, which demand a different set of skills (Rasheed et al., 2020). Developing the necessary skills to navigate an online learning space is critical to help manage the pedagogical and cognitive burden faced by teachers during online instructional delivery (Borup & Evmenova, 2018; Comas-Quinn, 2011). As highlighted by Brinkley-Etzkorn (2018), teachers need to be well trained in navigating technologies and integrating their acquired skills into their pedagogical system. Despite efforts to help teachers navigate technology effectively, its integration remains to be a challenge because of a one-size-fits-all approach to staff development (Comas-Quinn, 2011; Turugare & Rudhumbu, 2020).

Teaching Challenges in a Fully Online Learning Context

Although several studies have been undertaken regarding teaching challenges within a blended learning environment (e.g., Boelens et al., 2017; Martin et al., 2020; Rasheed et al., 2020), less attention has been paid to the challenges college teachers experience in a fully online learning context. One such study was by Comas-Quinn (2011), who investigated the impact of online teaching on teachers in a university in the U.S. The mixed-methods study found that

teachers' poor understanding of the tools and their pedagogical affordances, as well as the magnitude of adjustment that teachers needed to make in a short span of time, contributed to their challenges and negative attitude towards the online teaching environment. Teachers also reported that online social interaction and communication had less value than face-to-face interaction in terms of language learning. Finally, teachers did not gain sufficient opportunities to deepen their understanding of the tools and their pedagogical affordances despite the several trainings conducted. Similarly, Sword (2012) identified key challenges that nursing teachers in the U.S. experienced as they transitioned to online teaching. These include doubling workload, inefficacy of traditional teaching strategies, loss of personal connection with students, lack of resources, and adaptability issues. To address these concerns, the study recommended some possible solutions, such as teacher training, faculty involvement in policy making, orientation, and workload reduction. Similarly, Wingo et al. (2016) examined the benefits and challenges of teaching online using a multiple case study approach at three U.S. schools of nursing. They found that the challenges that teachers experienced during online teaching revolved around appropriate teaching strategies, instructors' availability, training and support, and institutional challenges. Additionally, they found some gaps in the perspectives among the teachers, which suggest communication issues. A parallel study was undertaken by Gil-Jaurena and Domínguez (2018) to determine the changes and challenges that teachers faced within a digital and open online environment at a university in Spain. Their findings indicated that teachers view this learning environment as innovative in terms of peer assessment, gamification, video lecturing, and peer support. However, they also reported that it reduced teacher presence and interaction with learners and hindered personalised attention to each learner. To expand the coverage of previous studies, Sithole et al. (2019) surveyed 17 teachers from five U.S. universities about the challenges they faced during fully online teaching delivery. Four key challenges emerged from this survey study: large class size in online courses, academic dishonesty (e.g., plagiarism, exam leakage, and cheating during exams), technical problems, and lack of connection with students.

More recently, studies on online teaching challenges have emerged as COVID-19 forced educational institutions to shift to fully online learning delivery. Among these is Varea and González-Calvo (2021), who examined the practices of 12 pre-service physical education (PE) teachers in Spain who were forced to shift to online instructional mode. Using multimodal data from interviews and participant-produced drawings, results indicated that PE teachers felt that PE courses lost their identity due to lack of physical contact with students and inability to employ cooperative and group activities. At a personal level, teachers reported some feelings of sadness, uncertainty, and lack of freedom because of the pandemic. Beyond PE courses, González et al. (2023) interviewed 151 teachers across eight Chilean colleges and universities about their experiences of online teaching during the pandemic. Using a qualitative hybrid thematic analysis approach, the study revealed that teachers who perceived themselves as having poor digital skills faced greater online teaching challenges. Teachers also reported a variety of internet connectivity problems and low student engagement, and they employed various strategies to overcome them, such as an empathic disposition, upgrading their digital skills, innovating course designs, and expanding their digital technologies.

While there have been studies exploring teachers' challenges in an online learning space, there is a dearth of research examining this phenomenon within the context of developing countries, such as the Philippines. One such study was that of Zamani et al. (2016) who mainly

focused on the challenges but did not explore teaching practices. Noor et al. (2020) carried out a parallel study that focused on both the practices and challenges. Although these two studies contributed to the body of knowledge concerning the online teaching experiences of teachers in developing countries, their scope was limited as they mainly centred on the individual and microsystem levels, excluding other important dimensions beyond the classroom environment. Thus, this study fills a significant gap in the literature.

Conceptual Framework

In this study, our analysis of teachers' practices and challenges during fully online teaching was informed by a systematic literature review of the key challenges that teachers experience in a virtual learning environment, with a primary focus on teachers in higher education (Boelens et al., 2017). While the Boelens et al. (2017) review focused on studies of blended learning rather than fully online learning, the Boelens framework was adopted because it goes beyond the individual and microsystem (e.g., classroom) levels and accommodates other important dimensions, such as the mesosystems (e.g., institutional factors) and exosystem (e.g., internet service at the national level).

Boelens and colleagues identified four categories of challenges in terms of facilitating learning in the online context: incorporating flexibility, stimulating interaction, facilitating students' learning processes, and fostering an affective learning climate. Incorporating flexibility suggests that students are given control over their own learning in terms of time (synchronous or asynchronous), place (remote or residential), path (order of providing course content), and pace (students' speed in processing the course materials) (Horn & Staker, 2014). Stimulating interaction relates to allowing the students to communicate with the teacher and peers through questioning, collaboration, feedback, and learning activities. According to Boelens et al. (2017), interaction is lower when transactional distance is high. Transactional distance refers to a "psychological and communications space to be crossed, a space of potential misunderstanding between the inputs of instructor and those of the learner" (Moore, 1993, p. 22). The third category—facilitating students' learning processes—involves the use of instructional activities to help students regulate their own learning. These self-regulation strategies include orienting and planning, monitoring, adjusting, and evaluating (Vermunt &Verloop, 1999). The final category, fostering an affective learning climate, relates to the instructional activities that make students feel motivated, safe, accepted, valued, and positive towards the teacher and the course (Mazer et al., 2007). Vermunt and Verloop (1999) identified five categories of affective strategies, namely, motivating, concentrating and exerting effort, appraising, dealing with emotions, and attributing and judging oneself.

Boelens' framework focuses closely on teaching and learning processes within the virtual classroom and does not necessarily address other related challenges teachers may face as they attempt to implement these processes. Accordingly, we remained attentive to other challenges (e.g., internet connectivity issues) which could interact with, or accentuate the challenges of, effective facilitation of learning.

Material and Methods

The present study adopted a descriptive case study approach, which provides a description of an existing phenomenon in a real-world context experienced by a group of people (Smith & Strahan, 2004). It involves the description of a behaviour without any intention to manipulate it or the environment in any way (Nevin et al., 2008). Hence, this approach allowed the researchers to collect complex data about teachers' experience in an online environment and to clearly understand the phenomena from an emic perspective.

Context and Participants

The participants of this study were 17 teachers from nine universities in the Philippines. They were recruited using direct person-to-person contact with prospective participants. Invitations for participation were sent to 20 teachers in the third quarter of 2021. However, only 17 accepted the invitation. The participants were selected through purposive sampling using the following eligibility criteria: (1) teaching in higher education, (2) with at least three years of teaching experience, (3) familiar with the use of technologies in the classrooms, and (4) have been teaching online for at least one year. Of the 17, nine are males, and eight are females; they have been teaching for 3 to 20 years (M = 9.09; SD = 4.90), handling courses in the field of arts and humanities (N = 7), social sciences (N = 3), business (N = 2), psychology (N = 2), math and engineering (N = 2), and education (N = 1). Most of the participants obtained a master's degree (N = 10), while a few completed their doctorate (N = 3), bachelor's degree (N = 2), post-graduate certificate (N = 1), or law degree (N = 1). All teachers conducted online classes using a combination of synchronous and asynchronous modes. All participants were informed about the purpose of the research and voluntarily consented to participate. Moreover, this study followed institutional research ethics protocol and ensured the anonymity of participants and confidentiality of information. Table 1 shows the profile of the participants.

Table 1

Summary of Teachers' Profile

Participants	Gender	Years of Teaching	Highest Educational Qualifications	Fields
T1	Female	13	Master's Degree	Arts and Humanities
T2	Male	10	Master's Degree	Social Sciences
T3	Female	20	Master's Degree	Arts and Humanities
T4	Female	7	Bachelor's Degree	Arts and Humanities
T5	Female	10	Master's Degree	Arts and Humanities
T6	Male	11	Master's Degree	Arts and Humanities
T7	Female	7	Post-graduate	Arts and Humanities
T8	Male	3	Bachelor's Degree	Business
T9	Female	4.5	Doctoral Degree	Psychology
T10	Male	10	Master's Degree	Math and Engineering
T11	Male	7	Doctoral Degree	Psychology
T12	Male	17	Doctoral Degree	Education
T13	Male	3	Master's Degree	Business
T14	Female	5	Master's Degree	Math and Engineering
T15	Male	3	Master's Degree	Social Sciences
T16	Male	13	Law Graduate	Social Sciences
T17	Female	11	Master's Degree	Arts and Humanities

Instrument and Data Collection

The data were collected using semi-structured interviews, which is an approach to gathering information from participants with personal experience, beliefs, and attitudes to the phenomenon under investigation (DeJonckheere & Vaughn, 2019). The interview protocol centred on two areas: participants' background information and the main questions. The *background information section* asked about the teachers' name, affiliation, gender, age, designation, years of teaching experience, courses being taught, highest educational qualification, and online learning mode used in class. The items in the *main questions section* are clustered into four subsections (Boelens et al., 2017): (a) promoting flexibility, which asked about the time, place, path, and pace of learning; (b) stimulating interaction, which asked about the verbal or non-verbal, spoken or written, and synchronous or asynchronous strategies that teachers employed; (c) facilitating learning processes, which asked about orienting/planning, monitoring, adjusting, and evaluating strategies; and (d) fostering affective learning climate, which asked about how teachers used affective strategies, promote positive attitude towards online learning, and encourage students. Each subsection asked how teachers facilitated their online class and the challenges they experienced. The interview protocol was validated by two experts with post-graduate degrees, multiple publications in reputable journals, and at least ten years of teaching experience in higher education.

All interviews were conducted online via Facebook messenger by the second author and lasted for about two hours. Synchronous online interviews were used because of the ongoing community quarantine and the proximity of the interviewer with the participants. The interviewer ensured that participants were comfortable and open to talk freely during the interview to avoid social desirability biases (Bergen & Labonté, 2020); for example, participants were informed that there were no wrong responses and that their identity and responses would be handled with the utmost confidentiality. With the permission of the participants, all interviews were recorded to ensure that all relevant information was captured accurately for transcription and analysis.

Data Analysis

The transcribed interviews were analysed using predetermined categories based on the conceptual framework and research questions. Specifically, we used multilevel coding in classifying the codes from the transcripts (Birks & Mills, 2011). First, we grouped responses into two general classifications: (1) Facilitating Learning, and (2) Other Challenges during an online class. We further classified the responses in each general category into the four Boelens et al. (2017) subcategories: promoting flexibility, stimulating interaction, facilitating learning processes, and fostering an affective learning climate.

To analyse responses within each of the four Facilitating Learning subcategories, we created more finely grained classifications suggested by the Boelens framework and others who have built on it (Horn & Staker, 2014; Mazer et al., 2007; Vermunt &Verloop, 1999). Then, we identified the relevant codes from the responses of each participant and categorised these codes based on the similarities or relatedness of their properties and dimensions. To analyse responses within the Other Challenges subcategories, we compared them across the four Facilitating Learning categories.

Note that we performed a constant comparative and progressive analysis of cases to allow the initially identified subcategories to emerge and take shape, while remaining open to the possibility of new categories, subcategories, or fine-grained classifications arising from the data. This means that we completed the analysis of all the responses of Teacher 1 before we proceeded to Teacher 2, and so forth. To ensure the reliability of the analysis, each of us independently analysed the 17 transcripts. Prior to analysis, we revisited the purpose, research questions, research method, and codes and coding scheme of the study. We also had a calibration session where we discussed ways on how we could consistently analyse the qualitative data. We discussed any disagreements until full agreement was achieved.

Findings

The current study investigated teachers' experience in a fully online learning space within the context of higher education. Specifically, we examined how they navigated the online learning environment to facilitate learning and the challenges they faced during fully online teaching.

Teachers' Practices to Facilitate Online Learning

Tables 2 through 5 summarize teachers' practices to facilitate learning within each of Boelens' four categories. Overall, teachers were most likely to discuss multiple practices related to fostering an effective learning climate (with $f = 79$ mentions across teachers), followed by facilitating learning ($f = 57$) and promoting flexibility ($f = 54$), while facilitating interaction was mentioned the least ($f = 25$).

Table 2 reveals that teachers extensively practised flexibility in the four key areas suggested by our conceptual framework (i.e., time, place, path, and pace of learning). Among these areas, flexibility in time was the most frequently used as teachers provided extra time to students to process the lesson (e.g., T4, T13, T15), set flexible deadlines for students' outputs (e.g., T5, T8), and employed both synchronous and asynchronous sessions (e.g., T3, T5). Teachers also showed some flexibility in the place of learning. For instance, T4 commented that "they can stay wherever they can to focus on our class regardless if it's in home, office etc." T5 echoed the same flexibility as she allowed her students to choose the learning space depending on their own context. In the case of order in which the content is provided in the course (path), teachers either adjusted the syllabus content or the course requirements. Take, for example, T9 and T14, who rearranged their course content to fit better to the online setting. Conversely, fewer than half of the teachers reported that they adjusted their teaching based on how students progressed at their own pace. These teachers showed flexibility in the pace of learning by simplifying the topics (e.g., T1, T9) and taking pauses to allow other students to catch up (e.g., T8, T12). Although teachers generally practise flexibility, some teachers also counterbalance their practises with inflexibility. For instance, T7 reported that teachers in their school employed the suggested teaching strategies as they match the school requirements. Some of them (e.g., T6, T8) also strictly followed the provided course outline as they found it easy to follow and useful to keep themselves and their students on track. These findings suggest either a dichotomy or continuum in teaching flexibility, which require further investigation.

Table 2
Summary of Teachers' Responses on Their Teaching Practices in Promoting Flexibility

Areas	*f*	Sample Responses
Flexibility in Time	17	*Extra time was given to the students to fully understand the concepts being taught to them.* (T4)
		Flexible in deadlines and outputs (T8)
Flexibility in Place	15	*They can stay wherever they can to focus on our class regardless if it's in home, office etc.* (T4)
		Preferably home, but students may choose wherever depending on their availability. (T5)
Flexibility in Path	14	*Modified some of my course content to fit better to our online settings* (T9)
		Trying to interchange topics which needs to be discussed on synchronous classes (T14)
Flexibility in Pace of Learning	8	*Some topics were adjusted and simplified* (T1)
		Taking pauses for my students to catch up, no one is left behind. (T8)

Boelens' framework suggests that practices to stimulate interaction include questioning, collaboration, feedback, and learning activities. Table 3 suggests that questioning was a popular approach among our teachers. For instance, T2 devoted "less time in discussion and more time with question and answer," while T16 employed a Socratic method, which is a cooperative dialogue between the teacher and the students through asking and answering questions. Other teachers asked students to recite during synchronous sessions to facilitate learning (e.g., T3, T9, T12). Meanwhile, four teachers engaged students in a collaborative discussion during synchronous sessions to ensure that everyone was listening (T13), expressing his/her thoughts (T6), and participating in learning activities (T7, T8). Few teachers mentioned providing feedback through one-on-one consultation (T2) and positive reinforcement (T17), while others used gamified learning (T5). In addition to the four themes suggested by Boelens, many teachers spoke to an additional theme of the technology affordances of LMS or social media to promote interaction. Among the affordances that they used are video tools and microphones (T2, T4, T7), whiteboard feature (T5), and instant messaging (T4, T6, T7).

Table 3
Summary of Teachers' Responses on Their Teaching Practices in Stimulating Interaction

Areas	*f*	Sample Responses
Questioning	8	*Less time in discussion and more time with question and answer* (T2) *Following the Socratic method* (T16)
Using LMS or Social Media Affordances	8	*For synchronous classes, we maximise the tool. So, I use the white board feature in our tool.* (T5) *Use videos mics for live classes* (T10)
Collaboration	4	*Encourage my students to join in the chat discussion, my students rely on the materials I have provided for them* (T7) *Asking for the students to be collaborative and join in the discussion* (T8)
Feedback	3	*The students can contact me for consultation for some of them are shy to recite during synchronous class* (T2) *Giving additional points to the students who participate actively* (T17)
Gamified Activities	2	*Use of some applications such as roulette, word choice and I do some game shows like jeopardy, family feud, etc.* (T5)

As shown in Table 4, teachers substantially employed different regulatory strategies, namely orienting and planning, monitoring, adjusting, and evaluating. During orienting and planning, all teachers reported that they conducted a course orientation using the designated LMS. In this session, students were given a course outline (T4, T14, T17) and learning materials (T16), were oriented on the policies, requirements, and grading system (T2, T5), and were asked about their expectations of the course (T10). In terms of adjusting, teachers mentioned the theme frequently; for example, five teachers conducted remediation when their students failed in formative assessment (T1, T8, T9, T16) or experienced reading difficulty (T2), while others adjusted the topic and activities to the level of their students (e.g., T5, T6, T10). Note that these adjustments were based on teachers' monitoring strategies during online learning sessions. As the learning space required, teachers administered online assessment activities, such as quizzes, writing tasks, reflective essays, and oral recitation (e.g., T6, T9) as well as navigated the various features of the LMS (e.g., T1, T12, T16) to monitor students' progress and provide comprehensive, timely, and quality feedback. In other cases, teachers rigorously monitored students' attendance (e.g., T13). Finally, teachers used a variety of strategies to determine the extent to which students achieved the learning outcomes. These summative tests or culminating activities included interactive examinations (T3), research papers (T2, T5), collaborative video development (T2), portfolio assessment (T6), objective test type (T10), and post-tests (T11).

Table 4
Summary of Teachers' Responses on Their Teaching Practices in Facilitating Learning Processes

Areas	*f*	Sample Responses
Adjusting	16	*Open for repeating the lesson when students find it difficult to understand and if most students fail on exam or quiz.* (T1)
		Do some revisions on the course outline for them to understand it more and explaining a bit more (T10)
Monitoring	15	*We use our learning platform for monitoring. The feature of the platform can easily manage to score, show the feedback, etc.* (T1)
		Online activity and quizzes, giving some timely feedback (T6)
Orienting and Planning	14	*I conduct orientation and overview for the course and lessons, providing initial requirements* (T2)
		Giving ideas and background regarding the course subject, overview of the whole topics (T15)
Evaluating	12	*Group papers, group videos, admission and final paper were asked to be written and submitted by the students* (T2)
		Summative tests were given as well as compilation of previous activities. (T6)

With reference to fostering an affective learning climate (Table 5), the most frequently used strategy relates to dealing with students' emotions ($N = 42$). To do this, teachers made themselves available to their students beyond the scheduled class time and practised open communication. As T15 shared, he made sure that he had "open communication with the students with *Kamustahan* Session". *Kamustahan* session is an informal talk between the teacher and the students for the sole purpose of knowing what is going on with the students' lives. Other teachers (e.g., T6, T10, T13) echoed the positive impact of establishing open communication on fostering an affective learning climate. Another strategy that teachers employed to deal with students' emotions is by showing empathy and consideration to students. T1 noted that she always tried "to be considerate and listen to their case and reasons." A similar feeling of empathy was expressed by T8, T14, T15, and T17. Other strategies that teachers used when dealing with students' emotions are appreciating students' effort and work (T1), encouraging optimism (T2), engaging students in reflective activities (T5), discussing mental health (T9), and using humour (T3, T5, T8, T12, T16) and background music (T11). Another key area that promotes affective climate is motivating students, that is, maintaining a willingness to learn and forming expectations about the course and its learning outcomes. To do this, teachers provided positive feedback and reinforcement (T4, T16), used motivational words (T8, T12), adopted personalised teaching (T1, T5), clarified the learning outcomes (T3), and encouraged peer learning (T6). On

the aspect of concentrating and exerting effort, half of the responses dealt with setting deadlines. The other half employed a Socratic method (T16), reviewed the previous session, and explicitly reminded the students to focus on learning (T6), and oriented students about the learning tasks (T12). In the case of attributing and judging oneself, all eight teachers converged to the idea that self-assessment helped students attribute learning outcomes to causal factors and develop a sense of self-awareness. Finally, five teachers incorporated appraising into their teaching by explaining to the students the relevance of the learning tasks. For instance, T4 reminded her students of the importance of completing the assigned task. Meanwhile, T11 required his students to write a reflection paper for them to realise the value of the learning activities.

Table 5

Summary of Teachers' Responses on Their Teaching Practices in Fostering Affective Learning Climate

Areas	*f*	Sample Responses
Dealing with Emotions	42	*I make sure that whenever they message, I am giving them words of empathy, words of acknowledgement.* (T5)
		Creating a culture of environment where my students are free to ask and communicate with me and joke with me but still respect and discipline should be observed (T13)
Motivating	14	*I give them positive feedback and then, I make sure that whenever I give them negative feedback it's for them.* (T4)
		Giving inspirations and a little pressure by saying "you are the next generation of educational teaching" (T12)
Concentrating and Exerting Effort	9	*I always set a deadline in a particular task to oblige all my students to submit the activity and encourage them to participate actively in group activities.* (T1)
		Giving house rules has been effective for my class (T10)
Attributing and Judging Oneself	8	*Self-assessments were done and sometimes I gave them the privilege to judge their works.* (T7)
		Assessing themselves based on the rubrics given to them from the start (T10)
Appraising	6	*I just remind them the importance of practice in doing the task they have to do.* (T4)
		Asking them to write reflection papers based on their performance (T11)

Teachers' Challenges in a Fully Online Learning Space

The findings confirm the serious challenges experienced in a low-resource contexts. Among these are poor internet service, technical problems, and restricted online learning activities. Nearly all teachers raised concerns about frequent internet interruptions due to poor signal. T17 narrated that poor internet connection resulted "less enthusiasm in participating in the class" and module preparation among students. Table 6 provides the Other Challenges teachers identified, comparing them across each of Boelens' four categories. As shown in the table, most teachers mentioned challenges in terms of the availability or quality of internet connections (N = 14). Take, for example, T9, T11, T14, and T16, who complained about the unstable internet connection. Both learner-related and teaching delivery and assessment challenges cut across four areas; the former is the most frequent when fostering an affective learning climate, while the latter is the most frequent when facilitating learning processes. Regarding learner-related challenges, T3 and T8 expressed concerns about the students' frequent but unclear email messages. Meanwhile, T12, T17, and T18 had difficulties in dealing with students' unresponsiveness. In the case of teaching delivery and assessment, teachers faced challenges when checking online activities (T3, T9, T13, T20), communicating with students (T7, T18), and giving feedback (T9). Others reported some challenges because of limited time and excessive workload (T8, T9, T10). Another major challenge that teachers needed to overcome was technological complexity, which refers to the teacher's exposure to complex and oversupplied technologies for online teaching. This challenge was most common when promoting flexibility. T5 noted that she had problems in making her instructional delivery flexible because of too many technicalities in the entire process. This is a sentiment shared by T1, T8, and T13. Meanwhile, five teachers acknowledged that the challenges they experienced were caused by their inability to manage or control their emotions, actions, and thoughts to achieve their teaching goals. For instance, T16 and T17 said that they had difficulties in adjusting to the sudden shift to online learning platforms. Very few comments were related to the teaching environment, learning materials, physical condition and health, and technological literacy and competency. In the case of teachers' challenges related to school policy, those who felt that their institutional policies were limited tended to be laxer and more flexible regarding deadlines and course requirements, as in the case of T3 and T6. Nonetheless, those involved in the crafting of the online learning policies claimed they somehow developed their sense of ownership and trust in the efficacy of these policies. This indicates that the more teachers trusted the institutional guidelines, the more they were committed to sticking to them.

Table 6
Teachers' Challenges During Fully Online Learning

Challenges	Promoting Flexibility	Stimulating Interaction	Facilitating Learning Processes	Fostering Affective Learning Climate	Total
Internet Connection	4	6	2	2	14
Learner-related	3	4	1	5	13
Teaching Delivery and Assessment	1	2	5	4	12
Technological Complexity	4	2	1	1	8
Self-regulation	3	0	1	2	6
Teaching Environment	1	2	0	1	4
Course Materials	1	0	2	1	4
Access to Technological Tools	1	3	0	0	4
School Policy	2	0	0	0	2
Physical Condition and Health	0	1	0	0	1
Technological Literacy and Competency	0	0	1	0	1

Discussion

The current study explores how teachers navigated the fully online learning environment and the challenges they experienced in this learning space. Overall data show that teachers extensively promoted flexibility, facilitated learning processes, and fostered an affective climate during fully online learning. Although teachers stimulated student interaction during the online learning space, it was not as extensive as the three other areas. To advance this line of research, this study provided relevant information on the specific factors that shaped these four key challenges and how the interaction among these factors contributed to the varying challenges, practices, and strategies of teachers in a fully online learning space. As shown in the above data, the teachers' navigation strategies and challenges vary from one area to another (i.e., promoting flexibility, facilitating learning processes, fostering affective learning climate, and stimulating interaction) and one teacher to another, depending on their teaching-learning contexts. The findings also highlight the key challenges in a low-resource context when engaged in fully online learning environment (see Barrot & Acomular, 2022; Andersson, 2008; Aung & Khaing, 2015; Barteit et al., 2020; Sithole et al., 2019).

The current findings reinforce earlier studies (e.g., Comas-Quinn, 2011; Johnson et al., 2020) that a lack of understanding of the tools and their pedagogical affordances as well as the adjustment needed in a short span of time contributed to teachers' challenges. This study also echoes earlier studies suggesting that in the online setting, teachers had reduced presence (Gil-Jaurena & Domínguez, 2018; Varea & González-Calvo, 2021) and interaction with students (Gil-Jaurena & Domínguez; Sithole et al., 2019), and restricted the use of collaborative activities (Varea & González-Calvo, 2021). Notably, this study concurs with the findings of González et

al. (2023), Johnson et al. (2020), and Varea and González-Calvo (2021) that these challenges were highlighted when teachers needed to abruptly shift to emergency remote teaching during the pandemic. With reference to Moorhouse and Wong's (2021) three-phase framework, the findings suggest that teachers in low-resource contexts (i.e., the Philippines) remained in the experimentation phase even two years into the pandemic due to multiple persistent resource-related challenges that they needed to confront (e.g., poor internet connectivity and limited online learning equipment).

The identified challenges faced by teachers align with earlier reports on the relevance of providing pedagogical and technical support, flexibility of time and space, and institutional guidance when conducting online classes (e.g., Çakıroğlu et al., 2022). To expand the current study, researchers may further probe into the strategies that teachers employ to overcome their online teaching challenges and the different factors that shape their use of these strategies. Further, this study extends previous studies and our understanding of teachers' experience in navigating the fully online learning space by identifying their specific practices and challenges when promoting flexibility, facilitating learning processes, fostering an affective learning climate, and stimulating interaction among students.

This study resonates with earlier reports (see Al-Samarraie & Saeed, 2018; Turugare & Rudhumbu, 2020) that teachers used the various LMS affordances to facilitate learning and overcome their teaching challenges in an online learning space. They also harnessed the power of technology for a more adaptive learning experience. This information reveals the critical role of choosing appropriate pedagogical technologies based on the teachers' unique context. However, it should be noted that teachers should not only understand how to use technology but also why they are using them. Also, teachers did not consider technological literacy and competency as a challenge because of the ample trainings provided to them by their respective institutions. Such trainings were continuous and progressive to ensure that teachers could catch up with the technological demands in class. The positive impact of training on teachers' ability to teach online has been reported elsewhere (e.g., Brinkley-Etzkorn, 2018).

Similarly, teaching and learning goals had a bearing on how teachers navigated fully online learning environment. Generally, teachers selected tools that would fulfil their pedagogical goals instead of just exclusively adopting the institutional LMS. For instance, several teachers in this study either supplemented their institutional LMS or used a different platform to meet the teaching objectives and the nature of their course. These findings reiterate earlier findings on the influence of teaching goals on online pedagogical practices (e.g., Phan et al., 2021). In the same way, institutional policies have the potential to mediate the online teaching practices of teachers. These findings echo the earlier reports of Wingo et al. (2016) and Muljana and Luo (2019) on the critical role of institutional support on teachers' practices and challenges in an online learning space. As noted by Orr et al. (2009) and Pedro and Kumar (2020), institutional practices, institutional support, and effective processes are essential to the success of online teaching efforts. The final key factor that shaped the challenges and practices of teachers online are the learners themselves. Because the selected universities follow the principle of flexible learning (i.e., flexible in time, mode, and place of learning) as mandated by the government education agency, teachers' instructional delivery heavily relied on the learning context of students, such as their home environment, socioeconomic status, resources, and

cognitive levels. These findings resonate with the earlier work of Barrot et al. (2021) and Sithole et al. (2019) on the critical role of student behaviour and characteristics in the success of online learning and teaching.

Some important insights that the findings contribute to the extant literature is that teachers can be both flexible and rigid at the same time, depending on how their decisions can contribute to their teaching goals and how they align with their beliefs. This suggests that a certain level of rigidity might have a positive impact on students' online learning experience. It was also found that affordances of learning technologies had some influence on promoting teacher-student and student-student interaction during online learning. Finally, the findings show that most of the teachers' practices to foster affective learning climate relate to extrinsic factors. However, some teachers tapped on intrinsic factors to reinforce positive online learning environment.

Conclusions

This study investigated the components of teaching in a fully online learning space, particularly the way teachers navigated this alternative learning environment and the challenges they experienced. Overall data indicated that they promoted flexibility and interaction, facilitated learning processes, and fostered an affective learning climate as much as they could. However, these teachers faced several challenges related to technological sufficiency, learner-related factors, teaching delivery and assessment, technological complexity, and self-regulation, among others. Their varying experience was linked to their unique context brought about by several factors, namely available tools, institutional policies, pedagogical goals, and learner-related factors.

Our findings provide several implications. First, this study shed light on the various challenges that online teachers faced and highlighted the importance of their readiness to embark on fully online teaching, particularly within a learning context with poor internet connectivity and limited resources. Higher education institutions with similar learning contexts could use these findings to enhance efforts toward a more efficient online learning environment. This study would also provide key information to policymakers, school administrators, and teacher trainers to reflect on the viable professional development programmes that may help teachers overcome these challenges and equip them with the necessary content knowledge as well as pedagogical and technological competence (Martin et al., 2021). Finally, the findings provided us with a nuanced understanding that teachers' navigation strategies and challenges were shaped by interrelated factors. As such, addressing the issues requires a systemic approach.

As in the case of other research, our study has limitations that need to be addressed in future studies. First, the study limits the investigation to teachers' navigation strategies and the challenges they experienced. Researchers may go deeper by probing into the specific strategies that experienced and less experienced online teachers use to overcome their challenges. Although we did not see any pattern in the navigation strategies and challenges per subject area because of the limited samples, this area merits further investigation to obtain a more nuanced view of the phenomenon. Also, our study did not explore teachers' attitudes toward online learning space and how these attitudes affect their practices and experiences. Future studies may investigate whether those who view online learning as a unique learning space recalibrate their

instructional practices extensively, or whether those who view it like traditional face-to-face classroom make a strong effort to re-create such an environment in the online setting. Another limitation of this study is its exclusive focus on teachers' perspectives. To have a better picture of the data, we recommend that the perspectives of other key stakeholders be considered, such as school administrators, technical support, and students. Note that this study exclusively used a semi-structured interview, which may not fully reflect teachers' practices. Future studies may complement this instrument with actual classroom observation for triangulation purposes. Finally, this study was delimited to the higher education context with a relatively small sample size due to its qualitative nature. Future studies may consider expanding the context to K-12 teachers and using mixed methods design with a larger sample size from different geographical regions for more robust findings.

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The Interplay of Institutional Support and Faculty Roles During the COVID-19 Pandemic: Implications for the Future of Online Teaching and Learning

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Abstract
While the outcome of the COVID-19 pandemic was largely the same across higher education institutions (HEI) – a rapid transition to online teaching and learning (OTL) – the processes and institutional support leading to this transition varied greatly. As such, the perception and anxieties experienced by faculty warrant exploration as these perceptions likely dictate the future of online teaching and learning within higher education institutions. Through the use of tweets made during the pandemic and interviews with faculty, this study reveals the emotional stress experienced by faculty when playing multiple, unfamiliar roles hindered the implementation of online teaching and learning initiatives. This hindrance may in part be alleviated through well-targeted institutional support.

Keywords: Online teaching and learning, higher education institutions, faculty roles, CCOVID-19 pandemic

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The COVID-19 pandemic generated the largest disruption to education systems in recorded history (Pokhrel & Chhetri, 2021; United Nations, 2020). While some institutions had already implemented online teaching and learning (OTL), others only had experience with traditional face-to-face modes of instruction. These institutions lacked training, resources, and strategies to implement online teaching at such a quick turnaround and speed. Despite challenges, the predominant response of educational institutions was to resume classes and try to "save the academic year" (Longhurst et al., 2020). This crisis required immediate action with an immediacy typically resisted in all institutions as bureaucracy and governance prevail (Vaira, 2004).

Institutions desired to find ways to resume courses for the benefit of students and help those who were reluctant or unable to engage in online learning. Universities, concerned about students' online learning satisfaction and overall experience, tried to target the various problems students encountered (Baloran, 2020; Maqableh & Alia, 2021). In contrast, not all institutions were able to support their faculty members effectively in terms of both technical and mental support (Walsh et al., 2021).

The widespread impact of COVID-19 resulted in a tsunami of social media news transmissions, guidelines and precautions (Mourad et al., 2020). Among the most frequently posted hashtags during the COVID-19 pandemic were those related to online education (Cruickshank & Carley, 2020). People around the globe joined hashtag communities to express their preferences, experiences, and emotions. Despite research showing how instrumental faculty are to the success of online teaching and learning (Orr et al., 2009; Bolliger et al., 2019), the attention—and social media posts—were largely focused on students during the crisis.

According to a search in Scopus within the fields of social sciences, arts and humanities, around 3,000 peer-reviewed articles were published on the topic of online learning during the COVID-19 pandemic between 2019 and 2021 (Aad 2022). Within this corpus, more than 600 articles address higher education in general. However, the focus of these articles was mainly on students' experiences and perceptions of E-learning (Budur, 2020; Laili & Nashir, 2021; Muthuprasad et al., 2021). Some of the findings addressed the physical and mental health of students in the online environment (Chaturvedi et al., 2021; Idris et al., 2021; Wieczorek et al., 2021) while others looked at ways to raise student awareness and ethics online (Meccawy et al., 2021). Interestingly, only 83 documents looked into the faculty experience in contrast to the more than 500 addressing the student experience. Nevertheless, faculty play a major role in the overall student learning and engagement experience (Kranzow, 2013; Horvitz et al., 2015). In this study, we examine how institutional support and faculty roles combined to yield various OTL strategies during the COVID-19 crisis and what the implications of those outcomes might be into the future.

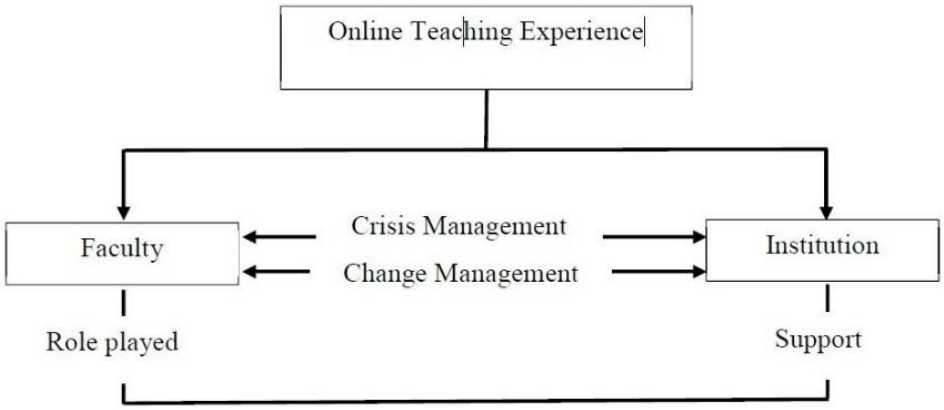
Our investigation follows a mixed-methods strategy. We begin by examining the full COVID-19 pandemic context in the arena of teaching and learning as it was this backdrop that influenced faculty perceptions of the crisis. We capture these perceptions of the crisis within online teaching and learning from tweets posted throughout the pandemic. We then drill down to the lived experience through first-hand faculty accounts regarding the rapid transition to online teaching within different conditions of institutional support.

The next section of this work discusses the literature review focusing on faculty roles and institutional support. The subsequent section presents the methodology applied to capture and analyze both the Twitter and interview data; after which we present the results of both the Twitter and interview analysis. Finally, the paper concludes with a full discussion on the roles played by faculty members in Online Teaching and Learning (OTL) during the COVID-19 pandemic while highlighting both practical and theoretical implications relative to the future of OTL in higher education institutions.

Review of Related Literature

This research addresses the interplay of faculty roles played and institutional support given against the backdrop of the broader online teaching environment during the COVID-19 crisis with the aim of understanding how different roles and levels of support might influence the future of OTL. Figure 1 illustrates the research model. In light of this research model, the remainder of this literature review focuses on the faculty role and institutional support during the COVID-19 crisis.

Figure 1
Illustration of Research Framework.



The Faculty Role

As mentioned in the UNESCO *COVID-19* educational disruption and response report 2020 (UNESCO, 2020), faculty were asked to teach online using virtual modalities with little regard for their previous experience or lack thereof often without the appropriate tools and resources, especially at the beginning of the crisis. The transition to OTL was made at a different pace by different educators. Some responded immediately, others within days, weeks or even months of the closure. Perrotta & Bohan (2020) note that the shift to online classes required faculty to interact and engage via discussion forums and other communication tools, either synchronous or asynchronous, and provide timely and frequent constructive feedback, encouragement, and motivation to help students achieve their learning goals. Furthermore, during the pandemic faculty were forced to explore various aspects of online learning such as

how to influence learner motivation using different forms of interactivity, enhance learner engagement, and find effective assessment methods (Martin et al., 2020)

The faculty's role in the online environment as a facilitator, course designer, mentor, and organizer is important for students to be able to engage meaningfully in the learning process (Young et al., 2001). Carril et al. (2013) argue that faculty with prior OTL experience are more confident in their pedagogical competencies in online teaching and learning. Bolliger et al. (2019) further confirm that with no experience, faculty teaching online are less likely to use appropriate activities to support and engage students. Hämäläinen et al. (2021) add that faculty's digital competencies should enable them to have the appropriate skills to achieve the necessary course learning outcomes. Several researchers agree that face-to-face teaching skills are different than online teaching skills (Ferrari et al., 2012; Hämäläinen et al., 2021).

During COVID-19, another role faculty had to play was that of coach, mentor, and good listener to help students navigate changes (Ersin et al., 2020; Krishan et al., 2020). Researchers specifically highlight the importance of the faculty in managing discussions, providing constructive and personalized feedback, and encouraging the use of information and communication technology (ICT) tools (Wright et al., 2023). The importance of multiple faculty roles in the online experience is not new; past research notes that these roles have either a direct or indirect effect on the students' emotions (Chen et al., 2019; Hattie, 2010; Horvitz et al., 2015; van der Spoel et al., 2020). Faculty in the online environment are not only facilitators or knowledge disseminators, but they also play the role of "leaders" and "accompaniers" who coach and mentor the students (Yao et al., 2020). Accordingly, higher education institutions need to ensure that they facilitate technology use which allows faculty to fulfil these roles with minimal barriers to integration (Tarhini et al., 2019).

Institutional Support

Like all technology-related sectors, OTL has seen immense growth in the higher education sector. Investment in online education was projected to reach $350 billion by 2025 (Research and Markets, 2019). Some universities engaged with OTL well before the COVID-19 pandemic and developed strategies for e-learning deployment (e.g., Durham University, Open Arab University, Arizona State University, University of Liverpool, University of Florida, etc.) (Keengwe & Kidd, 2010). Even though some institutions engaged early in OTL, the effectiveness of these measures varied from one institution to another (Curran, 2004). The pandemic accelerated OTL adoption forcing all institutions with or without prior institutional support or planning to transition rapidly.

Frankel et al. (2020) found that having appropriate technical and pedagogical support is vital to OTL transitions. In crises such as COVID-19, planning appropriately for technical support was not possible. While on one hand the technology used during the pandemic solved the problem of in-person attendance (Majewska & Zvobgo, 2023), it created several challenges related to issues of faculty training, student support, online pedagogy, and online implementation (P. Mishra & Warr, 2021a; Scherer et al., 2021). Faculty who effectively used technology in their face-to-face classes were not necessarily effective in a fully online teaching and learning environment. Additionally, both faculty and students experienced pandemic-related anxiety and uncertainty. Institutional support was necessary to overcome this anxiety and promote the idea

that OTL can yield effective engagement. Both pedagogical and technical support were needed to ensure quality assurance and readiness during the pandemic (Dhawan, 2020). Focusing solely on learning outcomes and the assessment of students' achievement of those outcomes was no longer an option, there was a dire need for faculty upskilling in appropriate course design and pedagogical decision making (Doo et al., 2023).

Through the Lens of Change and Crisis Management

Theories of crisis and change management show that the way employees adapt and respond to change influences their emotions (Pulakos et al., 2002; Baard et al., 2014). According to these theories, during a crisis, job positivity might drop due to anxiety and uncertainty; therefore, maintaining employees' emotional balance and engaging them in the change needed during a crisis can lead to a positive emotion (Spector, 1986; Brown & Peterson, 1993; Marques-Quinteiro et al., 2019). Furthermore, Howe et al. (2018) find that faculty who receive support from their institution during a change or a crisis, such as mentoring, training, or communication are more positive than those who don't.

Change management is crucial to any type of organization including educational institutions. Resistance to change is a common phenomenon in organizations especially when the change affects the routine of individuals; for any change to be successful, the organization must be ready to overcome resistance (Dent & Goldberg, 1999; Jager et al., 2017). People fear the unknown, they fear that change will require them to do more tasks, and they fear the change will affect their financial position (Bordia et al., 2004). Employee involvement in the change process has a positive impact on their emotions mainly when they have the knowledge and skills to contribute to that change (Osei-Bonsu, 2014). Employees who are engaged with the change tend to be more positive than if the change was imposed on them (Chien, 2015).

The notion of change management is credited to Kurt Lewin who believed that change happens through learning, planning, and involving individuals who will be affected by that change. In contrast, during the pandemic, institutes of higher education experienced unplanned changes. Mishra et al. (2020) discussed the shift to OTL as innovative and adapted Lewin's model of change into three steps: unfreezing, changing, and freezing.

Unfreezing is the first phase of change when the routine of individuals is shaken by a certain force or incident. For example, in the case of the pandemic, the mode of teaching and learning was unfrozen forcing faculty and students to adapt to online modes of delivery. Faculty and students who were used to face-to-face interactions were no longer able to meet physically on campus. Unfreezing motivates individuals to change directions and to identify and evaluate other options in order to fulfil their tasks despite unforeseen circumstances. In the pandemic, the change stage was the adoption of new technologies and ways of working to ensure continuity of learning. Freezing as adapted by Mishra & Warr (2021) is the final phase where individuals adapt to the change that happened. They will not go back to the old norms of face-to-face teaching and learning, but they will learn from the change and adopt a new mode. This is at the heart of this research: Investigating how the interactions between faculty and institutions during the unfreezing and changing phases of COVID-19 might affect the future adoption of online teaching and learning (OTL), with a focus on the implications for the freezing phase.

The three stages of change management are consistent with the three stages of crisis management (Smith, 1990, 1995; Burkle, 2019):crisis of management, operational crisis, and crisis of legitimation. It is in the crisis of legitimation stage when the institution accepts the crisis and adopts the change into their operations to sustain and resume functions. In the case of the COVID-19 pandemic this meant adopting online teaching and learning despite the absence of legislation in many countries such as Jordan, Egypt, and Lebanon (Al-Salman & Haider, 2021). During that phase, stakeholders were highly emotional as they have been affected by the crisis and they started to learn new ways. The change management stage of freezing begins during the crisis of legitimation stage, but also allows for innovation and the charting of a new course not dependent on potentially ad hoc crisis-driven solutions.

As this entire crisis trajectory occurs only when a crisis is perceived, it is critical to document the broader context in which the faculty and institutional interaction occurred in the lead-up to the OTL transition. Clearly the emotions driving both the faculty to recognize the crisis and the institution to establish support policies were fueled by the prevailing context. For this reason, this study takes a broad-to-narrow strategy in its methodology. We begin by looking at the prevailing feelings relative to online teaching and learning as reflected by Twitter and then narrow in on the specific lived experience of faculty members embedded in institutions of higher education.

Research Design

This study aims to explore how institutional support and faculty roles combined to yield various OTL outcomes during the COVID-19 crisis and what the implications of those outcomes might be in the future. The study was guided by the following research question:

1. How can the various OTL techniques—seen during the pandemic and driven by the interplay of institutional support and the roles played by faculty—inform the future?

Materials and Methods

Recognizing the importance of the broader context that fueled much of the anxiety felt by faculty and university administrators who were making policies relative to OTL, this research relies on two key strategies: an analysis of Twitter data, also known as “tweets,” and a critical reading of first-hand interviews with faculty members across a variety of institutions. The Twitter data, while not directly informative as individual faculty members and their institutions cannot be identified in the anonymized data, do serve to set the context in which institutions and faculty were operating during the rapid OTL transition. In many ways, with the isolation brought about by lockdowns during COVID, the broader social media landscape served for some to replace more traditional institutional channels for OTL support. The interview data are more germane to this topic and serve to answer the research question regarding the rapid transition to online teaching within different conditions of institutional support in a more direct manner.

Accordingly, this section is divided into two subsections: one on the social media (Twitter) strategy and one on the interviews.

Social Media Data Collection and Processing

Social media, specifically Twitter, was a source for many users worldwide to express their opinions related to online teaching and learning during the COVID-19 pandemic. Accordingly, we examined tweets posted in all languages using the Twitter API service from June 2020 to March 2021 with the hashtags #onlineteaching, #onlinelearning, #highereducation, and #COVID19. The total number of tweets after discarding retweets using the Duplicate Remover add-in within Excel yielded 2,350. A Google translate sheet was used to translate the tweets into English.

Textual data was imported into Rstudio to run a text mining analysis. First, the *tm package* was applied in R to clean and pre-process the textual data by removing stop words and other elements that don't have any impact on semantic meaning including mentions, URLs, emojis, numbers, and punctuation. Then we conducted an automatic sentiment analysis using the *syuzhet package* (Jockers, 2015). This analysis not only identifies "positive" and "negative" emotional expressions but also detects specific emotions including trust, surprise, sadness, joy, fear, disgust, anticipation, and anger. Once the emotions were identified, the different terms used to express these emotions were extracted for a more in-depth reading of the results. This analysis tokenizes the dataset at the word level, meaning a Tweet is considered to be a combination of individual words. Therefore, a single sentence can express mixed feelings such as fear and anticipation. Table 2 summarizes the findings of this investigation. To identify whether feelings changed over time, the dataset was split by month with the sentiment analysis repeated for each month (See Figure 3).

Interview Data Collection and Processing

To address the faculty's experience with OTL, namely, how faculty members at higher education institutions managed and adapted to the changes brought on during the pandemic, we interviewed 30 academicians who were involved in online teaching and learning in HEI during the pandemic. We administered an open-ended, semi-structured questionnaire to 30 academicians, including deans and professors at all ranks who taught online during the pandemic. Overall, these 30 academicians came from 10 institutions across the EMEA region. Notably, none of these institutions had previously implemented a full-fledged online program and only 2 of the 10 institutions provided optional formal training to faculty members prior to the crisis. During the pandemic period, at least one of these institutions provided both technical and pedagogical support for online learning while the remaining institutions provided only technical support to their faculty through the IT departments. The interviews were conducted using WebEx or Zoom and lasted an average of 40 minutes each. Table 1 summarizes the sample characteristics.

The interview protocol received two ethical approvals, one from Durham University and one from the Lebanese American university (DUBS-2020-06-11T10:54:03-wchz36, 11, June 2020 and IRB #: LAU.SOB.JS1.2/Jul/2020). All interviewees gave consent to record the interview. The transcriptions were completed using *Otter.ai* technology. The transcribed interviews represent qualitative data, the analysis of the interviews focused on the different factors that can lead to a successful online teaching experience. The results from the interviews provide a richer insight into the faculty teaching experience during the COVID-19 pandemic.

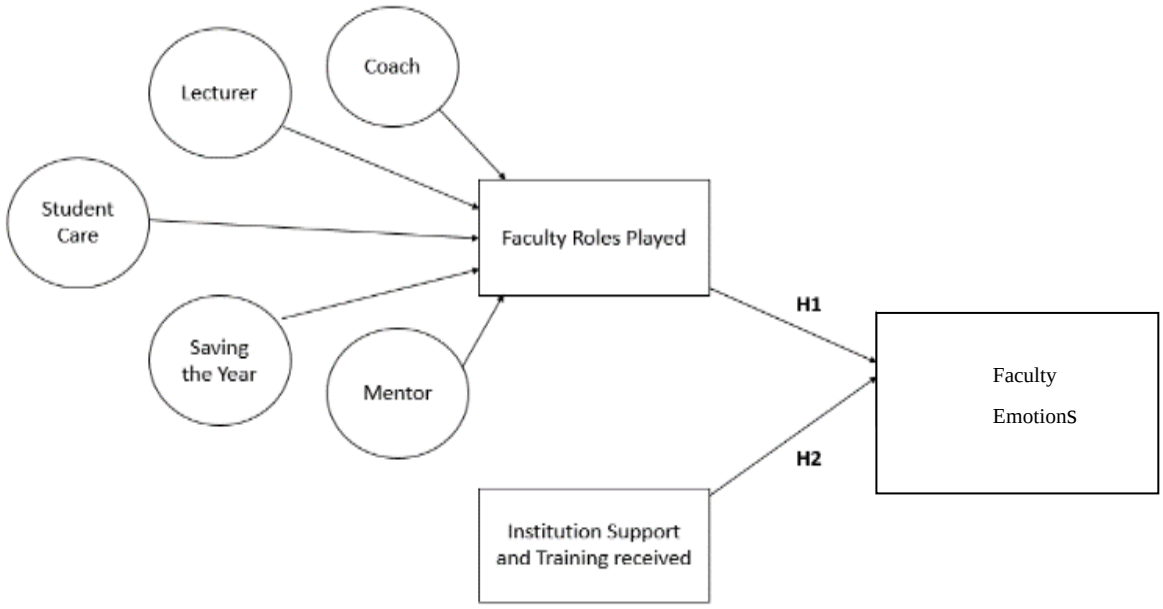
Table 1
Sample Characteristics

Characteristics		**Count**	**Frequency**
Gender	Male	17	57%
	Female	13	43%
Age Group	30~39	2	7%
	40~49	9	33%
	50~59	16	50%
	Above or equal to 60	3	10%
Employment Status	Full Time	29	97%
	Part Time	1	3%
Years of experience	5-10 Years	2	6%
	16-20 Years	20	67%
	20 or more	8	27%
Online Teaching pre COVID-19	Yes	12	40%
	No	8	60%
Quiet place at home	Yes	30	100%
	No	0	0%

The open-ended interview questions included general questions related to (1) online experience and training prior to COVID-19; (2) confidence and willingness to teach online; and (3) feelings about the decision to teach online and how the decision was communicated with specific questions asking about (a) the factors that can lead to a successful online experience; (b) whether faculty were supported by the institution's IT department; (c) whether interviewees believed COVID-19 accelerated the phasing out of face-to-face learning and what would be the acceleration impact; and (d) and whether they would shift to teach online 100% in the future.

The interview transcriptions were uploaded to NVivo, a qualitative data analysis computer software, for thematic analysis. Following Spiggle's (1994) guidelines, the data collected was coded and categorized following specific themes. Different themes emerged and were then integrated under higher-order conceptual constructs. Coding initially led to 137 themes which were consolidated and re-labeled based on redundant codes. The different themes were then consolidated into categories leading to the emergence of the suggested model (see Figure 2). Grounded theory principles were followed by collecting data and analyzing it at the same time. While coding the data on NVivo, comparisons were made with other interviews to evaluate if additional interviews were still needed. According to grounded theory, the sample size of the interviews is flexible (Chun Tie et al., 2019). Within this framework, data collection and simultaneous data analysis allowed for real-time judgments about whether to conduct further interviews. As mentioned by Corbin & Strauss (2007) when data collection is no longer bringing incremental benefit, this means the researcher has reached theoretical saturation and data collection can be stopped. Although data reached the saturation point at the 15th interview, fifteen additional interviews were conducted to ensure no important themes were missed.

Figure 2
Suggested Model



Results

We begin the results section by describing the broader online teaching and learning environment through the analysis of Twitter data. From here we continue to the results emanating from the interviews.

Twitter Results

Results showed that the majority of tweets are associated with positive emotional expressions. As shown in Table 2, trust, anticipation, and joy dominate the total expressions. The most recurrent negative emotional expressions convey sadness and fear.

Table 2
Emotional Expressions in Tweets Posted Between September 2020 and April 2021.

Emotion	**Count**
positive	3492
negative	775
trust	1310
anticipation	1285
joy	1158
sadness	646
fear	560
surprise	234
anger	195
disgust	69

In Table 3, the different terms used by Twitter users to express feelings towards online teaching and learning during the COVID-19 pandemic appear. Focusing on the most prevalent sentiment of trust, we see the most used affective terms are *gain, inspiration, achieve, create, successful*, and *hope*. These tweets were calling for keeping hope and trying to succeed and achieve the best results in OTL through creativity and inspiration:

- Tweet 47- Teaching is complex after the pandemic. Here are some ways to leverage what you know to achieve student engagement…
- Tweet 513 - The best teaching resources on the web … #educator #inspiration #stem #COVID #tutoring #success #parenting #music #teachingideas #life #technology #language #parents #COVID19
- Tweet 1632- Reinvent life and prepare for the future #life #education #onlinelearning #remotelearning #highereducation #COVID19

Anticipation is expressed through terms like risk, prevention, planning, excited, and improve:

- Tweet 1598- The transition to online learning was the culmination of weeks of planning … Learning talks about the transition, challenges; surprises of #COVID19.

Negative emotions such as sadness, fear, and anger are expressed through terms like struggle, devastating, loss, isolation, risk, quarantine, disruption, and fighting:

- Tweet 77- And once again online uni. I know it's for the best but let the struggle begin …

- Tweet 339- Stay home safe doing online or remote learning! Don't risk your life on campus! #COVID19 #pandemic #SocialDistancing #StayHome #Masks #remotelearning #onlinelearning #college …

Table 3
Different Terms Used to Express Feelings

Feelings	Terms used to express feelings
Anger	disruption, bad, fighting, inequality, loss, unfair, painful, distracting, devastating, scream, anxiety, killing, failing, broken, death, confusion, struggle, crazy, threaten, lonely, insane, violence, terrible, battle.
Fear	risk, quarantine, struggle, force, confusion, devastating, pandemic, emergency, scream, loss, failing, assault, outcry, challenge, problem, emergency, awful, infectious, difficult, pain, worse.
Sadness	struggle, devastating, loss, isolation, doubt, pandemic, terrific, overwhelmed, bad, disaster, weary, lonely, disappointed, painful, awful, restrict, disability.
Disgust	hypocrite, disappointed, death, provoking, disgraceful, homeless, disease, unbearable, infectious, unhealthy.

Anticipation	risk, prevention, planning, excited, improve, tomorrow, expect, coming, prevail, ready, inspiration, progress, preparation, production, advocacy, vision, independence, brilliant, longing.
Surprise	sudden, alarming, surprising, emergency, unprecedented.
Joy	inspiration, good, excited, bounty, success, thankful, laughter, hope, freedom, proud, love, companion excellent, passion, resources, generous, safe, wonderful, helpful, happy, joy, delighted, peace.
Trust	gain, inspiration, achieve, create, successful, hope, resources, proud, feet, improve, journey, generous engaged, independence, progress, organization, inspiration.

The results in Table 2 show that positive emotions dominate the investigated tweets during the COVID-19 pandemic and these emotions served in part to mitigate the negative impact of the crisis. Other studies have shown that students experiencing positive emotions throughout a flu pandemic retained higher trust in their college health center (Kim & Niederdeppe 2013). In fact, in times of crisis, fostering positive emotions can contribute to raising trust and effective coping, decreasing physiological arousal in the short term, and the risk of depression in the long term (Fredrickson, 2001; Kim & Niederdeppe, 2013).

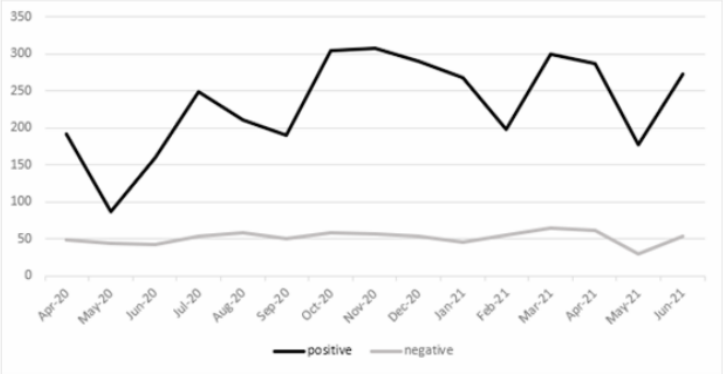
A recent study on collective emotions in tweets related to multiple topics including political, everyday life changes, and the pandemic; the COVID-19 pandemic showed that while positive emotions remained stable during the pandemic, negative expressions reflected an early, strong upsurge of anxiety then a high level of sadness and anger three weeks after the COVID-19 outbreak and onwards (Metzler et al., 2022). In our case, negative expressions remained relatively stable, whereas positive emotional expressions were constantly changing. As shown in Figure 3, between April and May 2020 these expressions were decreasing, and then they increased between May and July 2020. This pattern of decrease and increase is seen between July and October 2020 as well as January and June 2021. The emotions mostly contributing to this pattern are joy, trust, and anticipation.

We believe the variation of emotional expressions relates to worldwide COVID-19 lockdown measures. For instance, in most countries, the first lockdown started in March 2020 and ended in June 2020; Figure 3 reflects this change as an increase in positive emotions between June and July. These fluctuations also align with the different times schools announced their online teaching plans relative to the semester starts. It is interesting to note that when the positive tweets decreased there was no similar increase in the negative tweets thus the total number of tweets to these hashtags drops in these periods.

While the prevailing positive sentiment in this corpus of tweets is surprising, it serves to point to the way in which the teaching and learning community as a whole sought to use their privileged teaching/learning role to provide knowledge and mentorship. This, in many ways, at the global scale reflects what each individual faculty member found at the micro-scale, as noted in the interview results highlighted in the next section.

Figure 3

Negative and Positive Emotions Expressed in Twitter Hashtags Between April 2020 and June 2021



Interview Results

According to the interviewees, faculty were not consulted if they wanted to teach online as this was a crisis and there was no time for any negotiations. Decisions were imposed top-down. Faculty members who were asked to teach online were living uncertainties. From the 30 interviewees, 27 had no caring role at home and 3 had caring roles. Table 5 summarizes the most frequently occurring themes across all interviews and the number of interviews in which each theme was mentioned.

Table 5

Interview Themes

Group	Theme	Overall Frequency of Occurrence	Number of Interviews in which Mentioned
Online teachers will have to play several roles	Faculty role	22	13
	Faculty training	17	13
Online Pedagogy	Advantages of online	20	10
	Faculty adaptation	24	11
Barriers to OTL	Emotional distress/faculty concerns	94	16
	Student concerns	14	11

Broad overarching themes emerged from the data collected, including emotional distress as the most frequent theme among faculty concerns, along with COVID-generated acceleration of digital transformation, and characterization of faculty's disruptive and challenging journeys. These first-order themes then led to second-order themes such as online teachers' roles, online pedagogy, barriers, and challenges. The different themes were helpful to understand the various tangible and intangible aspects associated with OTL. For example, lack of resources and the use of technology are tangible aspects, while the faculty experience and roles are intangible aspects.

From this reading, a codebook of 22 codes was generated and then analyzed to highlight existing patterns and shared characteristics resulting in six themes.

"Faculty role" and "faculty training" gave more information on the role of faculty in teaching online during COVID. The categories "advantages of online" and "faculty adaptation" contributed to faculty satisfaction and increased the chances that they would continue to teach online even post-pandemic. "Emotional distress" and "student concerns" detailed the negative impact of the online experience during the crisis.

When asked the question "How did you approach your students online?" most interviewees mentioned that their first email was comforting, telling the students not to worry and that all will be okay; this highlights the coaching and mentoring role played by faculty.

Interviewee 1 who is a 54-year-old female, full-time Associate Professor, and a resident in the EMEA region with no online teaching experience pre-COVID-19 explained:

> I was asked to teach my class online at the same time when both my kids had their online school classes. So, we were 3 using the bandwidth at the same time, hearing each other's classes, and we were among the few lucky families who had 3 different devices to use. Many of my students told me they had to share and take turns in using one laptop! I felt sorry for them. I had to find ways to relieve my students from the stress they were facing because of uncertainties and the lack of resources. I first sent a comforting email telling them I am here to support them and to help them finish their course successfully. I spent time talking to them about their well-being, we are in this together and it shall pass, we will overcome the challenges I said. I even gave them my mobile number, I regretted this later [laugh] as I was bombarded day and night with their messages. But I felt I am not only their teacher. I had another role to play; I was their mentor and coach.

Another faculty member, a 60-year-old female, living alone in the EMEA region with no caring role said she would not teach online if she had the option not to. Specifically, she said that:

> I felt my role was no longer only teaching; I had to learn how to use online platforms such as "Teams," how to use Zoom, how to use WhatsApp, and all these things I dreaded using before. I had to find ways to engage my students during very challenging times. That was not an easy task. I have taught accounting for so many years in a classroom using a board and my markers. My course is not designed to be taught using a screen and a keyboard. This experience raised a flag that to teach a course online you need to design it differently. I am glad I will not have to do that as I will be retiring soon.

Interviewee 10 was a young faculty member, a 37-year-old male, with 5-10 years of experience, from the Americas, not living alone with no caring role who considered online to be the future of education. He mentioned:

> As this is the future, we need to embrace this new pedagogy and develop our roles that will no longer be restricted to teaching. As a faculty member, I believe I have to enhance my mentoring and coaching skills. I have also started learning some design skills so I can adapt my course to be taught online more interactively and interestingly. I think the university should invest in developing online courses post-COVID. They need to learn from this experience and be ready for the change. It is clear that hybrid is the future post-COVID, and we will see more and more universities offering online programs. Also, countries that have been resilient in accepting such programs will have to adapt and legislate that soon.

Interviewee 30, a 58-year-old male from the Asia Pacific, who held a Deanship position said:

> AI will even be used in the near future to help faculty in the many roles they will be playing and in giving instant feedback to students and answering their basic questions instantaneously. Each faculty will help their online assistant.

Most of the interviewees in our sample (19 out of 30) did not teach online before the COVID-19 pandemic. However, 25 of them would teach online in the future if they had the option not to and 28 out of 30 believe that the future will be hybrid.

In terms of institutional support, interviewees described the need for faculty training in the online environment. The pandemic caught universities by surprise, and most of them did not provide appropriate faculty support such as faculty training to face the crisis and successfully move their courses online. Interviewee 25, a 60-year-old male Dean in the EMEA, mentioned that:

> We saw this (the lockdown) coming even before the government. So we decided to move forward our semester break and use it to train our faculty on how to use the online platform in preparation for the upcoming crisis. I can proudly say that we were able in my school to train 95% of the faculty to be ready. And they were!

This was not the case with all other interviewees. Most responses revealed a rigorous workload on administration and IT staff during the sudden shift. When asked the question, "How were you asked to move online?" Most said that there was no prior consultation as this was a crisis. When asked about their feelings about such a sudden shift, most said there was no other way to try and help the students and they had to adapt, but if they had proper training this shift would have been smoother. The question about how they approached students online triggered faculty to talk more about the need for training. Most interviewees did not have prior online training and that was a challenge. Interviewee 1, a 54-year-old female with no prior online teaching experience pre-COVID, said:

> After 26 years of experience, learning a new skill all by myself is not easy. I was overwhelmed I was not able to start my online class on time because of technical difficulties. I felt behind, and I wondered what my students will think of me! I did not want them to say that I was an old, outdated professor. I needed support and

> since I did not have proper training, I called the young IT guru faculty members who shared with me some tips. IT staff were also very helpful but very overwhelmed with all the enquiries they were receiving. I just wish I knew how to use Teams before the crisis.

Interviewee 11, a 46-year-old male described his normal teaching routine that did not include the use of any technology:

> Suddenly I had to stop going to my classrooms, seeing, and talking to my students, writing on the white board…I was expected to do the same but virtually. I was not ready, and it took me a lot of time and effort to adapt.

Interviewee 4, a 74-year-old male, described the training offered to faculty members as follows:

> At the university level we were offered general training on how to use the online platform. But faculty needed to know how to specifically deliver their own subject online. Teaching economics online is different than teaching marketing for example. The general training was done online as we could not physically access the university premises and that also was challenging for me. Faculty members were expected to teach their lessons during normal times and keep regular office hours for students to contact them. They were also asked to give regular feedback and discuss any issues with their students.

Interviewee 2, a 58-year-old male, shared his concerns about not being able to appropriately use annotations online, or even to find appropriate tools to engage the students. He said, "I believe having appropriate training would make me feel more confident in this virtual environment."

In most cases training came after the start of the online course. Interviewee 16, a 58-year-old male, said:

> We didn't have time for training did we. This caught us by surprise. Friday March 20 the initial long lockdown came into effect with measures in place to restrict movement domestically. All nonessential movement was prohibited with permission to leave the houses to shop for food and medicine, or to go to work with the required permits issued by authorities. Schools and universities had to close, so we did not have much time to prepare. But we did it with no trainings at first. Training followed once classes started online a month later.

All interviewees in the sample did not have full training on how to teach online. This was one of the main challenges they faced as they had to learn using different platforms and familiarize themselves with online teaching technology in a very short time relying on themselves and the peer networks they had before the pandemic. In general, a positive attitude dominated with the interviewees who, despite the challenges, wanted to ensure students came first and adapted to the change.

Discussion and Conclusion

This study examined how institutional support and faculty roles combined to yield various OTL outcomes during the COVID-19 crisis and what the implication of those outcomes might be in the future. More specifically, the sudden move from face-to-face teaching to online delivery of material due to the COVID-19 pandemic had and will continue to have an influence on the broader OTL experience. In an attempt to understand this rapid transition through the faculty member lens, we first contextualized the rapid shift to OTL by extracting different emotional expressions manifesting on Twitter. These expressions provided insights into how the online community felt about the overall experience. After drawing a generic understanding, we applied a traditional interview method to gain a deeper understanding of the faculty experience. We examined the different roles faculty had to play during the pandemic and the institutional support that was given to them. Interview results aligned with the general emotions expressed on Twitter during the pandemic. For instance, while Twitter data showed that the most expressed emotion was trust, the interviews indicated, in accordance with previous research (Ersin et al., 2020; Wright et al., 2023; Yao et al., 2020), that faculty played different roles such as mentoring, coaching, and supporting their students—all roles that help in building trust. Moreover, the interviews showed that faculty expressed concerns about uncertainties and in parallel, the tweets expressed emotions associated with uncertainty—anticipation was the second most frequent emotion in the dataset. The interviews showed that emotional distress due to a lack of preparedness is one of the barriers to OTL, and similarly the online community expressed fear and sadness. These results confirm literature which suggests that faculty in OTL need to have the support and the resources in order to be confident with the online teaching experience (Krishan et al., 2020; Majewska & Zvobgo, 2023).

Aside from the alignment between the emotions manifest in the tweets and the experience expressed by faculty through the interviews, we can draw two primary conclusions relative to the future of OTL in higher education in the post-pandemic era. First, younger faculty and those more comfortable with technology are happy to embrace OTL and believe that hybrid teaching is the way of the future. This result is not particularly unexpected. Second, in contrast, is the revelation that nearly all faculty members—even those who were not comfortable with technology prior to the crisis—are willing to teach using this modality in the future. This finding, while unexpected, can be explained. Overall, the faculty interviewed noted that while their institutions dictated the transition without negotiation, there was institutional support for the transition—even if late or limited. This support coupled with the positive, supportive emotions reflected by the OTL community on social media seems to have helped faculty view the experience positively. Furthermore, the discovery by faculty that they could effectively play the multiple roles of mentor, coach, and educator online likely led to a feeling of achievement and positive view of OTL for the future.

This brings us to the key recommendations emanating from this work. Faculty need to have training in the skills to succeed in the online environment and maintain appropriate academic knowledge and communication with their students to overcome any challenges and hurdles. It is the continued provision of well-designed technological support that is critical to the maintenance of OTL as a long-term strategy within higher education. Future research could examine the design of OTL support for faculty focussing on specific facets of both the teaching

and learning experience such as hybrid learning or artificial/virtual reality-enabled learning and the differential impacts of faculty training levels relative to different student groups.

In this study, positive emotion and the capability of faculty to adapt and move on during the crisis by playing different roles despite the limited support given by their institutions could serve as a lesson for any possible future crisis. Education is delivered by the faculty to students, meaning that any change or implementation of a new mode of teaching and learning must include appropriate, positive communication. To prepare for future crises, universities should look back and reflect on what engendered positivity during the crisis and what didn't.

Limitations and Suggestions for Future Research

This study includes interviews with 30 faculty members from business schools in different universities working during very challenging times. Scholars are encouraged to collect data from a more diverse population in other schools and disciplines. Furthermore, a longitudinal study would serve to capture the retrospective view of faculty with the aim of determining when the "freezing" phase of change management occurred, what changes froze, and what changes have since thawed.

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All R Scripts used for analysis are available upon request from the corresponding author; study data is in some cases proprietary or confidential, sharing may be possible in some cases – requests should be directed to the corresponding author.

Two ethical approvals were granted prior to the data collection, one from Durham university where one authors was doing her doctorate and one from the Lebanese American university where the same author was working:

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The Viability of Topic Modeling to Identify Participant Motivations for Enrolling in Online Professional Development

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Abstract
Identifying motivation for enrollment in MOOCs has been an important way to predict participant success rates. In this study, qualitatively coding discussion forums was combined with topic modeling to identify participants' motivation for enrolling in two successive statistics education professional development online courses. Computational text mining, such as topic modeling, has proven effective in analyzing large volumes of text to automatically identify topics or themes. This contrasts with traditional qualitative approaches, in which researchers manually apply labels to parts of text to identify common themes. Combining topic modeling and qualitative research may prove useful to education researchers and practitioners in better understanding and improving online learning contexts that feature asynchronous discussion. Three topic modeling approaches were used in this study, including both unsupervised and semi-supervised modeling techniques. The topic modeling approaches were validated and compared to determine which participants were assigned motivation themes that most closely aligned to their posts made in an introductory discussion forum. Though the three techniques have varying success rates in identifying motivation for enrolling in the MOOCs, they do all identify similar themes for motivation that are specific to statistics education.

Keywords: MOOCs, topic modeling, online professional development, discussion forums, motivation

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Introduction

Massive Open Online Courses (MOOCs) are a form of online professional development (OPD) that can be useful for learners to communicate and provide professional development (PD) that is on-demand and timely. Rising enrollment in MOOCs has led many researchers to explore participant motivation for enrolling (Boroujeni & Dillenbourg, 2019; Douglas et al., 2016; Frankowsky et al., 2015; Kellogg et al., 2014). Despite the advantages MOOCs offer, MOOCs have high dropout rates, and literature suggests this may be tied to participant motivation (Badali et al., 2022).

Motivation can have a positive impact on the participant performance in a MOOC. Researchers have linked motivational goals for taking a course to engagement levels (Littlejohn et al., 2016, Milligan et al., 2013) and retention rates (Xiong et al., 2015). Identifying motivation for enrolling in MOOCs is often achieved by analyzing enrollment surveys (Creager et al., 2018; Hollebrands & Lee, 2020; Moore & Wang, 2021; Wilkowski et al., 2014). Using enrollment surveys may limit the motivations that can be identified to just closed-ended choices. A richer data source to identify motivation may be introductory discussion forums.

Topic modeling is an unsupervised learning method that can be used for classifying large groups of texts into discrete word groups (Silge & Robinson, 2019). Since reading and identifying themes for motivation on a large volume of discussion forum posts can be a daunting task, using topic modeling may be an appropriate alternative to traditional qualitative methods of identifying themes.

This paper aims to chronicle how three different methods for topic modeling were used to identify participant motivation from discussion forum posts and why these methods may prove useful for other educational researchers. The following sections include a literature review of prior research, a methodology section detailing the three topic modeling methods, the results of each method, and finally a discussion highlighting the importance of this work. We hope to provide a different way to categorize themes for motivation specific to the courses in this study, rather than themes generic to any MOOC.

Literature Review

This literature review will provide an overview of the methodological approaches that researchers have used to identify motivations for individuals to enroll in MOOCs. We will first discuss how enrollment surveys have been used to identify motivation, the most common approach. We will then introduce how traditional qualitative methods, such as hand coding qualitative data, have been used to identify motivation. Finally, we will explore the potential advantages that topic modeling may have over traditional qualitative methods.

Enrollment Surveys

MOOCs provide participants autonomy in engagement in courses, making it important for researchers and practitioners to understand what motivates participants to enroll. In a systematic review of 50 studies, Badali et al. (2022) identified the role motivation plays in

retention rates in MOOCs. Of the 50 studies, 64% used quantitative methods, 16% used qualitative methods, and 20% used mixed research methods. Badali et al. classified the motivational factors into two broad themes: need-based (academic, course, and professional) and interest-based (social, personal, and technological). The data collected for these studies were interviews (18%), surveys (70%), and a mix of interviews and surveys (12%).

Identifying motivation for enrolling in a MOOC is often achieved by asking for responses to closed-ended questions on enrollment surveys (Brooker et al., 2018; Creager et al., 2018; Hollebrands & Lee, 2020; Moore & Wang, 2020; Wilkowski et al., 2014). Wilkowski et al. (2014) sought to identify groups based on their motivations for enrolling in a MOOC hosted by Google. Participants were asked about their motivation on the enrollment survey. Possible answers included learning about aspects of the course or earning certain certificates. Moore and Wang (2020) examined the responses of an enrollment survey for a MOOC from Harvard University to identify underlying profiles for students' motivations to learn. Using Latent Profile Analysis, students were grouped as intrinsic or extrinsic learners. Moore and Wang found that those who were grouped as intrinsically motivated tended to have higher rates of course completion.

Closed-ended questions on enrollment surveys limit the types of motivations that can be identified to only those listed on the survey. Providing a space for participants to express their motivation outside of a closed-ended survey may provide a richer overview of what brings participants to a MOOC.

Qualitative Approaches

Another alternative space for identifying motivation, outside of enrollment surveys, could be in online discussion forums. Online discussion forums are spaces where participants can interact and express their individuality. Tang et al. (2018) used responses to introductory discussion forums in one MOOC to identify learners as extrinsically or intrinsically motivated. Two researchers read a total of 444 responses and used the constant comparative method to qualitatively code each introductory discussion forum post. No other studies were found that used introductory discussion forum data as an identifying source for motivation.

Qualitative approaches to analyzing discussion forum data have been done by many other researchers. Despite large numbers of discussion forum posts, researchers have tackled analyzing the data using qualitative methods by reading each post to identify themes. Nandi et al. (2012) used a grounded theory approach through open coding to identify the quality of interactions between participants and instructors in two courses that had 1,352 participants. Wang et al. (2015) used a discourse framework to hand code 7,990 discussion forum posts for a psychology MOOC. Hollebrands & Lee (2020) used open coding (of 977 posts) to identify what triggers may have caused a shift in participants' beliefs during their participation in an OPD for statistics teachers.

These studies showcase the range of questions that can be answered by using qualitative data analysis approaches, but these approaches are time-consuming. Perhaps text mining techniques may be a more efficient way to analyze a large corpus of data, such as discussion forum data in MOOCs.

Topic Modeling

Text mining is a computational approach to analyze large collections of text to try to make meaning of data (Hearst, 2003). Topic modeling, which consists of both unsupervised and supervised machine learning methods for text mining, is used for classification of large groups of texts into discrete groups of words, or "topics" (Silge & Robinson, 2019).

Unsupervised topic modeling groups words, based on certain statistical criteria, that become the topics for a large corpus of data (Silge & Robinson, 2019). It is up to researchers to interpret these topics as they apply to the data. Ezen-can et al. (2015) used an unsupervised topic modeling technique to create seven clusters from 550 discussion posts that were part of a MOOC for educators on digital learning. Latent Dirichlet Allocation (LDA) was then used on the posts in each cluster to identify the textual themes.

Reich et al. (2016) used topic modeling to analyze themes of 350 posts in an educational policy MOOC. The topics found described patterns of discussion in the forums on the use of school vouchers and feelings about instituting the Common Core. Vytasek et al. (2017) applied four unsupervised topic modeling approaches to a set of 813 posts in a medical statistics MOOC. They found that the best way to make sense of the topics was to nest the topics as subtopics that are part of more general topics.

Seeded topic modeling is a semi-supervised learning method that identifies topics using a predetermined seeded dictionary of terms (Watanabe & Xuan-Hieu, 2020). Ramesh et al. (2014) used a semi-supervised learning method of fitting a LDA model by inputting a seeded dictionary of terms to identify topics that they assumed should be common to the context of MOOC discussion forums. Wong et al. (2019) were able to show that using a seeded LDA method was effective for tracing forum posts back to topics specific to a MOOC.

Nelson et al. (2021) recognized the gap that may exist between hand coding text and using computational methods to identify themes in socially constructed content. Nelson et al. used three common computer text mining approaches, dictionary, supervised, and unsupervised machine learning, to compare the results of the computerized text mining to previously hand coded textual data. Newspaper articles had already been coded based on themes on income inequality. Nelson et al. found that the unsupervised machine learning method worked best and 91% of the articles were coded with the same theme as the hand coding method.

Building on the motivation research, prior qualitative approaches to analyzing discussion forum data, and topic modeling approaches, has led to the research question: how can topic modeling be an effective tool for classifying the motivations of participants who enroll in online professional development courses for statistics educators?

Methods

Context and Participants

The data in this study is a large collection of posts from discussion forums in two online professional development (OPD) courses designed for statistics educators, primarily those

teaching in middle schools (age 11) through introductory college courses. The context of this study is critical in understanding the outcomes of the topic modeling approaches used.

Statistics has made an impact in the mathematics curriculum, which has led to challenges in preparing teachers to teach statistics. Professional development (PD) opportunities for teachers of statistics have been implemented to foster the knowledge, skills, and dispositions necessary to effectively teach the subject. The American Statistical Association (ASA) endorsed the Statistical Education of Teachers (SET) report to guide pre- and in-service teacher preparation for teaching statistics (Franklin et al., 2015). The SET report stresses the need for professional development at the local or state level to aid mathematics teachers to teach statistics, while also recognizing the limitations of providing such professional development (Franklin et al., 2015). OPD) can be a way to provide this PD for those who need it (Lee & Stangl, 2015). The second author and her team created two OPD courses (Course 1 and 2) for statistics educators. Each course is meant to enhance teachers' understanding of statistics and teaching strategies in middle school through introductory level college courses.

The two online courses analyzed were created to provide high quality OPD for statistics educators. The "overarching goal of Course 1 is to engage participants in thinking about statistics teaching and learning in ways that are likely different from their current practices in middle school through college-level introductory statistics" (Hollebrands & Lee, p. 4). Course 2 was meant to be an extension of Course 1 while emphasizing inferential reasoning.

Course 1 was offered seven times, with the first offering in fall 2015 and the last in fall 2018. A total of 3,115 people enrolled in Course 1. Course 2 was offered three times, fall 2017, spring 2018, and spring 2019, with a total of 700 people enrolled. The courses were asynchronous. Each course had an orientation unit and five units of learning material.

Of the 3,815 total people enrolled in either course, 1,592 accessed at least Unit 1 of a course; those are the participants included in this study. Researchers have found a high drop-off rate of participants after the first unit of MOOCs (Hollebrands & Lee, 2020; Erikkson et al., 2017; Onah et al., 2014), which likely indicates participants visited and found they were no longer interested or no longer had the time to participate.

There are participants who enrolled in more than one course or enrolled in another section of the same course. Since motivation can change over time, it was decided to treat each time a person took a course as a separate participant. Participants are identified using their numeric user identification and course identification numbers (userid_bycourse). Of the 1,592 unique participants, 357 registered for more than one course, resulting in 1,949 participants for analysis purposes.

Discussion Forum Data

The data for this study is from the first discussion forum, in the orientation unit of each course titled *Meet Your Colleagues*. The prompt asked participants to introduce themselves and share why they enrolled in the course. Participants can either create a new thread or respond to other participants. Initial posts and replies were included in the data for this study.

Discussion Forum Data Preparation

In unsupervised topic modeling there are often topics that are found that do not always make sense to the user (Hu et al., 2014). To avoid the general topics that naturally arise, the data was prepared prior to modeling so that the discussion, or noise, that is not centered on motivation was reduced as much as possible. An exploratory topic modeling approaches was used to isolate relevant data.

Identifying parts of posts that may prove useful for identifying themes for motivation for taking these specific courses may not be obvious to anyone able to perform topic modeling. Thus, it was critical that the researchers were familiar with the data. The authors' expertise includes OPD for statistics teachers, so they are familiar with what motivates people to enroll in courses like these. Additionally, the authors have worked with discussion forum data from these course offerings in the past, offering a unique perspective to the best ways to prepare this specific set of data for topic modeling.

All posts from the *Meet your Colleagues* forum in the orientation unit were collected from each of the course offerings. This resulted in 1,639 posts. (Note that not all participants posted in this forum.) These posts were blinded by removing all mentions of names or locations. Many entries included introductory information about the participant, such as what they teach, where they are from, etc. For instance, in the following post, the first part is introductory information about where they teach. The second sentence was retained for analysis. "Hi, all. I have taught an Elementary Statistics course at ---- Community College for 14 years.; I have a few classroom activities that I use regularly, and I would like to get additional ideas for activities to keep my students engaged."

After reading all posts, 1,099 were considered to pertain to motivation. The 1,099 posts include multiple posts that may have been made by the same participant. The posts could have been initial posts creating a new discussion thread or replies to posts. Replies were kept for analysis purposes as well as initial posts since there were often clues to their motivation for taking the course within reply threads. Since we are interested in what motivates each participant to take the course, any posts that were made by the same participant in a specific course were merged so that when performing topic modeling the corpus of posts from each user would be read as a single document, rather than multiple documents from each user. This eliminated the possibility that more than one topic could be applied to any participant. In all, there were 946 unique participants with usable discussion posts. Thus, there were 946 documents used for topic modeling. These documents are the unit of analysis.

Identifying Text Terms in Document

To perform topic modeling, posts must be broken down, or tokenized, into strings of individual words (Silge & Robinson, 2019). These individual words form what are called a document term matrix (DTM). In the DTM, each row represents one participant's document and each column represents one word. The count of each word is recorded for each participant in the corresponding cells. The DTM was created in R using the CreateDTM function which is part of the textmineR package (v.3.0.4; Joanes & Doane, 2019). Stop words were removed

from DTM prior to performing topic modeling to ensure that common English words such as *a*, *the*, *and*, etc. did not become grouped into topics (Silge & Robinson, 2019).

Stemming can be used in topic modeling to group words with the same stem (Wu et al., 2017). For instance, *learn*, *learning*, and *learned* all have the same connotation. The Porter stemmer method (Porter, 1980) was used to stem words in the posts using the stemmer function in the SnowballC package (v.0.7.0;Bouchet-Valat, 2020). There are those who caution that the use of stemming can degrade the topic modeling process (Schofield & Mimno, 2012). The decision to use stemming was made after an exploratory topic modeling approach was done without stemming words. This exploratory approach had words such as *statistics*, *statistical*, *statistic* or *learned*, *learning*, and *learn* appear so often in the topics that other words that may be helpful in identifying topics did not appear as top words. After the stemming approach was used, which combined *statistic*, *statistical*, and *statistics* to just the stem *statist*. This made room for other meaningful words to appear such as *engage* or *science*.

The DTM can be made using one word grouping or any n-sized groups of words. For this analysis, the DTM was made of one- and two-word groups, unigrams and bigrams, respectively. Wang et al. (2007) developed a topic modeling approach using groups of words to identify relevant two-word groupings such as "white house" as well as unigram and other n-gram phrases. Similarly, we used two-word groups were used to capture terms such as *build confidence* or *statistical thinking*. Including these terms would help to distinguish between words such as *learn_statistics* and *teach_statistics*. If we did not use bigrams, *statistics* would just be counted once, but we know that the motivation to learn statistics is much different than being motivated to teach statistics. Any two successive terms were considered bigrams. It is possible to look at n-gram groupings higher than n = 2 to capture more phrases. Researchers have found interpreting topics with these higher order phrases is possible, but requires programming methods specific to phrases, instead of words, which were not used in this study (Das et al., 2016; Huang, 2018; Schmiedel et al., 2019).

After the DTM was created, topic modeling was performed on a random set of 100 posts to test if any words outside of common stop words appeared more often that may not have meaning when identifying motivation. This topic model had the following terms appear most often: *ways*, *wait*, *looking forward*, *hope*, and *take*. These terms were removed from posts before creating the DTM.

The following illustrates how the steps identified above were used to clean the posts that were used to create the DTM. Below are the combined posts for participant 4451_9.

> My Name is xxx, I teach at xxx in xxx. I teach AP Statistics and am hoping to get some ideas of how I can encourage my colleagues to incorporate more statistics and data collection into their courses so that a course such as mine isn't the first time that students are exposed to Stats. It seems that most of high school courses lead students to Calculus, but I think that Statistics is much more interesting and applicable to more students.

After going through the steps described above, the following words were included in the DTM for participant 4451_9. Cleaned documents, like the one below, were used to create the DTM.

Stop words and stemming still appear in this step, those were not filtered out until the creation of the DTM.

> I teach AP Statistics and am get some ideas of how I can encourage my colleagues to incorporate more statistics and data collection into their courses so that a course such as mine isn't the first time that students are exposed to Stats.

The resulting DTM was a matrix with 946 rows (representing the participants) and 8,933 columns (representing the 1- or 2-word groups). The cells of the matrix are the number of times each word(s) occurred for that participant. Figure 1 shows that participant 10014_52 used the word *as* 1 time, whereas participant 10185_52 used the word *as* 4 times. The complete row for each participant has all possible unigrams and bigrams, 8,933 columns.

Figure 1
Truncated View of the DTM

	as	i	get	closer	to	graduation	,	am	seeking	enhance	my
10014_52	1	2	1	1	4	1	1	1	1	1	4
10040_40	0	2	0	0	2	0	1	2	0	0	3
10168_52	0	2	1	0	4	0	1	1	0	0	1
10168_76	0	0	1	0	1	0	0	0	0	0	0
10185_52	4	9	0	0	5	0	5	0	0	0	4
10204_52	0	2	0	0	2	0	0	1	0	0	2
10215_52	0	0	0	0	0	0	0	0	0	0	0
10221_52	1	1	0	0	2	0	2	0	0	0	2
10223_52	0	1	0	0	2	0	1	0	0	0	1
10225_52	0	4	0	0	5	0	0	2	0	0	0
10225_76	0	6	0	0	3	0	1	1	0	0	1
10248_52	0	1	0	0	1	0	0	1	0	0	1
10280_52	0	3	0	0	2	0	2	1	0	0	1
10290_52	0	1	0	0	3	0	0	1	0	0	2
10301_52	0	1	0	0	2	0	1	0	0	0	0
10334_52	0	3	0	0	4	0	1	1	0	0	1
10344_52	0	5	0	0	5	0	2	0	0	0	4
10344_76	1	2	0	0	4	0	2	2	0	0	2

Topic Modeling Analysis

The purpose of this study is to determine the ways in which topic modeling could be an effective tool to identify themes without traditional qualitative coding. There were three topic modeling approaches used in this study, referred to as Method 1, 2, and 3.

Method 1

Method 1 used an unsupervised learning method, using a computer algorithm to determine a list of unknown topics without input from the researcher. Though the number of topics must be predetermined, which topics are chosen is entirely determined by the topic modeling algorithm. A LDA model was used to assigned topics to the DTM described above

(Silge & Robinson, 2019). LDA considers every document as a mixture of topics and every topic a mixture of words (Silge & Robinson, 2019). This means that for any document the LDA model may deduce that the terms in document A are 60% from topic 1 and 40% from topic 2, not assigning each document only one topic. Each topic is made up of a mixture of words, which can also overlap. Topic 1 may have the words *bell, ring, and chime* and Topic 2 could have *married, ring, and partner* LDA is a mathematical model that determines the likelihood of a document relating to each topic while simultaneously determining the likelihood that a word belongs to a topic (Silge & Robinson, 2019). The *LDA* function uses probabilistic functions to determine a beta value and gamma value using a predetermined number of topics. The beta value is the probability that a single word belongs to a topic. The gamma value is an estimated proportion of words from each document that belong to a topic (Hornik & Grün, 2011).

Identifying topics using method 1. Method 1 used the *LDA* function in the *topicmodels* (Grun et al., 2021) package in R to assign a mixture of words to each topic as well as assign a topic to each document (Silge & Robinson, 2019). The *LDA* function requires a DTM and a user assigned number of topics, *k*. For this function, the DTM constructed for the discussion posts was an input as well the number of topics, k = 6, which was based on the results of the *FindNumberTopics* function that is part the of the *ldatuning* package (v1.0.2; Nikita & Chaney, 2020).

Themes for the six topics were determined using their respective "bag of words"—the top 20 words with the highest beta value. Each bag of words was analyzed to identify a motivating theme. These were distributed to other mathematics and statistics education researchers to ask for their interpretation. Six volunteer researchers read the 20 words associated with each topic and completed the prompt "This group of participants is motivated to take this course because…" Using these responses, as well as knowledge of the goals of the course, and reading many of the discussion posts prior to analysis, we decided on themes for each topic. The themes identified will be discussed in the results section.

The *LDA* function also assigns each document and its assigned topic a gamma value. The gamma value is the proportion of words from each document that are generated from the assigned topic (Silge & Robinson, 2019). The higher the gamma value, the higher the probability that the document aligns to a given topic. The *LDA* function can assign a document to more than one topic. For instance, a gamma value of 0.55 for topic 1 and 0.45 for topic 2 would show that about 55% of the words in the document are generated from topic 1 and 45% from topic 2.

It was decided to include topic assignments that had a gamma value greater than 0.5 for each participant. For the purposes of this research, we were interested in the one topic most likely associated with a participant. The topic for each participant was recorded. Of the 946 documents (collection of posts), all but six had a gamma value greater than 0.5. Thus 940 documents were assigned topics. Table 1 shows the topics generated using Method 1. For brevity, the 10 top words for each topic are shown. The title and theme of each topic were determined after trying to make sense of the bag of words applied to each topic.

Method 1 validation. After each document was assigned a topic, then each document was read to determine if the topic assigned was appropriate. Of the 940 documents assigned to a topic, 573 participants' posts, or 61%, were assigned to a topic that seemed appropriate for that collection of posts.

Table **2** shows the percentage of times it was determined each document was assigned correctly to a topic. Topic 6 was assigned "Yes" the lowest percentage of the time, with about 50% of the documents applying to the topic assigned. Topic 1 had the highest percentage of agreement, with 70% of the documents assigned appropriately.

Table 1

Topics for Motivation to Enroll Identified Using Method 1

Topic	Bag of Words	Theme for Motivation Described by Researchers	Description This group of participants...
1	Statist, teach_learn, student, teach_statist, excited, interested, class, educate, love, mooc	Teach and understand statistics using data	... is excited and interested in learning to teach and understand statistics with data.
2	statist, teach, learn, student, stat, teach_statist, class, data, teacher, curriculum	Preparing to teach new curriculum that uses statistics	...is interested in learning and teaching statistics (using technology and data) especially as it pertains to new curriculum.
3	learn, student, statist, data, teach, class, engag, experi, understand, teacher	Teach with data, make class engaging, and interact with others	... is interested in learning how to teach students using data and make the class more engaging and interesting.
4	statist, teach, learn, student, math, understand, mooc, knowledge, al, improv	Improve teaching/knowledge of statistics by incorporating data and technology	….is interested in learning how to teach statistics, to improve their knowledge of teaching statistics and excited to incorporate interesting data and technologies.
5	statist, teach, student, year, learn, school, high, high_school, interest, ap	Preparing to teach high school students, particularly AP students	... is preparing to teach high school students this year, particularly AP students, and wants to learn ideas to engage and interest students.
6	teach, statist, student, learn, teach_statist, class, year, stat, time, idea	Looking to get new ideas and resources to prepare for the upcoming year	... is excited to learn to teach statistics for this upcoming year and gain new ideas and resources.

Table 2
Method 1 Topics and Validity Count and Percentages

Topic	Researcher Determined Theme for Motivation	Total Documents Assigned Topic	Topic Correct by Qualitative Coding?			
			Yes		No	
			n	%	n	%
1	Teach and understand statistics using data	182	128	70.3%	54	29.7%
2	Preparing to teach new curriculum that uses statistics	155	93	60.0%	62	40.0%
3	Teach with data, make class engaging, and interact with others	168	107	63.7%	61	36.3%
4	Improve teaching/knowledge of statistics by incorporating data and technology	141	87	61.7%	54	38.3%
5	Preparing to teach high school students, particularly AP students	143	83	58.0%	60	42.0%
6	Looking to get new ideas and resources to prepare for the upcoming year	151	75	49.7%	76	50.3%
Total		940	573	61.0%	367	39.0%

The following illustrates an example of the validation process for a participant's collection of posts. Participant 13262_58 posted the following:

> I hold a Masters in Curriculum and Instruction and am completing this course because I despise numbers, despite the fact that I'm quite good with them. I tend to face my fears, lol.

Method 1 assigned this document Topic 4, "improve teaching/knowledge of statistics by incorporating data and technology." This post does not mention anything about this individual

wanting to improve their teaching or knowledge of statistics. Though it may be implied that this person is trying to improve their knowledge of statistics, every effort was given to apply validation on what was written, not what was implied. This topic assignment was not correct.

Method 2

Method 2 used a semi-supervised learning method, seeded topic modeling, to determine the topics specific to motivation. Qualitative methods were used to create a list of topics for motivation based on a sample of randomly chosen posts to create a seeded dictionary of topics.

Determining topics for the seeded dictionary. For Method 2 a seeded word dictionary was needed to create predefined topics to run a supervised topic model. The dictionary was created using a priori coding and in vivo coding (Creswell, 2013) to identify themes for motivation based on 10% of the discussion forum posts. Since there were 1,639 original posts from the introductory discussion forums, 164 random posts were chosen to code to identify motivation themes. The 164 posts were a stratified random sample of the 10 courses based on the percentage of posts to this forum in each course.

A priori codes were based on questions that were asked in the enrollment survey. Additional codes were created as the posts were read. The codes were combined to identify the themes for motivation (topics) as well as words to seed each topic. This resulted in 14 topics for the seeded dictionary (Table 3). For example, one topic was titled “confidence.” Those participants were motivated by an opportunity to increase their own confidence to teach statistics. The seed words for this topic were *confidence*, *confident*, and *build** (the * indicates the stem is used as the seed word).

Instead of defining the DTM as it was for Method 1, a data frame was made with a list of rows of two variables, userid and post. This data frame was then converted to a document feature matrix (DFM), which is the acceptable input for the *seededlda* function. Like the DTM from Method 1, the DFM has the rows of the matrix as the participants and the columns are all the words that appear in the corpus of posts. The dictionary and the DFM were fed into an LDA function that is part of the *seededlda* package to assign each participant a topic.

Assigning and validating topics per participants. To assign topics, the *textmodel_seededlda* function in the *seededlda* package was used (Watanabe & Xuan-Hieu, 2020). The function assigns each topic (see
Table) to a user based on the frequency of times the words appear in the DFM. The *seededlda* function returns a list of words that define each topic for each user. This will include the seed words from the dictionary as well as other words that fit into the theme based on the likelihood that each topic produces each term (Watanabe & Xuan-Hieu, 2020).

Like Method 1, the posts for each user were read and determined whether the topic assigned was appropriate. The results of this validation process were recorded for the overall posts as well as for each topic.
Table shows the number of documents assigned to each of the 14 topics for Method 2 and the number of valid assignments for each topic. Of the 946 documents, 463, or 48.9%, were

considered to have an appropriate topic assigned to them by Method 2. Additionally, 483, or 51.1%, were not considered to be assigned correctly.

Table 3
Method 2 Topics and Validity Count and Percentages

Topic	Title	Total Documents Assigned Topic	Topic Correct by Qualitative Coding?			
			Yes		No	
			n	%	n	%
1	library of resources	99	68	68.7%	31	31.3%
2	collaborate	88	63	71.6%	25	28.4%
3	repeater	88	25	28.4%	63	71.6%
4	students reasoning	78	25	32.0%	53	68.0%
5	learn statistics	73	37	50.7%	36	49.3%
6	confidence	71	29	40.9%	42	59.1%
7	engaging class	67	27	40.3%	40	59.7%
8	requirement	61	13	21.3%	48	78.7%
9	pedagogy	60	38	63.3%	22	36.7%
10	technology	59	24	40.7%	35	59.3%
11	professional practice	58	35	60.3%	23	39.7%
12	preparing	54	39	72.2%	15	27.8%
13	real data	48	29	60.4%	19	39.6%
14	stats investigation	42	11	26.2%	31	73.8%
	Total	946	463	48.9%	483	51.1%

The following example illustrates how validity was determined. Participant 11997_58 posted "Statistics is not a strength of mine. I do not want my students to struggle because their teacher struggles with concept."

Method 2 assigned this document to Topic 4, "students' reasoning." Since the post includes the word "students" it makes sense why the assignment was made, but this participant is clearly struggling with their own confidence, not with how students are reasoning with statistics. This post was not assigned a valid topic.

Method 3

Method 3 generated topics based on a condensed version of topics from Method 2. The number of overall topics in Method 2 was higher than Method 1 (14 topics versus 6), which could have led its lower validity rate.

Topics and validation. The topics from Method 2 (**Error! Reference source not found.**) were collapsed into four topics (
). The first motivation topic in Method 3 grouped six topics from Method 2 (real data, technology, stats investigation, students reasoning, library of resources, collaborate) together that were all related to course objectives. When enrolling, participants could see the course objectives. We assumed that some people were motivated by these visible goals.

Table 4
Method 3 Topics and Validity Count and Percentages

Topic	Title	Total Documents Assigned Topic	Topic Correct by Qualitative Coding?			
			Yes		No	
			n	%	n	%
1	Course specific goals	414	367	88.6%	47	11.4%
2	Continuing professional learning	207	113	54.6%	94	45.4%
3	Learn statistics/increase confidence	144	81	56.3%	63	43.7%
4	Pedagogical goals	181	156	86.2%	25	13.8%
	Total	946	717	75.8%	229	24.2%

The second topic combines goals specific to continuing professional learning (professional practice, requirement, repeater). Since these courses give people the opportunity to earn continuing education credits, some people may enroll for professional learning goals outside of specific course goals or take a course again. Another common theme in discussion forums is for participants to want to become better teachers, hence the third topic of pedagogical goals (engaging class, preparing, pedagogy). The fourth topics centers on those who want to learn statistics/increase confidence (learn statistics, confidence). These could be separate topics, but when reading posts, it was found they often occur together. We recognize that other groupings may have been appropriate. The 14 topics were collapsed based on the researchers' prior experience with the data and course context.

The topic a participant was assigned in Method 2 carried over to Method 3. Then each topic was renamed to the appropriate topic in

. If the topic applied to a participant in Method 2 was valid, it remained valid in Method 3. The participant documents that were not considered valid in Method 2 were then reassessed for the validity based on the new topics. Of the 946 documents, 75.8% were determined to be assigned to an appropriate topic and 24.2% were not.

Discussion

If the goal of this study was to determine which method was better at assigning topics, then we could say that Method 3 is "best" since it has the highest validity score. It is of interest that Nelson et al. (2021) found that the dictionary-based method they used was not the most aligned to hand-coded data, suggesting "dictionary methods will struggle with the identification of broader concepts but can play a role when specific phrases are of interest" (p. 228).

Instead, the goal of this study was to investigate how topic modeling can be used for analyzing qualitative data, particularly analyzing the motivation of participants to enroll in OPD for statistics teachers using discussion forum data. Badaldi et al. (2022) identified 50 articles that sought to identify motivation, none of which used discussion forum posts as a source of data. None of these articles used topic modeling as a means to identify motivation. By comparing the different topic modeling methods to qualitative analysis results, this study suggests that topic modeling can be a useful tool for qualitative researchers in their analysis process. Analyzing qualitative data is a "process of bringing order, structure, and meaning to a mass of collected data" (Marshall & Rossman, 1990, p. 111). Though qualitative data analysis produces rich and informative results, the process can be tedious, time-consuming, and messy (Creswell, 2013; Hilal & Alibri, 2013). This is even truer now in our world of large data.

The unsupervised technique in Method 1 was used to identify themes for motivation using a computer algorithm, rather than researchers reading every post to identify themes. Though the validity score for Method 1 was not very high (61%), the themes identified gave good insight into why people enrolled in these courses, outside of the choices they indicated on an enrollment survey. For instance, the two top assigned topics were "Teach and understand statistics using data" and "Preparing to teach new curriculum that uses statistics." From this, we can encourage those that are designing OPD for statistics educators to create content that centers around data.

We also believe that anyone with access to large amounts of discussion forum data could use these techniques to lessen the work of traditional coding methods. Methods 2 and 3 used a semi-supervised learning method to assign predetermined themes for motivation to individuals. Methods 2 and 3 required the input of a seeded dictionary. This is not unlike traditional qualitative methods, where a group of researchers may code a subset of the data, identify, and define themes, then create a "codebook", and apply those codes to the rest of a dataset (Roberts et al., 2019). We created a codebook with the seeded dictionary, then let the computer algorithm code the remainder of the data. This semi-supervised learning method is particularly useful when there is a lot of data, but not a lot of research capacity (i.e., people

hours) to apply the codes to a large dataset. Though the validity scores for Method 2 were very low (~49%), the validity for Method 3 rose to approximately 76%.

The seeded dictionary for the approach used in Methods 2 and 3 was created using the expert knowledge of the first two authors. Others have attempted to create seeded dictionaries from more diverse knowledge sources. For instance, Resnik et al. (2015) qualitatively analyzed 6,459 stream of consciousness essays written by college students about depression. Using this prior research, they then created a seeded dictionary describing general themes about depression. They used this dictionary to analyze a series of random Tweets about depression and determined the topics identified by college students were useful in identifying themes for the general public. Perhaps other researchers may find it useful to created seeded dictionaries from large datasets that have already been qualitatively analyzed to then attempt to model other datasets, rather than letting a random sample of the data inform the dictionary as was done in this study.

Limitations

Several limitations to this study should be taken into consideration. This study used the *topicmodels* and *seededlda* packages in R, there are many more methods available not only in R but also in other statistical software tools. The discussion forum posts that were used as the dataset included only text. There were posts that included pictures, hyperlinks, or other html inputs such as emojis, that were not part of the data analyzed.

The Porter stemmer method was used to stem words in the creation of the DTM in Method 1 and DFM in Methods 2 and 3. The Porter stemmer method is susceptible to over-stemming words or causing faulty conflation of words (Farrar & Hayes, 2019; Krovetz, 1993), meaning that words seem to appear more often because they were shortened so much. There are other methods that could have been used, such as the Krovetz method which attempts to help this over-stemming process but is also known to under-stem words (Farrar & Hayes, 2019). This study acknowledges the limitations of the Porter method in the data cleaning process of the discussion forum data.

Conclusions

Isoaho et al. (2021) states that many studies that employ topic modeling interpret results of the topics in isolation from the documents used to produce the topics. This study did not make that mistake. The topics produced and validity of the model were interpreted and evaluated with the context of the data always present. The researchers' knowledge of the course and experience in the context of statistics teaching was critical in making decisions related to all aspects of the process. We assert the context of the textual data used to produce topic models must always be the biggest consideration in every step of the process, especially when interpreting and sharing results.

Ability to replicate a study is often hard to do for any qualitative analysis, since researchers do not often share the steps of how codebooks are made or how thematic coding is applied (Roberts et al., 2019). It is the hope that enough detail is provided in this article so that

the topic modeling methods can be replicated and built upon so that topic modeling can become a useful tool in analyzing online discussion forum data.

Ethics Board Approval

The data used in this study was approved for research for use through the institutional review board of the institution of the second, third, and fourth author. All data was blinded prior to analysis.

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Comparison of On-Campus and Virtual Self-Assessment Outcomes for Incoming Appalachian STEM Undergraduates' First Research Experience

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Abstract
The First2 Network is an alliance of higher education institutions across the State of West Virginia striving to improve science, technology, engineering, or math (STEM) education by supporting rural, first-generation, and underrepresented college students pursuing STEM majors. Over the summers of 2019 and 2020, the First2 Network delivered two-week summer research immersion experiences at various institutions throughout West Virginia, including our institutions. The 2019 program was delivered on-campus at four universities while the 2020 program was redesigned to be delivered virtually, due to the COVID-19 pandemic, across nine sites. Before and after the immersion experience, students who participated in the program completed a variety of survey questionnaires for the assessment of their interests, expectations, identity, and belonging in STEM. We found that the in-person research experience in 2019 had better outcomes compared to the virtual experience, suggesting that students conducting research directly under their faculty supervisors in-person and on-site will have a more positive impact on their STEM education and career. However, participation in the virtual research format with

structured group activities still resulted in an improvement in belonging and STEM identity, indicating that connecting with students remotely is still worthwhile when it is the most viable option. The student population in West Virginia/Appalachia region faces a number of academic barriers, so there is much to gain by finding new ways to reach as many students as possible with early career development programs. Our virtually delivered program using citizen science projects, group discussions, and team building activities may be a useful template for other STEM programs to search for new ways to connect with a broader population of students off-site.

Keywords: Virtual, in-person, research, network, first-generation, immersive

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The First2 Network is an alliance of public and private higher education institutions throughout West Virginia focused on supporting rural, first generation, and other underrepresented students in the first two years of their college experience. The First2 Network initiative is funded by a 5-year Human Resource Development grant from the National Science Foundation focused on improving science, technology, engineering or math (STEM) participation in underrepresented populations. A major initiative of the First2 Network is summer immersive research experiences for rising freshmen, mentored by undergraduate students and faculty or staff members at the host institution. A goal of the alliance is to double STEM graduation rates in the Appalachian region through immersive experiences, conference attendance, STEM career shadowing, mentoring, and research involvement. Interventions begin the summer prior to freshman year when students are placed at sites throughout the state to gain experience carrying out scientific research. They are also able to continue research after matriculation at their undergraduate institutions by involvement in a campus First2 club and other student leadership activities. These professional development activities not only provide students with resources on their own campus, but also foster a statewide community of STEM engagement.

The student population in rural Appalachia faces several obstacles to their education. These include financial hardship, limited technology and broadband access, deficient career and college attendance information, poor academic preparation, and lower educational expectations. Rural students are less likely to obtain a bachelor's degree due to their lower socioeconomic background (Byun et al., 2012) with only 15.6% of adults receiving a bachelor's in rural Appalachia compared to 29.8% of the US overall (Pollard & Jacobsen, 2017). This is compounded by challenges such as a lack of career opportunities other than coal mining and steel production and effective career interventions targeting the cultural and community values of Appalachia (Gibbons et al., 2019). Digital inequalities are also difficult to overcome because of the region's physical landscape, where hills block wireless signals and make cable instillation difficult (Khan et al., 2020). High school students in Appalachia with aspirations to pursue a STEM career had higher scores in investigating self-efficacy, college outcome expectations, STEMM (additional "M" for medical) college major outcome expectations, math and science self-efficacy, and interest than their peers, making them a high-yield group for potential intervention (Rosecrance et al., 2019). The First2 network targets these students with the goal of incorporating them into the academic and STEM community.

While the 2019 First2 summer immersion experience was in-person on campuses throughout the state of West Virginia, the onset of the coronavirus (COVID-19) pandemic necessitated a transition and redesign for virtual delivery in 2020. Careful consideration was taken during the planning of the online curricula to ensure that the students were still active participants and members of a cohort that got to know each other and their research mentors. The parallel in-person and virtual delivery modes between the two respective years provides us with a unique opportunity to compare learning environments within the same program with the same learning goals. A survey was given to the participants at pre- and post- immersion experience each year, which was used to assess four main aspects of the student's perspective of their place in STEM before and after the summer immersion program.

We assessed the following four subsets of student perspective: (1) career, (2) efficacy, (3) identity, and (4) belonging. (1) Career certainty was evaluated in order to gauge student convictions in pursing STEM careers before and after completion of the First2 program. Career questions focused on student commitment to a STEM career path and whether the choice of career path was their own. (2) Efficacy was assessed with respect to self, specifically measuring student confidence in their skills as future scientists. Similarly, we also evaluated (3) identity to predict the strength of the student's scientific identity. Finally, (4) belonging was assessed in conjunction with academic achievement, since students with meaningful connections form a sense of belonging that is believed to help them excel academically. The belonging questions centered on how students anticipate being accepted and respected in the college environment. Overall, the evaluation of these four aspects allowed us to assess the effectiveness of the First2 program and observe how students' perceptions changed over the course of the two-week immersion experiences.

Prior to the virtual immersion program, we attempted to identify potential shortcomings due to the digital environment. A previous study comparing on-site to virtual interactions showed that while effectiveness was not diminished, in-person activities fostered more accountability and support (Cilliers et al., 2021). While we incorporated virtual team-building activities, we thought that it might still be difficult to replicate the in-person support. Many sites incorporated office hours into the schedule, either with student mentors and/or faculty members. Other factors influencing the effectiveness of virtual education include digital division, meaning accessibility and quality, and a lack of social skills among students in the virtual environment (Dung, 2020). The inequality of broadband internet access is especially true in many rural areas of West Virginia (Ferris & Vesely, 2021) where our programs took place. We contacted students prior to the immersion and mailed some combination of laptops, hotspots, and cameras to students based on their specific needs.

The objectives of this study were to (1) compare the pre- and post-immersion student surveys for each learning environment to assess the program as a whole, (2) compare in-person vs. virtual experiences to assess whether delivery mode impacted student STEM perspectives, (3) report outcomes for the first two academic years for prior interns, and (4) consider the benefits and challenges that we encountered during virtual experience in the discussion of this paper, highlighting qualitative faculty and student responses and reactions to the program. We expected less positive change in student STEM perspectives with virtual immersion delivery compared to in-person immersion delivery, partially due to the quick transition to this mode, lack of in-person support (Cilliers et al., 2021), and digital connection inequality among participants. As we addressed objective 2, we considered the type of classroom environment because, as a STEM program, much of the delivery was laboratory and hands-on activity based, and laboratories techniques may be easier to learn in-person where the student participated in troubleshooting during data collection. Based on previously published studies, we expected either 1) no significant difference between online and in-person learning efficacy, or 2) in-person learning would be more effective than online learning (Zhang & He, 2022; Soltanimehr et al., 2019). We expected that identifying some of the challenges encountered would allow us to provide insights for other educators planning similar STEM-related programs.

Methods

Immersion Program Description

The two summer programs (2019 and 2020) that were conducted as part of the First2 Network Summer Immersion Experience focused on helping students understand the commitment required to succeed in the STEM college environment. Students applied to the summer research program for the upcoming summer session before they matriculated at their undergraduate institution. Participation requirements included being either a first-generation college student (neither parent having graduated with a four-year college degree) or belonging to an under-represented group in STEM (including women, people of color/minority, etc.), and with an intention to major in a STEM discipline. Students indicated their preferred immersion sites on their application and were then matched based on STEM interests and majors. Mentors and site leaders collaborated to create a schedule for incoming summer student interns that included research, professional development, and team building. These summer programs are paid internships funded by the First2 Network, and successful completion of the internship resulted in a $600 stipend to each intern.

The inaugural year of summer programming (2019) was an in-person research experience at four sites throughout the state of West Virginia, supporting 31 student interns. These sites included West Virginia University, West Virginia State University, Fairmont State University, and Marshall University. Each of these sites incorporated original research and seminars to connect participants to prospective faculty mentors and undergraduate mentors. There were also industry tours and rotations through participating laboratories. The in-person program was supplemented with a strong focus on community building with the site participants, which included meal preparation, games, and movie nights. The two-week programs culminated in student research presentations to the other site participants, family, and faculty members.

With the onset of the global COVID-19 pandemic, the 2020 program was converted to a 100% virtual experience. Due to the success in the 2019 program, it was expanded to nine sites with the inclusion of government institutions, nonprofit organizations, professional schools, and additional undergraduate institutions. There were 74 student interns, more than double the intern participation of 2019. The additional sites added were Green Bank Observatory, High Rocks Academy, West Virginia School of Osteopathic Medicine, University of Charleston, and West Virginia Institute of Technology. Each day, students took part in research activities that included citizen science projects (https://secure.lamotte.com/wwmday/), data collection, and data processing for ongoing research projects. With the transition to virtual participation, statewide seminars on diversity and inclusion, student resources, and student wellness were added. Students also took part in online games, movie nights, and other programming activities to introduce the participants to one another and build a community before they began their undergraduate careers.

Similar daily schedules were adopted for both the 2019 in-person and 2020 virtual immersion experiences (Table 1). Each site was allowed to create their own specific activities to take advantage of the strengths and resources of that particular institution. A detailed example of one site's events and schedule is outlined in the supplemental information (Stover et al., 2021).

Table 1
General Daily Program, Outcomes, and Example Activities for Both the 2019 In-person and 2020 Virtual Immersion Experiences

Time (M-F, 2 weeks)	Session Type	Outcome	Example Activity
Morning Session 9-12am	**Group Lectures and Discussion**	Describe the steps of the scientific method and design your own research projects	Lecture: "Scientific Method and communication" Discussion: Hypothesis development
Early Afternoon Session 1-3pm	**Independent Research**	Collect, analyze and report data	Collection: Take samples, measure water quality Report: Add data to shared repository
Late Afternoon Session 3:30-5pm	**Professional Development**	Display professionalism and ownership of individual growth and self-reflection	Presentation: "How to find a research mentor"
Evening Session 7-9pm	**Team Building**	Support fellow interns and construct a team dynamic	Game Night: Charades

Survey Protocol

During the 2019 and 2020 research internships, pre/post online survey data were collected as part of the external evaluation of the First2 Network conducted by ICF International. A filter question at the beginning of the survey asked students to confirm that they were at least 18; if not, they were automatically exited from the survey since they were still minors and not allowed to participate without parental consent. This project was approved by the ICF Institutional Review Board (Project# 180739.0.001).

The pre-test version of the survey was administered on the first day and the post-test version was administered on the final day of each immersion. Pre/post surveys were matched based on an identification code that students created in the pre-test and replicated on the post-test. The survey included four STEM subscales identical to those reported previously (Hanna et al., 2021), broadly defined below:

1. The "STEM career" subscale (career) asks students to indicate how certain they are about their decision to pursue STEM education and career (Woodcock et al., 2016).

2. The "STEM efficacy" subscale (efficacy) measures students' expectations about how well they think they will perform in their STEM college courses (Pintrich & De Groot, 1990).

3. The "STEM identity" subscale (identity) gauges students' sense of themselves as people who are engaged with STEM (Chemers et al., 2011).

4. The “school belonging” subscale (belonging) assesses the extent to which students think they will feel connected to their college (Anderson-Butcher & Conroy, 2002).

Students were asked 8 career, 6 efficacy, 5 belonging, and 6 identity questions, which can be found in the Supplementary Information.

Career certainty was evaluated in the pre- and post-surveys to determine how many students were planning to pursue a career in STEM. Our students were either first-generation college students or belonging to an under-represented group in STEM (including, for example, women and people of color/minority). Therefore, many students who participated in the First2 Network summer program faced multiple subsets of stereotype threats, which led to a negative impact on the student's intention to pursue a career in STEM (Woodcock et al., 2016). First2 and other similar programs are designed to help students sustain their academic and scientific interests despite the negative impact that stereotyping may have on their perspective of STEM careers. Specifically, these programs are designed to strengthen academic preparedness, research skills, and professional development skills (Woodcock et al., 2016). Therefore, by evaluating the student’s commitment to a STEM career we can determine whether the program encourages participants to persist in that pursuit.

In line with participants’ career certainty, their perspective on “efficacy” was also evaluated. Self-efficacy was found to be a strong predictor for commitment; specifically, we aimed to evaluate student's commitment to STEM by measuring their expectations on their performance in STEM courses (Hanna et al., 2021). Multiple studies on self-efficacy have found that confidence in one’s abilities to perform a task is more highly and accurately predictive of performance than objective measures of ability alone (Chemers et al., 2011). Other studies have found that engagement in authentic scientific engagement programs such as First2 strengthens students’ confidence in their skills by appreciating the actual work of science (Chemers et al., 2011). Survey questions related to STEM efficacy asked how confident the student was to understand basic and complex material, excel on tests, master skills, and attain good grades in STEM college classes.

Additionally, “identity” as a scientist is also a strong predictor of commitment to a STEM field and was used to evaluate how participants perceive their place in STEM. While the development of identity can be confusing, Arnett (2004) proposed that optimal adolescent development is achieved by forming a sense of coherence that integrates students’ multiple perspectives and identities. Studies have found that identification tethered in a context-relevant element such as student or scientist is more predictive than racial or ethnic identity for persistence and performance (Chemers et al., 2011). Participating in a program like First2 allows students to form a strong connection to science and identify with academic roles, such as being a science or engineering student, which is shown to have a greater persistence to degree completion than students who identify more strongly with their social identity (Chemers et al., 2011). Research experience and belonging to an organization enhances greater involvement in the scientific community, thus strengthening the student's sense of identity in STEM. Survey questions on identity focused on whether students view themselves as future scientists or engineers, and how relevant being in a scientific field is to their self-image.

Finally, "belonging" to school or an academic entity—specifically, college—was assessed due to its association with academic achievement. School belonging was found to be the most important indicator for placing increased value on learning difficult scientific topics (Smith et al., 2022). The belongingness hypothesis developed in 1995 by Baumeister and Leary postulated that students must maintain significant interpersonal relationships that are both lasting and positive. Developing these relationships helps to form a sense of belonging in an academic community which can also positively affect students' achievement, motivation, and well-being (Smith et al., 2022). Thus, when evaluating students' perspective on STEM, it is important to assess their sense of belonging to STEM. The survey questions in this area asked about students' sense of being accepted, expressed as feeling comfortable, respected, and fitting in at college.

To secure outcome data for students, First2 Network staff contacted the 2019 and 2020 interns via email and text messages to confirm retention status and whether they persisted with a STEM major two years after participation in the immersion experience.

Statistical Approach

Questions within the same subscale were pooled, resulting in averages for career, efficacy, identity, and belonging, both before and after the immersion experience. Averages were derived from Likert scores, which are non-parametric data. Therefore, differences were determined by Wilcoxon tests in JMP (Version 15. SAS Institute Inc., Cary, NC, 1989-2021) and reported in Table 2 and Table 3, addressing our first objective. To compare changes in students' perspective of their place in STEM between in-person and virtual environments, paired data were used to find delta values by subtracting the pre-survey score from the corresponding post-survey score for each question within each immersion year. Responses without both pre- and post-immersion responses were omitted from the analysis.

For our second objective, we compared in-person and virtual experiences to assess whether delivery mode impacted student STEM perspectives. To identify differences between the two learning environments (in-person, 2019; virtual, 2020), only data from the original four institutions that were involved both years were included (Figure 1). Student outcome data (persistence rates in STEM) were analyzed using Chi-Square tests. For all statistics, alpha was set at 0.05.

Results

In 2019, of 31 students who finished the First2 program, 27 completed a pre-test and 25 completed a post-test. Of those 27, more than half were female (56%) and about two-thirds described themselves as white (67%). About a third (35%) indicated they qualified for a federal Pell grant, nearly all (96%) identified themselves as first-generation students, and more than three-fourths indicated they grew up in a town (48%) or rural area (35%) (Howley et al., 2022). Pell grant status is noteworthy because receipts have been shown to be a good proxy to estimate income bracket, as students who receive these grants come from families with a lower than average income in the United States (Carnevale & Van Der Werf, 2017; Heller, 2004).

In 2020, 69 students (out of 74) completed a pre-test and 59 completed a post-test. Of those 69, about two-thirds (67%) were female and 81% described themselves as white. Sixty

percent qualified for a federal Pell grant, and more than half (58%) considered themselves as first-generation students. Nearly three-fourths indicated they grew up in a town (26%) or rural area (48%) (Howley et al., 2020). This summary data can be found in Table 1 of the Supplementary information.

The first objective focused on how STEM perspectives changed due to the immersion program within each learning environment (Tables 2 and 3). During the in-person experience in 2019, there was an increase in STEM efficacy (6.2%, p=0.0016), belonging (14.9%, p<0.0001) and identity (11.1%, p<0.0001). No significant difference was observed in students' perspectives on STEM career (2.6%, p=0.239). The virtual experience increased students' perspectives on belonging (7.4%, p<0.0001) and STEM identity (6.1%, p=0.0004) but STEM career (-1.3%, p=0.5687) and STEM efficacy (2.3%, p=0.2066) showed no difference between the pre- and post-surveys.

Table 2
Comparison of Pre- and Post-immersion Survey Results from the In-Person Experience

	N	Questions	Average Pre-results	Average Post-results	Delta	Percent change	P value
STEM Career	25	8	3.84	3.94	0.102	2.6%	0.239
STEM Efficacy	25	6	4.01	4.26	0.254	6.2%	0.0016
STEM Identity	25	6	3.77	4.19	0.414	11.1%	<0.0001
Belonging	25	5	3.95	4.54	0.596	14.9%	<0.0001

Note. Survey data outcomes from before and after the in-person research experience delivered in 2019. All questions within a given subscale were pooled to give an average rating for STEM career, STEM efficacy, belonging, and STEM identity. Significant differences were determined with p<0.05.

Table 3
Comparison of Pre- and Post-immersion Survey Results from the Virtual Experience

	N	Questions	Average Pre-results	Average Post-results	Delta	Percent change	P value
STEM Career	58	8	3.78	3.73	-0.048	-1.3%	0.5687
STEM Efficacy	58	6	3.99	4.08	0.09	2.3%	0.2066
STEM Identity	58	6	3.78	4.01	0.214	6.1%	0.0004
Belonging	58	5	3.94	4.23	0.29	7.4%	<0.0001

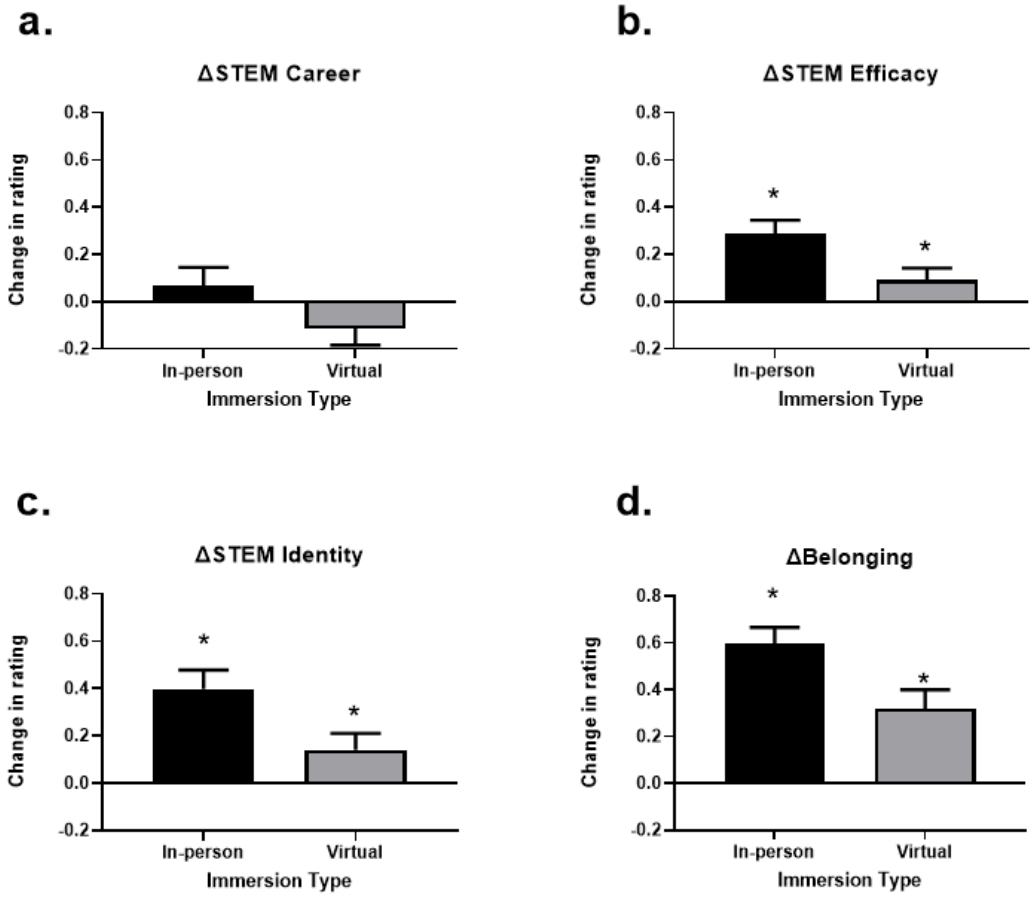
Note. Survey data outcomes from before and after the virtual research experience delivered in 2020. All questions within a given subscale were pooled to give an average rating for STEM career, STEM efficacy, belonging, and STEM identity. Significant differences were determined with $p<0.05$.

For objective two, we compared the two learning environments (in-person and virtual) in the four institutions that were involved both years to determine whether the delivery mode impacted student STEM perspectives during the immersion program (Figure 1). The data suggested that there was no difference between pre-and post-experience results in STEM career ($p= 0.0904$). However, the in-person learning environment had a greater increase in rating for STEM efficacy ($p=0.0327$), STEM identity ($p=0.0218$), and belonging ($p=<0.0015$) (Figure 1).

For objective three, of the 31 students experiencing the in-person research internships in 2019, retention status could not be secured for four students. Of the remaining 27, 18 persisted in a STEM major between the fall 2019 and fall 2020 semesters, for an early STEM persistence rate of 67%. Eight did not re-enroll in a STEM major in the fall of 2020 (30%) and one student (4%) dropped out of college (Hanna et al., 2021). Of the 31, 8 (26%) served as mentors for the 2020 internships and 4 served as mentors during the 2021 internships. For the 74 students experiencing the virtual research internships in 2020, status updates were obtained on 27 of them. Of these, 21 persisted in a STEM major between the fall 2020 and spring 2021 semesters (78%). Five students did not re-enroll in a STEM major in the spring of 2021 (19%), and one student dropped out (4%). Of the 74, 8 (11%) will be serving as mentors for the 2021 internships. STEM persistence rates did not differ by experience type.

Figure 1

Changes in Immersion Survey Results for the In-Person and Virtual Immersive Research Experiences



Note. Survey results for A. STEM career, B. STEM Efficacy, C. STEM Identity, and D. Belonging. Change values were determined by subtracting the pre-immersion survey results from the corresponding post-immersion survey results for each student. Twenty-five in-person students (2019) and 31 virtual students (2020) answered 8 career, 6 efficacy, 6 identity, and 5 belonging questions. Means with an asterisk symbol differ significantly ($p<0.05$).

Discussion

With the sudden emergence of COVID-19 related restrictions, we had the opportunity to assess differences between in-person and virtual formats for delivering summer immersion programs. Overall, both the in-person and virtual experience improved select aspects of STEM self-assessment. However, the in-person program led to more post-program improvement. After one year of college, 67% of in-person students and 78% of virtual students remained in a STEM discipline, although these numbers were likely affected by the low response rate as reported in the results. Prior work analyzing the 2019 program reported that persistence in STEM after one year was lower than the state rates for non-First2 students (74% in 2018 for rural Pell-grant recipients), but the virtual student STEM retention percentage was higher in the 2020 virtual cohort (Hanna et al., 2021). The intention of the First2 program is to increase STEM persistence

for participants by providing a community, support and special programs like the one described here. We hope that by continuing to monitor and receive feedback from the students who both stay in STEM majors and those who leave, we can continue to improve the program to increase STEM persistence in this important student population.

We found that the in-person format increased STEM efficacy, identity, and belonging when comparing the pre- and post-immersion scores, whereas the virtual format showed an increase only in STEM identity and belonging. The virtual format was not able to increase the student's confidence in math and sciences. This could be due to the different amount of participation possible, such as simple citizen science projects versus live bench science, or watching the groups' statistics be analyzed rather than doing them on their own. There was also less one-on-one time virtually with mentors to help build that confidence. We did not expect to see a difference in career perspectives with either group, as these questions focus on a career path. First2 students have already selected a STEM major and dedicated part of their last pre-college summer to a STEM program, so it is not surprising that no change was observed over the two-week period.

Our results confirmed the hypothesis that virtual delivery would change student STEM perspectives less than the in-person immersion experience. This program was shifted quickly to the virtual environment, and while care was taken to maintain similar structure and objectives, there were certainly differences in teaching approaches and group activities. However, we still observed that the virtual format led to some significant increases in STEM perspectives, specifically STEM identity and belonging, indicating that a virtual experience is still much better than no participation at all. The difference observed between in-person and virtual outcomes may be due to a lack of in-person support (Cilliers et al., 2021), digital connection inequality among participants (Ferris & Vesely, 2021), and forming friendships among peers without face-to-face interactions (Bikowski, 2007). Indeed, due to poor internet connectivity, even with hotspots, some students had to turn off their cameras at various times to circumvent lagging issues.

The surveys also included free responses that allow us to assess some of the qualitative student feedback. In addition, each site leader completed a follow-up report within two weeks of the end of the immersion program, and we have summarized the results in the following two sections to address our fourth objective.

Benefits of the Virtual Experience

There were many benefits to the virtual immersion program, including flexibility in schedule, interacting with the broader First2 network, tailoring research projects, and engaging with students in new and different ways. Virtual experiences can also eliminate significant costs such as those associated with room and board. A greater number of students may have the opportunity to participate remotely and without the need for transportation.

Some flexibility was built into the online platform schedule since it did not require a particular physical space. The sites requested daily feedback and were able to adapt as needed if students required more time to accomplish a goal or finish a discussion, as activities were synchronous. If a demonstration was required, for example showing students how to use a microscope to analyze a sample, a camera could be set up in a lab and every student had access

to the video livestream. Students could also share their screens to show everyone data or present their work, and small group work could be accomplished by opening multiple breakout rooms. Students were able to adapt quickly, as many of them had finished the school year using similar platforms. “Zoom Fatigue” (Wolf, 2020) was avoided as much as possible by offering activities on and off-line, such as going outside to collect samples and breaks for mealtimes.

The virtual immersion also allowed students to have additional experiences that would not have been possible on-site. Rather than just interacting with small on-campus groups, students participated in state-wide meetings and took tours of industry, educational, and laboratory facilities they would not be able to visit at their assigned campus. Guest speakers did not need to be physically present, so the students had an opportunity to hear from more diverse presenters, with one site even including international speakers. These interactions can potentially help broaden the students sense of STEM community even in the virtual environment. Indeed, this approach has transformed the scientific community over the past year, making conferences and seminars more accessible to people around the world (Price, 2020), and this practice is likely to be carried over, likely taking the form of a hybrid format in future years.

One unexpected outcome highlighted in the site reports noted that it tended to be easier to get to know shy students. When a student’s camera is on you can comment about something unique or meaningful in their space such as a poster, stuffed animal, or pet, allowing that student to open up. Undergraduate mentors were also utilized to engage the rising freshman and create an inclusive environment. They organized the evening socialization and various sites provided activities such as scavenger hunts, book clubs, movies, and games. Everyone went into the virtual program with an open mind, making it easier to have fun and team build. The undergraduate mentors, who had been through the program previously, helped get students to speak openly and freely during the team-building time, noticeably increasing student engagement in the other activities as the week went on.

Students still received meaningful research and mentor experience through the virtual immersion. Lab-based projects were still carried out with the students collecting samples such as water, soil, or insects which were tested either by the student or sent to the lab. Many sites used citizen science projects which allowed students to get outside to collect meaningful data and be part of a bigger project such as tracking fireflies (West Virginia Division of Natural Resources (WVDNR), Light Up West Virginia), box turtle identification (WVDNR, Box Turtle Citizen Science Survey, 2020), or water quality testing in the region (EarthEcho International, monitorwater.org). Students then worked together to analyze the data and interpret the results. Though this was online, these research experiences tended to allow students to focus on a topic of interest to answer a specific research question, often as a subset of the whole group’s data. By the end of the two-week program, students had advanced their project through the scientific method and presented their work to the site group. The faculty were very pleased with how far this class of virtual students had progressed in such a short time period.

Challenges of the Virtual Experience

Many challenges arose during the virtual immersion program. Both students and faculty members were hesitant about the virtual environment. Internet accessibility and equality were

problematic. Digital fatigue was unavoidable while managing the expectations and interaction of students.

Despite a monetary incentive, nine students withdrew from the virtual immersion experience before it even began. One possible explanation may be that some students had a negative view of digital experiences due to the rapid closure of schools and transition to online teaching that occurred in the spring of 2020 (Hebebci et al., 2020). However, some self-selection may have also occurred, as a previous study found that students who chose to enroll in an online class felt they possessed greater self-regulation and effort strategies that could help them succeed in this setting (Quesada-Pallarès et al., 2019). In addition to students, many faculty members were slightly apprehensive about hosting the virtual experience, facing struggles with learning, and working with new technology. Perhaps not surprisingly, all sites indicated they would prefer in-person immersions. Students may have felt disconnected if faculty members did not feel comfortable in an online setting. The site surveys state that all sites struggled with organizing and technology. Even though all sites expressed caution and hesitancy towards the virtual experience, they articulated the importance of having a virtual experience and felt it was worth the time and effort.

Another challenge of the virtual experience was the ability of rural students to access broadband internet. Connectivity is an issue facing many rural areas, with West Virginia ranked as the 44th worst state for high-speed internet (Ferris & Vesely, 2021). Some students were issued hotspots and computers, while others logged on from parents' phones. Poor internet may have caused students to miss a portion of the presentation or not be able to see a demonstration, decreasing self-confidence with the online format, which could certainly influence STEM efficacy and identity. Virtual teachers and mentors should have increased awareness of a student's ability to access broadband and adapt accordingly, for example sending temporary hotspots or checking in after a session to see what the student might have missed.

Some amount of digital fatigue is unavoidable over the course of an extended online program (Bailenson, 2021). There was certainly some degree of digital fatigue over the course of the two-week immersion felt by students, mentors, and site leaders. Lectures could not be avoided and most sites were online for 5-6 hours a day, broken up by breaks for eating and collecting data. Because groups were relatively small, everyone was visible on camera for extended periods of time, which could lead to long periods of direct eye-gazing, reduced mobility, and visualizing oneself (Bailenson, 2021). Statewide seminars were the lowest-rated event because they were not actively engaging, tending to be long lectures around dinner time. We suggest thinking very carefully about scheduling when developing an online camp-like experience. While there may be many interesting topics to cover, the effectiveness is easily diminished if the audience spends too long in front of the screen without enough breaks (Fauville *et al*., 2021).

A few other issues emerged based on expectations and interactions associated with the virtual format. Some students felt that because the immersion experience was virtual they would be able to take on additional courses or responsibilities. At the outset of a program, clear terms of agreement and expectations should be explained to students to ensure students are present. Additionally, managing students' interactions can prove challenging as mentors walk others

through sharing screens on different devices, keep everyone engaged, and monitor discussions, especially considering the impact behavior has on meeting satisfaction and effectiveness in online formats (Odermatt et al., 2018). Tailoring the schedule to include activities such as brainstorming, peer review, and think-pair-share is crucial for active student engagement (Brent et al., 2021). Finally, additional financial costs should be considered as homes will not likely be stocked with research related materials, and mailing equipment can become limiting and expensive.

Benefits and Challenges of In-Person Learning

While in-person learning is the more traditional method of teaching, we did want to highlight a few observations of the modality within the context of this study. Our in-person learning environment had a greater increase in rating for STEM efficacy, STEM identity, and belonging than the virtual experience (Figure 1). The in-person students were able to spend time on campus in a faculty member's lab and had more one-to-one face time with mentors. In the online format, it was often a few students working with one mentor at a time, with the potential for dominant personalities to receive more attention. Students were also able to form connections to peers in-person and spent more time with their peers overall, for example at meal times. Both of these factors likely increased their confidence and sense of community within the STEM fields. However, the STEM retention after one year did not reflect an increase in benefit, as the retention was similar, if not lower, than state-wide rates, although it should be noted that the sample set was only 27 students.

There were a few challenges to highlight with the in-person format, including cost, logistics and the potential to limit participation. It was more expensive to run the in-person program due to the cost of room and board, and some sites did not have dorms to house students. Transportation was also an issue for some sites, which required daily transport to campus, or at least a way to get to the site to begin camp which might be hours away from their home location. Many students did not have access to a car, which limited the participation of some students. Additionally, some students were still minors, which led to more logistical issues, with some sites unable to accommodate students under 18 years of age. Indeed, this led some sites to continue using the virtual format for the 2021 immersion camp.

Effectiveness of Virtual versus In-Person STEM-Based Learning

While virtual programs increase accessibility to STEM education, the effectiveness of virtual learning must parallel in-person learning for students to obtain a quality education regardless of the learning platform. Studies within higher education programs report either in-person or virtual learning to be more effective depending on the population of students being evaluated and the educational goals of the program, with some studies reporting confounding results. For example, when post-graduate students were evaluated on their clinical performance, which can be compared to laboratory activities, test scores were positively correlated with either (i) in-person class attendance or (ii) there was no significant difference between virtual and traditional style learning platforms (Soltanimehr et al., 2019; Zhang & He, 2022). These opposing results show the variability based on the particular program or curriculum. However, when the goal of learning is knowledge development and retention, a virtual learning format is correlated with higher test scores (Moazami et al., 2014; Soltanimehr et al., 2019). These mixed experimental results support the idea that a hybrid learning format may optimize learning

(Bowers et al., 2022). However, additional experimental studies are necessary to determine which methods of learning are more effective depending on the learning goals, the specific population of students, and the students' level of education.

Many experimental studies show that virtual learning is as effective as in-person learning when general knowledge and retention are the measurements of learning efficacy. However, there are conflicting results of virtual versus in-person learning efficacy among STEM programs with a laboratory-based learning objective. Studies conducted during the COVID-19 pandemic that compared in-person to virtual learning courses with laboratory activities found that students cannot master biological experiments and practice technical skills within an online learning platform. Both skills are necessary for students to conduct research within an academic setting or pursue a career within research. While there are some distinct advantages to online teaching, hands-on experience in labs using scientific equipment is also needed. These findings further support the optimization of learning through a hybrid format (Zhou, 2020). Our immersion program was an introduction to the scientific method with some simple synchronous laboratory activities. Each site sent supplies to their participating students, including scientific equipment such as microscopes or experimental kits, which likely provided a somewhat similar experience to the in-person program. In some cases, training was done synchronously, such as how to use a microscope, while in other cases the student had to troubleshoot on their own in the field while collecting data. Higher level courses with a complex laboratory component would be much more challenging to carry out virtually and likely not as effective. Laboratories are also a good opportunity for peer learning (Choi et al., 2021), which is more challenging to do in separate locations.

Only a limited number of studies compared in-person to online learning among underrepresented student populations studying STEM majors. An analysis of data from over 10,000 course enrollments conducted in 2020 found that first-generation college students pursuing an online STEM degree had lower grades compared to their in-person attending peers (Mead et al., 2020). Based on limited experimental studies, the current literature inconclusively evaluates the effectiveness of online versus in-person learning formats among underrepresented college students pursuing STEM majors. The focus of our study directly compared underrepresented first-generation college students' online versus in-person research immersion experience and the program's effect on improving students' STEM education. Student populations such as those in rural Appalachia have much to gain from programs that increase STEM access and build an academic community. Both the in-person and virtual immersion platforms were effective in increasing both STEM identity and belonging, making this type early career intervention a viable option for increasing STEM retention among these underrepresented student groups. Care needs to be taken in the planning stages to have activities that build community within the cohort, as well as building confidence through close mentorship and professional results, such as presentations.

Conclusions

While the in-person summer research immersion program had higher overall improvement in STEM self-assessment, the virtual program still showed improvement in the areas of STEM identity and belonging. The virtual learning environment are more flexible and reach more students at a lower overall cost, but certain steps need to be taken to ensure digital

equality and student engagement through carousel scheduling and planning of interactive activities. The in-person program was especially helpful to foster STEM identity and belonging, while also increasing student's confidence in their math and science abilities. We felt that the use of group research such as Citizen Science projects can be very useful for these types of programs. Scheduling time for fun group activities as well as off-screen time to prevent burnout should also be considered in planning a virtual extended program for students. Ideally, the goals of a particular program should be assessed before selecting the mode of delivery if a choice is possible.

The virtual format during the pandemic has largely changed the pattern of our life and work. As the pandemic is better controlled and life returns to normal, we expect that the First2 Network program will mainly be delivered as the in-person format, as before the pandemic. Indeed, for the 2021 program, a majority of the participating institutes allowed the students conduct research and perform other activates on-site. However, based on our study, the virtual format is still a beneficial consideration to enhance STEM education especially for certain hard-to-reach student populations and in certain circumstances such as a lack of funding, space, equipment, ability to travel, or other resources.

Declarations

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Competing interests: The authors declare that they have no competing interests.

Availability of data: The datasets generated and analyzed during the current study are not publicly available since participants did not agree for their data to be shared publicly but are available from the corresponding author on reasonable request.

Code Availability: Not applicable.

Authors' Contributions: CP, TL, KS conceptualized this project, CP analyzed the data, KS, KC, and KH drafted the work, CP, MF, and TL revised the work.

Ethics approval: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the ICF Institutional Review Board (Project# 180739.0.001).

Consent to Participate: Informed consent was obtained from all individual participants included in the study.

Consent for publication: Participants signed informed consent regarding publishing their data.

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Online University Students' Perceptions of institution and Program Community and the Activities that Support Them

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Abstract
The twenty-eight item Sense of Online Community Scale was completed by 293 online students at a midsized southeastern United States university to ascertain community importance and activities associated with its formation and maintenance on the program and institutional level. A large majority of these students believed that a sense of community was important and that a sense of belonging, affiliation, and trust were valuable for community formation. Participants also believed that program and institutional activities, both academic and social, played key roles in community formation. However, academic activities (e.g., advising, program milestones, writing centers, library support) were rated as more influential than social activities (e.g., get-togethers, online games, institution sporting events). When demographic characteristics were considered, non-White participants rated their sense of affiliation with their program/institution higher than White participants. Participants who lived within a one-hour commute to campus (51% of our sample) rated institutional social activities higher than those who lived farther out. Doctoral students rated program activities as more conducive to community formation than masters, and graduate certificate students and undergraduate students rated affiliation to their program/institution higher than master's and graduate certificate students.

Keywords: online learning, higher education, distance education, community, affiliation

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Even before the COVID-19 pandemic, online learning had a strong foothold in higher education (Muljano & Luo, 2019; Seaman et al., 2018). Benefits of distance learning (e.g., reduced physical boundaries, reduced delivery costs, accommodated flexible schedules) are well documented in research literature (Bolliger et al., 2019; Exter et al., 2009; Kang & Pak, 2023; Trespalacios et al., 2021). Because physical presence is not required on campuses of higher education, non-traditional students increasingly frequent online degree programs (Milman et al., 2015; Pigliapoco & Bogliolo, 2008; Stephen et al., 2020). Indeed, half of all students enrolled in distance education courses take them exclusively (Seaman et al., 2018). Although distance education is a popular choice for working professionals, it is not without challenges. Student and instructor isolation, miscommunication, and increased attrition are common discussions in distance education research. Various approaches have been used to combat these challenges, including setting clear expectations, establishing open and honest communication, embedding instructor and student presence, and providing timely feedback (Jaggars & Xu, 2016; Lehman & Conceição, 2010; Rockinson-Szapkiw & Wendt, 2015; Smith et al., 2017; Speiser et al., 2022). An additional approach is the establishment of a sense of community.

Community is "a feeling of belonging, affiliation, purpose, and interdependence that exists among instructors, support staff, students, alumni, and program, college, or university friends as they collaborate and progress on shared learning goals and activities over time" (Shepherd & Bolliger, 2022, p. 2). As participants interact with each other, feelings of comfort and membership increase. These feelings can lead to a sustained sense of community (Larson & James, 2022; Lehman & Conceição, 2010; O' Shea et al., 2015; Palloff & Pratt, 2007; Rovai, 2001; Shepherd & Bolliger, 2019). Community formation and maintenance has received much attention from a course perspective as programs strive to reduce the challenges associated with distance education (Boston et al., 2016; O' Shea et al., 2015; Rockinson-Szapkiw & Wendt, 2015; Speiser et al., 2022; Thormann & Fidalgo, 2014).

However, lesser attention has been placed on the establishment of sustained program and institutional networks, commonly found in face-to-face programs, and their role in online community formation (Bolliger et al., 2019; Dennis et al., 2016; Kang & Pak, 2023; Milman et al., 2015; Shepherd & Bolliger, 2019; Trespalacios et al., 2023; Xu & Jaggars, 2013). Formal and informal interactions (e.g., hallway conversations, guest speakers, dinner meetings, research partnerships, interest groups) help students and faculty develop a sense of membership that extends beyond course settings (Kang & Pak, 2023; Schulz & Roßnagel, 2010; Soukup, 2006). Failing to consider community at the program and institutional level can result in students who feel comfortable within current courses yet distanced from faculty, alumni, and other students (Exter et al., 2009; Shepherd & Bolliger, 2019). Focusing community formation and maintenance within courses may also tax faculty abilities and resources (Bolliger et al., 2019; Larson & James, 2022; Shepherd & Bolliger, 2019). This study evaluated online students' perceptions of community beyond course settings and the perceived effectiveness of activities meant to promote program community. Research questions included:

1. How important is community among online degree seeking students?

2. Which program and institutional initiatives influence perceptions of community among online degree-seeking students?

3. How are student perceptions of community influenced by individual differences (e.g., ethnicity, classification, distance from a campus, and time spent in online degree programs)?

Literature Review

Community development has a rich history in online education. Derived in part from psychological research regarding physical communities and the sense of belonging developed over time as individuals interact with each other, online community research sought to instill and maintain a similar sense of belonging in online learning settings (O' Shea et al., 2015; Speiser et al., 2022; Thormann & Fidalgo, 2014; Trespalacios et al., 2021). Although various physical community models exist, most suggest that interaction through shared experiences over time results in a sense of closeness or trust that increases one's investment in the community, raises one's level of influence, and provides a sense of membership (Glynn, 1981; Graves, 1992; McMillan & Chavis, 1986; Westheimer & Kahne, 1993). As research on physical communities progressed, proponents became interested in community formations unbounded by physical locations, shifting the focus to online communities (Rovai, 2001; Trespalacios et al., 2021, 2023).

The majority of online learners in higher education are non-traditional students that live within 50 miles of their institution (Seaman et al., 2018; Stephen et al., 2020; Xu & Jaggars, 2013). Generally, these learners are older than traditional students, may have family or dependent care responsibilities, and manage full-time employment (Milman et al., 2015; Seaman et al., 2018; Stephen et al., 2020; Wladis et al., 2015). They are also more likely to have specific goals associated with higher education (Merriam & Caffarella, 1999). These students come with different needs and interests than traditional, on-campus students (Milman et al., 2015; Trespalacios et al., 2023).

Instructors can take steps to facilitate entrance into online courses. Careful space design can clarify navigation, identify desired learning outcomes, structure content, and indicate processes used for learning (Jaggars & Xu, 2016; Muljana & Luo, 2018; Speiser et al., 2022; Sun & Chen, 2016). These structures may clarify expectations and reduce perceptions of distance that arise in online settings (Moore, 2007; Palloff & Pratt, 2007; Sun & Chen, 2016). Clear expectations may promote a sense of safety and trust within the space as students gain clarity regarding procedures for success (Erdoğmuş et al., 2022; Speiser et al., 2022).

Additionally, instructors can design opportunities for communication between students and themselves. As students respond to other's posts, participate in group activities, and receive detailed instructor feedback, a greater sense of community forms (Dzubinski, 2014; Erdoğmuş et al., 2022; Larson & James, 2022; Milman et al., 2015; Rockinson-Szapkiw & Wendt, 2015; Shackelford & Maxwell, 2012). Regular interaction through communication and group activities may reduce feelings of isolation as students get to know each other better, recognize they are not alone in their courses and degree programs, identify shared ideas and interests, and gain greater voice and respect. Interaction with others may also highlight shared experiences with students and instructors, promoting further interaction and future collaboration.

However, community formation requires resources that may not be available in courses (Bolliger et al., 2019; Borup et al., 2020; Muljana & Luo, 2019; Schulz & Roßnagel, 2010). Community proponents stress that development occurs through interactions with others over extended periods of time (Bellah et al., 1985; Liu et al., 2007; Smith et al., 2017; Wellman, 1979). Four to fifteen-week courses may provide insufficient time for interactions to move beyond a sense of belonging and shared interests into relationships with shared goals, reciprocity, and interdependence (Motteram & Forrester, 2005). Indeed, in a review of Community of Practice literature in online/hybrid settings, Smith et al. (2017) found that while many proponents claim time is needed to form a sense of community, few researchers have examined time as a factor for community development. Extended timeframes around program progression and matriculation may be required to deepen relationships (Pifer & Baker, 2016). Additionally, it may not be feasible for course instructors to provide the services required for community development and maintenance (Bolliger et al., 2019; Fong et al., 2016; Glazer et al., 2013). Educators already serve various roles in online settings, including content instructor, mentor, technology trainer, multimedia developer, and course manager (Huang & Chou, 2015). Added responsibilities are rarely recognized or compensated and may tax instructor abilities to perform other job duties (Bolliger et al., 2019; Larson & James, 2022).

Services provided by higher education institutions, degree programs, and other entities may move beyond restricted course timelines, continue student and instructor interaction, and provide additional opportunities for goal alignment, collaboration, and community formation (Lee & Choi, 2011; Milman et al., 2015; Muljana & Luo, 2019; Trespalacios et al., 2023). Institutions provide library and research-support services, writing centers, guest speakers, career services, support groups, student clubs and organizations, and so forth. Programs provide orientations, socials, advising, program milestones, guest lectures, research collaborations, and opportunities for conference presentations. These services may support community development. Indeed, Palloff and Pratt (2007, p. 27) suggested "the class community would fit within the larger concept of community at the institutional level… the institution forms the larger community…." This suggestion of multiple layers of online community aligns with community of practice principles, where one's participation in larger social systems and involvement in additional communities influence their feelings of membership (Lave & Wenger, 1991; Smith et al., 2017).

Demographic factors may also influence desired community support. Wladis et al. (2015) and Xu and Jaggars (2013) found that non-White males were underrepresented in online STEM programs at community colleges, even when accounting for differences in SES and academic preparation; however, they found higher representations of women in online courses than in the general college population. Milman et al. (2015) found that students from underrepresented groups were more likely to value career and counseling services than their Caucasian peers. Indeed, some students indicate that they have no desire for online community (Exter et al., 2009; O' Shea et al., 2015; Shepherd & Bolliger, 2019).

Although community proponents describe community layers within higher education settings, less research is conducted on these layers, focusing predominantly on classroom practices (Bolliger et al., 2019; Exter et al., 2009; Glazer et al., 2013; Thormann & Fidalgo, 2014; Trespalacios et al., 2021). Thus, a gap in the literature exists regarding student perceptions of program and institutional support and their influence towards online community development

that extends beyond single online courses. In 2019, Shepherd and Bolliger conducted a small-scale study of graduate student perceptions regarding community outside of single courses. The purpose of this survey-based cross-sectional research study is to further examine these perceptions on a larger scale among online undergraduate and graduate students and investigate which events and activities support program and institutional community.

Methods

The study used a survey-based research design to collect data from university students with the use of a newly developed instrument by the researchers. The survey-based design was selected to reach a larger population from which to draw a sample to obtain a numeric description of perceptions of university students in online programs (Creswell, 2009) at one institution of higher education in the southeastern United States regarding online community, and to provide researchers with the ability to generalize the findings to a larger population at similar settings and learning environments.

Participant Selection and Implementation

Following Institutional Review Board approval from institutions associated with the principal researchers, we requested the names and contact information of all undergraduate and graduate students enrolled in online degree programs at a midsize, urban university located in the Southern United States during the fall 2021 semester. This resulted in a list of 2033 students.

Beginning midsemester, we emailed participants four times. Email messages briefly described the study purpose, its voluntary nature, and benefits and limitations of participating. It also provided a link to the anonymous survey, housed in Qualtrics. When participants selected the survey link on the email invitation, they were provided with the study's purpose and a list of benefits and limitations. They were also informed that submitting the survey explicitly expressed their informed consent to participate. Completers were able to register for the drawing of one of ten $10 gift cards by providing a name and email address in a Google form. In accordance with Dillman et al. (2014), weekly reminder/thank-you emails about the survey were sent for three weeks. However, at the conclusion of the fall 2021 semester, about 200 students had responded to our survey. To increase participant numbers, we sent four additional reminder emails to the same group of students midway through the spring 2022 semester.

Instrument

The Sense of Online Community Scale (SOCS) is a 28-item instrument that asks respondents about the importance of community in their degree program and the extent that various program and institutional events and activities influence perceptions of community. Items on the instrument used a 5-point Likert-type scale that ranged from 1, *strongly disagree* to 5, *strongly agree.* A *not applicable* option was also provided for each item.

Items 1 to 6 focused on the importance of community and its elements (e.g., "The following are important to help me develop a sense of program community: Trusting others in my program." "Feeling that I belong in my program."). Items 7 to 16 focused on program-specific elements of community (e.g., "The following program elements help me feel like I am part of a program community: Opportunities to participate in faculty research." or "Student-initiated social activities within my program."). Items 17 to 28 focused on institutional activities

that influence perceptions of community. One open-ended question asked respondents to indicate what contributed to their sense of community. The SOCS also included seven questions regarding characteristics of students' programs (e.g., undergraduate versus graduate, predominantly synchronous versus asynchronous, cohort-based) and four questions about student demographics (e.g., ethnicity, age, gender, and physical distance from campus).

Prior to the administration of the instrument, the scale underwent a review by an expert panel. Four experts who either held the rank of associate or full professor and who had at least six years of online teaching experience in higher education participated in the review. Additionally, these experts have conducted extensive research in the area of online learning, such as course design, course community, student satisfaction or student engagement. After the data were collected, a confirmatory factor analysis was conducted to validate the instrument. Results indicated the SOCS was a valid and reliable instrument. Model fit estimates were either good or acceptable to the data ($\chi^2 = 812.78$, $df = 340$; CFI = 0.86; RMSEA = 0.08; SRMR = 0.07) (Shepherd et al., 2023). Internal reliability coefficients were also calculated for the instrument and its subscales. The instrument's Cronbach alpha was 0.94. The reliability for all subscales was acceptable (see Table 1).

Table 1
Reliability for Subscales

Subscale	No. of items	Cronbach's α
Importance	6	0.82
Program/Academic	6	0.80
Program/Social	4	0.88
Institution/Academic	6	0.87
Institution/Social	4	0.88
Affiliation	2	0.84

Data Analysis

In total, 319 students responded to the survey. However, 26 cases were deleted because one-third or more of data was missing. The data set included 16 outliers ($z = \pm 3.0$); however, these cases were not deleted. This resulted in 293 valid cases and a 14.4% response rate. Frequencies, mean scores, and standard deviations were generated. Correlation coefficients were calculated to detect relationships between subscales. Analysis of variance and independent *t* tests were conducted to analyze differences in participants' responses based on students' ethnicity,

classification, distance from a campus, and time spent in their online degree program. Responses to one open-ended question were analyzed qualitatively for themes and frequencies using open-coding and constant comparison techniques (Creswell, 2012; Patton, 2002).

Participants and Program Characteristics

The demographics and characteristics of respondents are displayed in Table 2. Participants' ages ranged from 19 to 74 (M = 39.5, SD = 11.8). Their time in their current online program ranged from 0 to 6 years (M = 1.69, SD = 0.84). Most participants were in their first (44.7%) or second year (40.1%) of their programs. Only 15.3% of students had been in their current programs longer than two years. When asked whether they lived within a 1-hour commute to a main or satellite campus, 51.0% answered *yes*, 48.6% answered *no*, and 0.3% were *unsure*.

Table 2
Demographics of Participants

Demographics	*n*	%	Characteristics	*n*	%
Gender (*N* = 287)			Program (*N* = 288)		
Female	235	81.9	Undergraduate	141	49.0
Male	47	16.4	Graduate certificate	16	5.6
Prefer not to say	3	1.0	Master	80	27.8
Non-binary	1	0.3	Doctoral	45	15.6
Other	1	0.3	Other	6	2.1
Ethnicity (*N* = 281)			College (*N* = 287)		
White/Caucasian	146	52.0	Business & economics	59	20.6
African American	97	34.5	Professional & liberal studies	53	18.5
Latinx	8	2.8	Education	47	16.4
Asian	7	2.4	Arts & sciences	35	12.2

Hispanic	5	1.8	Health sciences	32	11.1
Bi-ethnic	5	1.8	Nursing	23	8.0
Not applicable	4	1.4	Public health	16	5.6
European	2	0.7	Unsure	16	5.6
Multi-ethnic	2	0.7	Communication & fine arts	5	1.7
Native American	2	0.7	Communication sciences & disorders	1	0.3
Pacific Islander	1	0.4			
Other	2	0.7			

Respondents' details pertaining to their programs are displayed in Table 3. Most participants were enrolled in programs that were delivered asynchronously (82.3%), and 46.9% of students were not in cohort-based programs. Of those who indicated they were enrolled in a cohort-based program (n = 66), 84.8% felt the cohort helped them feel part of a program community, whereas 4.5% felt it did not. Some students (10.6%), however, were unsure. Most students reported they were not required to attend in-person meetings (94.1%).

Table 3
Program Characteristics (N = 288)

Characteristics	*n*	%
Delivery		
Asynchronous	237	82.3
Synchronous	8	2.8
Combination	40	13.9
Other	3	1.0
Required meetings		

Yes	11	3.8
No	271	94.1
Unsure	6	2.1
Cohort-based program		
Yes	66	22.9
No	135	46.9
Unsure	87	30.2

Results

Research Question 1: Importance of Online Program Community

The first section of the survey asked participants about their perceptions of the importance of community and elements that may contribute to their feelings of community. The majority of online students who participated in the study (72.0%) *agreed* or *strongly agreed* that a sense of community in their programs is important (M = 3.95); only 10.9% of respondents *disagreed* or *strongly disagreed* with this statement (Table 4). Over 80% of participants *agreed* or *strongly agreed* that the following elements were important in the formation of community: feeling a sense of belonging (88.8%), affiliation (85.6%), and trust (81.9%). In contrast, having similar interests and experiences with others was less important. The element of belonging had the highest mean score (M = 4.36), whereas the element of similar experiences had the lowest mean score (M = 3.70).

Table 4

Descriptives and Frequencies for Importance Subscale Items (N = 293)

Item	Percentage				*M*	*SD*
	SD/D	*N*	*A/SA*	*N/A*		
1. Having a sense of community in my program (e.g., a sense of belonging, interconnection, trust) is important to me.	10.9	17.1	72.0	0.0	3.95	1.09
The following are important to develop a sense of program community:						

2. Trusting others in my program.	3.1	14.3	81.9	0.7	4.17	0.82
3. Having similar interests with others in my program.	8.5	22.5	68.3	0.7	3.89	0.95
4. Having similar experiences with others in my program.	13.7	25.9	59.4	1.0	3.70	1.03
5. Feeling that I belong in my program.	4.4	5.8	88.8	1.0	4.36	0.86
6. Feeling that I am affiliated with my program.	4.1	9.6	85.6	0.7	4.33	0.86

Note. Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). *N/A* = not applicable.

Research Question 2: Activities that Influence Student Perceptions of Program Community

The next two subscales of the survey included items pertaining to academic and social activities offered to students in online programs. All items in the subscale pertaining to academic activities offered by the program had a mean score above 3.00 (Table 5), indicating they assist students develop a sense of program community in online programs. However, a high percentage of participants responded *neutral* to items 12 (taking required courses outside of the program, such as statistics) and 9 (participating in faculty research), 31.4% and 27.3% respectively. The two items that had the highest mean scores pertaining to elements that made them feel like a part of an online program community were items 8, completing program milestones (M = 4.10), and 11, sharing professional resources (M = 4.08).

Table 5

Descriptives and Frequencies for Program/Academic Subscale Items (N = 293)

Item	Percentage				*M*	*SD*
	SD/D	*N*	*A/SA*	*N/A*		
The following elements help me feel like I am part of a program community:						
7. Program advising activities (e.g., orientations, retreats, guidance regarding course selection)	11.3	14.7	70.0	4.1	3.95	1.05
8. Completion of program milestones (e.g., portfolios, exams, defenses)	7.5	12.3	79.5	0.7	4.10	0.95
9. Opportunities to participate in faculty research (e.g., research groups, presentations, publications)	9.2	27.3	60.1	3.4	3.80	0.98
10. Opportunities to attend academic program events outside of courses (e.g., guest lectures, internships, field trips, professional meetings)	10.6	17.4	66.2	5.8	3.88	1.05

11. Professional resource sharing with others in my program (e.g., job postings, conference announcements, calls for proposal, professional services)	6.8	14.7	75.1	3.4	4.08	0.92
12. Taking required courses that include students from outside the program (e.g., statistics, writing)	15.0	31.4	50.1	3.4	3.55	1.08

Note. Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). *N/A* = not applicable.

In general, respondents agreed less with program initiated social activities being helpful in developing a sense of community compared to academic activities. All items in this subscale had a mean above 3.00 but below 4.00 (Table 6). The two items with which respondents had the highest agreement were items 14 (virtual or remote social activities) and 16 (professor-initiated social activities); over 60% of individuals *agreed* or *strongly agreed* with these statements. These two items also had the highest mean, 3.71 and 3.69 respectively. In-person social activities did not apply to 13.3% of participating online students. These students most likely lived too far from a campus, or these activities were not offered to students who studied via distance.

Table 6

Descriptives and Frequencies for Program/Social Subscale Items (*N* = 293)

Item	Percentage				*M*	*SD*
	SD/D	*N*	*A/SA*	*N/A*		
The following elements help me feel like I am part of a program community:						
13. In-person social activities within my program (e.g., picnics, parties, get-togethers)	18.4	26.3	42.0	13.3	3.39	1.17
14. Virtual or remote social activities within my program (e.g., social media posts, online games, chat rooms)	15.7	17.4	62.8	4.1	3.71	1.11
15. Student-initiated social activities within my program	16.0	25.3	52.6	6.1	3.56	1.10
16. Professor-initiated social activities within my program	13.0	22.2	60.4	4.4	3.69	1.06

Note. Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). *N/A* = not applicable.

Respondents were also asked to share their levels of agreement pertaining to academic and social activities offered by their universities that helped them develop a sense of program community. The academic activity items with the highest agreement were 20 (institutional academic support) and 21 (institutional career services). Over 70% of participants *agreed* or *strongly agreed* with these items, and they had the highest means in this category (Table 7). The least helpful activity was the use of special interest groups, such as social media or research groups offered by the institution.

Table 7
Descriptives and Frequencies for Institution/Academic Subscale Items (*N* = 293)

Item	Percentage				*M*	*SD*
	SD/D	*N*	*A/SA*	*N/A*		
The following institutional elements help me feel like I am part of a program community:						
17. Academic events for multiple programs (e.g., capstone meetings, retreats, guest speakers, research days/symposia)	10.9	20.5	63.9	4.8	3.76	0.97
18. Student organizations associated with my program	10.6	21.5	63.9	4.1	3.77	1.00
19. Institutional wellness supports (e.g., personal counseling, health centers, fitness centers)	10.6	20.1	61.7	7.5	3.79	1.06
20. Institutional career services (e.g., career counseling, interview support, resume building)	8.2	14.0	73.7	4.1	3.99	1.01
21. Institutional academic supports (e.g., writing centers, tutoring, library and research services)	7.5	13.3	76.1	3.1	4.06	0.98
22. Voluntary interest groups (e.g., social media groups, study or research group)	10.2	26.3	59.4	4.1	3.72	1.02

Note. Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). *N/A* = not applicable.

In the institutional social activity category, items had mean scores between 3.55 and 3.82 (Table 8). The statement with the highest agreement (63.8%; *M* = 3.82) was item 23 (institution-wide equity and inclusion initiatives), whereas the item with the lowest agreement (50.8%; *M* = 3.55) was item 24 (institution-wide sports events).

Table 8
Descriptives and Frequencies for Institution/Social Subscale Items (*N* = 293)

Item	Percentage				*M*	*SD*
	SD/D	*N*	*A/SA*	*N/A*		
The following institutional elements help me feel like I am part of a program community:						
23. Institution-wide initiatives regarding equity and inclusion	9.9	21.8	63.8	4.4	3.82	1.03
24. In-person or remote institution-wide sporting events (e.g., football, basketball, soccer)	16.0	25.6	50.8	7.5	3.55	1.15
25. In-person or remote institution-wide fine and performing arts events (e.g., plays, concerts, ballets, art galleries)	13.3	23.2	57.7	5.8	3.65	1.07
26. In-person or remote institution-wide celebrations (e.g., homecoming, graduation, Veteran's Day celebrations)	10.9	24.9	59.1	5.1	3.71	1.03

Note. Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). *N/A* = not applicable.

Open-Ended Question Responses

An open-ended question asked respondents what contributed to their sense of community in their online program. Figure 1 depicts the top 10 responses. Of the 293 participants, 36 did not respond. An additional 21 indicated "nothing," "I don't have a sense of community in this program," or "N/A." Within the 236 remaining responses, 48 indicated a connection or interconnection with faculty members and students and 30 mentioned a sense of belonging. Representative comments included "Sense of belonging, I feel I have a seat at [t]he table" and "feels like home." Twenty-seven individuals mentioned "trust."

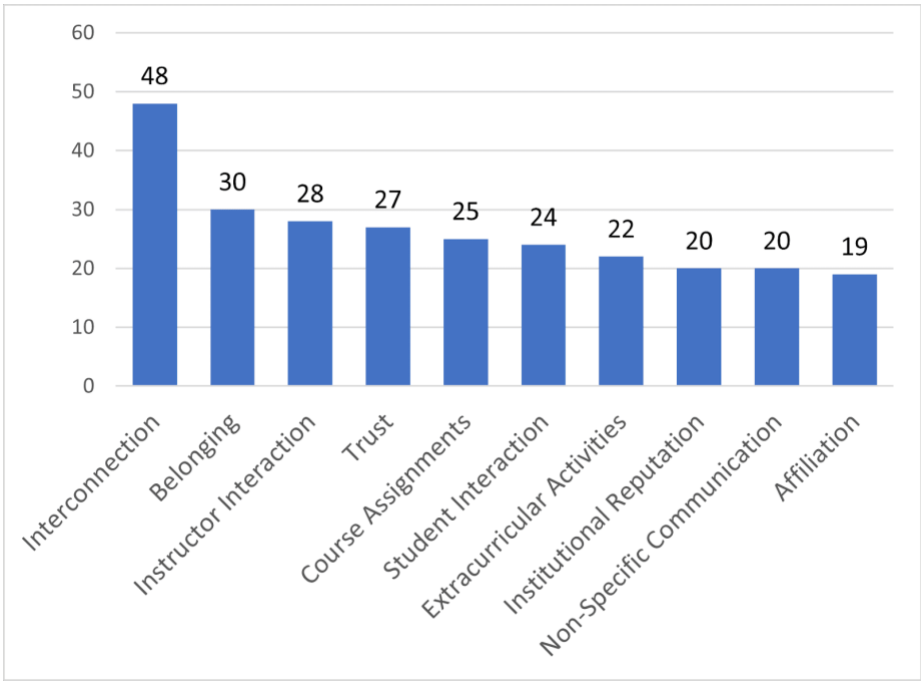
Interactive events also contributed to a sense of community. Twenty-two respondents mentioned specific program activities (e.g., "co-writing research papers," "social activities," "accessible online clubs and organizations," "virtual and in-person activities"). Twenty-eight mentioned instructor interactions, 24 mentioned student interactions, and 20 mentioned non-specific forms of communication (e.g., "communicating with others in my program," "communication").

Additionally, 20 respondents mentioned the reputation of the institution, sport teams, and other institution-wide resources as sources of community. Nineteen students mentioned affiliation specifically, though it was unclear whether affiliation related to their degree program or the institution. Yet, 13 respondents directly mentioned seeing the same students in multiple classes (through cohort programs) as a community contributor. Additionally, 25 respondents tied

course activities and assignments to their sense of community. Representative comments included "classes/schoolwork, projects, books, exams, quizzes, etc. …." One person wrote,

> Interpersonal interactions through the on-line course can bring about new friendships-professional and/or personal. Through coursework & required assignment(s), opportunities may arise to begin to form these relationships. Team building enhances and contributes to my overall sense of community belonging.

Figure 1
Community Contributors by Response Frequency (*N* = 257)



Note. Individuals were able to record multiple responses.

Lastly, participants were asked to respond to statements about their sense of affiliation with their online programs and universities. Most students (58.7%) *agreed* or *strongly agreed* they had a strong affiliation with their online program (*M* = 3.61). A slightly higher percentage (62.5%) had a strong affiliation with the institution they attended. However, over 20% marked *neutral* for both statements (Table 9).

Table 9
Descriptives and Frequencies for Affiliation Subscale Items (*N* = 293)

Item	Percentage				*M*	*SD*
	SD/D	*N*	*A/SA*	*N/A*		
27. I have a strong affiliation (e.g., sense of membership) with my current online program.	19.5	20.1	58.7	1.7	3.61	1.19
28. I have a strong sense of affiliation with my current university.	16.0	20.8	62.5	0.7	3.69	1.13

Note. Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). *N/A* = not applicable.

Descriptive statistics for all subscales are displayed in Table 10. The importance subscale had a relatively high mean score (*M* = 4.05), which indicates that many students associate value with having a sense of community in their online program. Of the four activity subscales, the academic activities offered by the program had the highest mean (*M* = 3.80), whereas the program/social subscale had the lowest mean score (*M* = 3.47). Overall, students indicated that activities that help build community were somewhat important. However, they perceived social events and activities—offered by both the program and the institution—as less important than academic events and activities.

Correlation coefficients among the six subscales were calculated. Using the Bonferroni approach to control for Type I error across the 15 correlations, a *p* value of less than 0.003 (.05/15 = .003) was required for significance. Results in Table 10 show that all correlations were statistically significant and were greater than or equal to 0.34. Results show that the lowest correlation (*r* = .34) was between the program/social and affiliation subscales, whereas the highest correlation coefficient (*r* = .74) was between the institution academic and social subscales.

Table 10
Descriptive Statistics and Correlations for Subscales

Subscale	*n*	*MD*	*SD*	1	2	3	4	5	6
1. Importance	292	4.05	0.70	-					
2. Program/Academic	289	3.80	0.80	.40**	-				
3. Program/Social	281	3.47	1.04	.41**	.61**	-			

4. Institution/Academic	287	3.74	0.87	.42**	.63**	.66**	-	
5. Institution/Social	285	3.57	0.98	.35**	.53**	.58**	.74**	-
6. Affiliation	290	3.64	1.08	.39**	.46**	.34**	.39**	.40**	-

Note. **$p < .01$ (2-tailed). Scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*).

Research Question 3: Individual Differences in Responses

Ethnicity

Similar to Milman et al. (2015) respondents were categorized into White and non-White based on their write-in responses because of the large representation in both groups. Independent samples *t* tests were conducted to evaluate whether ethnicity had an influence on students' responses. The test was significant for the affiliation subscale, $t(271) = -4.331$, $p = .008$; $d = -.525$. Non-White students ($M = 3.94$, $SD = 0.94$) felt more affiliated with their program and institution compared to White students ($M = 3.39$, $SD = 1.14$). The effect size for this analysis (Cohen's D) indicated a medium effect.

Classification

Respondents were recategorized into three groups: (1) undergraduate, (2) master's and graduate certificates, and (3) doctoral students. A series of ANOVAs were conducted to evaluate students' responses on the subscales. The tests were significant for program academic activities, $F(2, 277) = 3.21$, $p = .04$ and affiliation, $F(2, 276) = 3.81$, $p = .02$. The effect sizes were relatively small, $\eta^2 = .023$ and $\eta^2 = .027$, respectively.

Dunnett's *C* follow-up tests were conducted to evaluate pairwise differences among the means because equal variances among the three groups were not assumed and group sizes were unequal. There was a significant difference in the means between master's/graduate certificate students and doctoral students for the program academic activity subscale. Doctoral students had a higher mean on the program activities subscale than students in master's/graduate certificate programs (Table 11). There was also a significant difference in the means between undergraduate and masters/certificate students on the affiliation subscale. Undergraduate students had a significantly higher mean than master's/graduate certificate students on the affiliation subscale (Table 12). While doctoral students had a higher mean score than master's/certificate students, the difference in mean scores was not statistically significant, possibly due to unequal group sizes—there were twice as many master's/graduate certificate students than doctoral students in our sample.

Table 11

95% Confidence Intervals of Pairwise Differences in Means for Three Groups for the Program Academic Activities Subscale (*N* = 280)

Group	*M*	*SD*	Group 1	Group 2
Undergraduate	3.81	0.90		
Master's/Certificate	3.64	0.75	[-0.09, 0.43]	
Doctoral	4.01	0.70	[-0.51, 0.11]	[0.06 to 0.68*]

Note. An asterisk indicates that the 95% confidence interval does not contain zero, and therefore the difference in mean is significant at the 0.05 significance using Dunnett's *C* procedure.

Table 12

95% Confidence Intervals of Pairwise Differences in Means for Three Groups for the Affiliations Subscale (*N* = 279)

Group	*M*	*SD*	Group 1	Group 2
Undergraduate	3.75	1.05		
Master's/Certificate	3.40	1.14	[0.01, 0.70*]	
Doctoral	3.81	0.95	[-0.47, 0.34]	[-0.03 to 0.86]

Note. An asterisk indicates that the 95% confidence interval does not contain zero, and therefore the difference in mean is significant at the 0.05 significance using Dunnett's *C* procedure.

Distance

To determine whether students who lived within a 1-hour commute responded differently compared to those students who did not, independent samples *t* tests were conducted. The test was significant for the institution/social subscale, $t(278) = 2.88$, $p = .007$; $d = .344$. Participants who lived within a 1-hour commute to a main or satellite campus had higher mean scores ($M = 3.73$, $SD = .87$) compared to those who did not ($M = 3.39$, $SD = 1.10$). The effect size was relatively small.

Time in Program

Independent samples *t* tests were conducted to evaluate differences in students' responses based on time in the online program. Participants were grouped into two groups, 0 to 1 year and more than 1 year because so many of our participants were in their first and second year of their programs. Results were not significant on any of the subscales.

Discussion and Recommendations

Importance of Community

Results indicate that most students (72.0%) *agreed* or *strongly agreed* that a sense of community in their program is important. Additionally, most students felt that a sense of belonging, trust and affiliation with their program was important. However, 10.9% of participants *disagreed* or *strongly disagreed* that a sense of community in their program is important, aligning with findings from other studies (Bolliger et al., 2019; Exter et al., 2009; O' Shea et al., 2015; Shepherd & Bolliger, 2019). Those who do not place importance on community may have other professional and personal support systems and their primary goal may be to complete the degree (Bolliger et al., 2019; Exter et al., 2009). Yet, because most students desire a sense of community, limiting services under the assumption that students do not care seems ill-supported (Milman et al., 2015; Muljana & Luo, 2019). Students have differing needs at differing times of their educational experience (Pifer & Baker, 2016). That said, a desired community may not translate into use of services. Some faculty became reticent to provide social activities in online programs because of low student participation (Bolliger et al., 2019). We argue that the responsibility to support community development and sustain community for online learners lies with institutions and academic program personnel. Both provide myriad services for learners who are physically on campus. Therefore, online learners—whether they are truly at a distance or within close proximity to a campus—should have similar opportunities to partake in social and academic activities that support *their* academic community.

However, institutions and programs may have to better communicate the underlying goals regarding extracurricular social and academic events to encourage participation. Most online students are nontraditional. They have alternative social networks, employment, family responsibilities, and other duties that compete for time and attention (Kang & Pak, 2023; Milman et al., 2015; Stephen et al., 2020; Wladis et al., 2015). Promoting non-course-related activities (whether academic or social) may first appear superfluous and time-intensive. Instruction and program administrators may need to help students realize that these events are developed to reduce course hierarchies, provide opportunities for informal dialogue and interest exploration, promote shared experiences, and encourage a sense of belonging, trust, membership, and collaboration that can lead to deeper professional and goal-directed experiences. Of course, activity planners and promoters must realize that attendance is ultimately dependent on student interests, availability, and other factors. However, communicating the underlying purposes of social and academic events may increase perceptions of relevance and interest.

Activities and Affiliation

Twenty-five participants directly tied community formation to course activities while responding to the open-ended question. This aligns with prior literature regarding community formation in online courses (e.g., Erdoğmuş et al., 2022; Larson & James, 2022; Trespalacios et al., 2021). Course projects, interactions, and activities provide necessary components to develop a sense of community. They should not be ignored when institutions and programs strive to promote and maintain community among their students.

However, most participants also recognized the need for academic and social community at the program and institutional level. On the program level, students rated milestones, resource sharing, and professor-initiated and remote social activities highest. On the institutional level,

highly rated activities included academic support and career services, equity and inclusion initiatives, and institution-wide celebrations (among others). These findings align with those of Lee and Choi (2011), Trespalacios et al. (2023), and Muljana and Luo (2019) who found institutional and program services of use to online students for community-building purposes. Students also rated academic activities higher than social activities. These findings align with those of Skelcher et al. (2020) where online learners desired a variety of program and institutional services, including relevant emails to distance students, cohort programs, and similar services available to campus students. Yet, our findings suggest that social activities, even on-campus activities, were considered important to distance students. This finding differs from that of O' Shea et al. (2015) where on-campus activities further isolated distance students by reminding them of their inability to participate.

Distance to Campus

One reason for this difference may be based on the number of distance students located within close proximity to campus. Seaman et al. (2018) found that most online students lived within 50 miles of campus. Because the university in question is situated within a metropolitan area, we considered travel distance as a better indicator of proximity (Xu & Jaggars, 2013). Regardless, 51% of respondents indicated they lived within one hour of the main or a satellite campus. These proximate participants also rated institutional social activities higher for community formation. Although on-campus activities may isolate distance students that are unable to attend (O' Shea et al., 2015), they should not be dismissed as irrelevant for online community development. Students may live or work near a campus and have the ability to attend on-campus events such as advising sessions, brown bag lunches, graduate student defenses, college or institutional conferences, art exhibits, sporting events, and so forth. Even if they do not live within close proximity, students may be able to visit for one day. Some of them may be able to combine the attendance of an academic or a social event to meet with their advisor or committee members, tour the campus, or take advantage of services the campus library, employment services, or the writing center offers. Yet, on-campus services should not be solely relied upon for institutional and program community support. Distance services should support distance students, meeting their unique needs and fostering their sense of belonging to the larger institution (Shepherd & Bolliger, 2023; Milman et al., 2015). Indeed, more research is needed regarding the optimal frequency and sequence of academic and social events to sustain a sense of community and how they should be distributed among programs and institutions.

Underrepresented Participant Perspectives

Larson and James (2022) described how marginalized students require additional services to navigate higher education because they may be less accustomed to the rules and traditions of that setting. Online learning may exacerbate these problems as perceptions of isolation increase. Of the 287 participants who identified their ethnicity, 97 (34.5%) characterized themselves as African-American/Black and 32 (11.4%) as another underrepresented group. Interestingly, underrepresented participants in online programs felt a higher sense of affiliation with their degree program and institution than White participants. Our survey did not provide specifics as to why these differences occurred. However, participants did not identify differences in desired academic and social activities. This finding differs from that of Milman et al. (2015), where non-White students were more interested in career and counseling services. Although our study did not compare individual items between groups, focusing instead on composite subscales, less than 11% of all respondents disagreed that career and health services contributed to their sense of

community. Most participants indicated a desire for these services. Despite our larger sample of non-White students in comparison to the other studies mentioned, additional research is needed to see if these findings replicate in other settings.

Graduate Classification and Time in Programs

Additionally, doctoral students had a higher mean score on the program activities subscale than master's and graduate certificate students. It can be difficult for doctoral students to acclimate to academia and connect with others in the program via distance (Pifer & Baker, 2016). Therefore, participating in faculty research projects, attending professional conferences, networking events, and sharing professional resources may be more important to doctoral students than to undergraduate or master's degree-seeking students. In a study conducted by Studebaker and Curtis (2021), doctoral students valued community and attributed the connections they made to their success. Furthermore, this study did not find statistically significant differences between students' time in the program. This differs from some research where differences were hypothesized or found when investigating online student connectedness, related to program community (Pifer & Baker, 2016; Shepherd & Bolliger, 2022; Trespalacios et al., 2021). For example, second-year graduate business students felt more connected than first-year students (Jamison & Bolliger, 2020). Although survey items do not provide additional insight, it is possible that students began with more experience and comfort managing online learning because of their prior experience during the COVID-19 pandemic. Additionally, the large majority of our participants were in the first two years of their program, providing only a limited view of time spent in most undergraduate and doctoral degree programs (Pifer & Baker, 2016). More research should capture a larger representation of degree type and time spent in programs to consider differences.

Limitations

This research includes some limitations. The participating institution and the sample were not selected at random. Second, the study is geographically limited to one, large, research-intensive, public institution in the southeast United States. This study also included fewer doctoral students ($n = 45$) than undergraduate and master's degree students, possibly limiting the representation of their ideas. Additionally, 82% of respondents were female. While this number aligns with other's claims regarding student makeup in online courses, (e.g., Wladis et al., 2015; Xu & Jaggars, 2013), it may limit the voice of males. Other researchers may replicate the study and include multiple sites, geographical areas, degree programs, demographic makeup, and different types of institutions based on the Carnegie Classification of Institutions of Higher Education (n.d.). Lasty, all data are self-reported. Readers are encouraged to interpret results with caution as results may not be generalizable.

Declarations

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