

# Introduction to OLJ Volume 29, Issue 1

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This issue of *Online Learning* presents a diverse collection of research studies exploring innovative teaching strategies, technology integration, faculty and student engagement, and instructional methodologies in online education. These studies offer insights into the evolving landscape of digital learning, contributing valuable findings for educators, instructional designers, and administrators.

In their article, "Active Learning and the Development of 21st Century Skills in Online STEM Education: A Large-Scale Survey," Ilana Ram, Rinat Rosenberg-Kima, Daniel R. Lewin, Abigail Barzilai, Olga Chumtonov, and Ido Roll from Technion, Israel Institute of Technology investigate the relationship between active learning strategies and the development of key 21st-century skills in online STEM courses. Analyzing survey responses from undergraduate students, they find that activities aligned with the Interactive, Constructive, Active, and Passive (ICAP) framework significantly enhance communication, collaboration, and critical thinking skills. Their study underscores the necessity of structured active learning designs in remote STEM education to maximize student engagement and satisfaction.

Dara Tafazoli from the University of Newcastle, Australia, introduces a "Development of Computer-Assisted Language Learning (CALL) Literacy Framework for Foreign Language Teachers." This study identifies digital literacy, language proficiency, and pedagogical competency as critical components of CALL literacy. Through phenomenological inquiry and Delphi validation, the framework provides a structured approach for educators to integrate CALL effectively. The research highlights the growing necessity for language teachers to develop multifaceted technological competencies to optimize language instruction.

Michelle L. Ackerman, Bettina Shapira, Joel B. Goodin, and Sunilda A. Andriotis from National University, San Diego, examine dissertation completion rates in online doctoral programs in their study, "Sequentially Structured Online Dissertation Model: Implications for Timely Completion Among Online Psychology Doctoral Students." Their findings suggest that a structured approach incorporating mentor feedback loops and scaffolded research components significantly reduces time-to-completion. The study offers evidence that implementing a sequentially structured model fosters student accountability and supports dissertation progress, addressing persistent challenges in online doctoral education.

Mohamed Shameem Adam, Junainah Abd Hamid, Ali Khatibi, and S. M. Ferdous Azam analyze instructional strategies in their article, "Investigating the Effects of Direct Instruction and Facilitated Discourse on Social and Cognitive Presence in Blended Learning." Utilizing the Community of Inquiry framework, their study reveals that social presence plays a mediating role in the relationship between teaching presence and cognitive presence. Their research offers valuable guidance for designing blended learning environments that balance structured instruction with interactive discourse to enhance student engagement and critical thinking.

In "Predictive Model to Analyze Real and Synthetic Data for Learners' Performance Prediction Using Regression Techniques," the authors explore the effectiveness of machine learning in educational analytics. Comparing real, synthetic, and hybrid datasets, they demonstrate that synthetic data can achieve predictive accuracy comparable to real data. Their findings emphasize the potential of privacy-preserving synthetic data to support personalized learning interventions while maintaining data security and accessibility.

Hebatullah ElGamal from Carl von Ossietzky University of Oldenburg presents "What is the De Facto? Implementation of the Flipped Classroom Approach in Higher Education." Through interviews with veteran professors across multiple disciplines, the study identifies key benefits and challenges of sustained flipped learning implementation. Findings highlight the need for institutional support, student readiness, and theoretical frameworks to optimize the effectiveness of this pedagogical approach in higher education.

The "Greek Version of the Blended Teaching Readiness Instrument (BTRI): Results of the Pretest Study and the Content Validation" study examines the adaptation and validation of the Blended Teaching Readiness Instrument for Greek educators. The research provides insights into teachers' preparedness for blended learning and underscores the importance of professional development programs tailored to local educational contexts.

Kosmas Vlachos from the National & Kapodistrian University of Athens investigates the impact of written assignments on postgraduate TESOL students in "Written Assignments in Technology-Enhanced Postgraduate Courses in TESOL." Findings indicate that structured assignments incorporating modern technologies improve teacher trainees' instructional design skills and intercultural awareness. The study highlights the role of reflective practice in fostering continuous professional development in language education.

Yujin Park, Jewoong Moon, and Hunhui Na explore elementary STEM educators' use of Open Educational Resources (OER) in "Elementary STEM Teachers' Open Educational Resources and TPACK in a Professional Learning Network: A Case Study." Analyzing online interactions within a professional learning network, their study reveals that technology-related resources and pedagogical content knowledge are the most frequently discussed topics. The research underscores the role of PLNs in supporting elementary STEM teachers' professional development and resource-sharing practices.

Fang Tang's study, "Setting the Stage for Success: Readiness and Connectedness as Antecedents of Learning Continuance Intention in Online Learning," investigates the relationship between online learning readiness and student connectedness. Through hierarchical multiple regression analysis, the study finds that motivation and course facilitation significantly impact students' intentions to continue online learning, emphasizing the importance of fostering readiness and support structures in digital education.

Kristi Arnesen's article, "Encouraging Self-Regulation in an Online University Course for Preservice Teachers: An Intervention Study," examines the role of goal setting and self-reflection in fostering self-regulation among online learners. Findings suggest that structured interventions

significantly enhance students' ability to manage their learning, demonstrating the benefits of self-regulation strategies in online education.

Yam B. Limbu and Christopher McKinley's systematic review, "Factors Associated with Student Engagement in Online Learning During COVID-19 Pandemic," synthesizes research on student engagement drivers in online education. Their review identifies key student, instructor, and institutional factors that impact engagement, providing a framework for enhancing digital learning experiences.

Hasini Perera's research, "Fostering Higher-Level Inquiry in Online Asynchronous Discussion with Kit-Build Concept Mapping," explores how structured preparatory activities can enhance cognitive engagement in online discussions. The study finds that using concept mapping leads to deeper inquiry and improved discourse, offering practical strategies for fostering higher-order thinking in digital learning environments.

Saif Al-Hammouri's article, "The Effectiveness of the Good Behavior Game on Students' Academic Engagement in Online-Based Learning," evaluates how gamification strategies can improve student participation and engagement. The study's results indicate that structured competitive learning activities significantly enhance both the quantity and quality of student engagement in online courses.

Together, these studies provide a comprehensive exploration of instructional design, faculty and student engagement, and technology integration in online and blended learning environments. The findings contribute to a deeper understanding of effective pedagogical strategies, ensuring that digital education continues to evolve in a manner that is inclusive, innovative, and impactful.

We extend our gratitude to the authors and reviewers who contributed to this issue and to the *Online Learning* community for their continued support in advancing research and best practices in digital education.

# Active Learning and the Development of 21<sup>st</sup> Century Skills in Online STEM Education: A Large-Scale Survey

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## Abstract

While the benefits of active learning to student experiences are well documented, less is known about active learning in online education, especially regarding the development of 21<sup>st</sup> century skills (e.g., communication, collaboration, critical thinking, creativity). Specifically, open questions remain concerning the contribution of different active learning pedagogies to different sets of skills in online Science, Technology, Engineering, and Mathematics (STEM) education. The current research addresses this gap. We surveyed 744 undergraduate students to evaluate the relationship between learning design, 21<sup>st</sup> century skill development, and satisfaction in the context of a course taken remotely during the COVID-19 pandemic (Spring 2020). Using an exploratory and a confirmatory factor analysis as well as several multiple linear regressions, we extracted the relationship between various properties of course design (e.g., frequency of groupwork) and the self-reported development of key 21<sup>st</sup> century skills. Results show that these skills can be grouped into three sets: communication and collaboration skills, domain-general skills, and STEM-specific skills. We further found that designs for active learning explain variance in students' development of 21<sup>st</sup> century skills. Specifically, individual work, group work, long-term work, and synchronous work explain variance in students' reports of skill development. Moreover, supporting students in skill development was associated with greater satisfaction with the course. Our findings suggest that activities in the higher levels of the Interactive, Constructive, Active, and Passive framework (ICAP; Chi et al., 2018) are associated with greater learning of key 21<sup>st</sup> century skills and increase students' satisfaction. We discuss implications for design and institutional support.

*Keywords:* Active learning, 21<sup>st</sup> century skills, STEM education, remote teaching and learning.

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Leading organizations (e.g., UNESCO, OECD, APEC; Ananiadou & Claro, 2009) call for educational systems to prepare their students to be “full participants in a dynamic, ever-changing world and industry” (Kennedy & Sundberg, 2020, p. 482). Accordingly, students should be taught skills and competencies that go beyond any specific content-based professional curricula. Achieving this is particularly important in Science, Technology, Engineering, and Mathematics (STEM) education as there is often a gap between the curricula and the skills students are expected to demonstrate upon graduation (Jang, 2016; Kennedy & Sundberg, 2020). These skills are often referred to as 21<sup>st</sup> century skills. The Partnership for 21<sup>st</sup> Century (2011) defines these skills as “The Four Cs”: i) Communication, ii) Collaboration, iii) Critical Thinking, and iv) Creativity (Christensen & Knezek, 2015).

Recent work shows an association between instructional approaches emphasizing active learning and the development of 21<sup>st</sup> century skills (Christensen & Knezek, 2015; Lavi, Tal & Dori, 2021). Learning opportunities that include complex problem-solving, collaboration, and critical thinking, improve students’ domain-specific performances (Freeman et al., 2014; Hattie, 2010) as well as 21<sup>st</sup> century competencies (Buitrago-Flórez et al., 2021; Lopatto, 2007). However, most studies on active learning and 21<sup>st</sup> century skills focus on a face-to-face instructional context. Thus, it is still unclear if the advantages of active learning instruction in a face-to-face context are transferable to an online educational context. This is particularly relevant as the COVID-19 pandemic introduced new challenges to online teaching and learning (Basdogan & Birdwell, 2023; Hadi Mogavi et al., 2021). Here we explore the relationships between active learning, 21<sup>st</sup> century skill development, and student satisfaction in the context of online STEM education. For this purpose, we surveyed the undergraduate student community of a leading technological university in Israel. The survey focused on remote learning during the first wave of the COVID-19 pandemic (Spring 2020).

## Background

### *Active Learning and 21st Century Skills*

Active, student-centered learning builds on constructivist theories of learning. This theoretical framing refers to learning opportunities in which students actively construct their knowledge and take control and responsibility over their learning processes (Chi et al., 2018; Duffy & Cunningham, 1996). Such learning opportunities allow learners to think critically, practice their communication skills, and find creative ways to solve problems (Hmelo-Silver et al., 2007). Furthermore, learning activities differ in the degree of learners’ participation as well as in the cognitive processes that they facilitate (Chi et al., 2018). When considering participation and cognitive engagement, instructional activities can be classified based on the learners’ level of engagement into a learning activity taxonomy known as the ICAP framework: *Interactive*, *Constructive*, *Active*, and *Passive* learning (Chi et al., 2018). The ICAP framework is organized hierarchically so that more advanced learning activities produce deeper, more meaningful learning (Interactive > Constructive > Active > Passive). While ICAP refers to student activity, different instructional designs can call for different levels. For example, collaborative activities, such as group projects, facilitate joint attention and the synthesis of different learners’ contributions and thus support *interactive* learning. Next, activities that facilitate *constructive* learning ask learners to produce outputs that are additional to the instructional material, for example, producing summaries. *Active* learning refers to overt learner

behaviours such as highlighting, copying text, forwarding, or rewinding a video. These behaviours, while active, do not produce novel outputs. The provision of instructional materials enables learners to engage in this level of activity. *Passive* learning does not include any overt student activity, as when listening to a lecture or watching a video linearly and is contrasted with the three prior types of activities. While this taxonomy was originally developed for face-to-face instructional contexts, recent work suggests that it is applicable for online educational contexts with some adaptations (Prince et al., 2020). For example, a “think-pair-share” activity is classified as a constructive and an interactive activity that requires students to interact with the course’s content, their peers, and the instructor. Further, according to Prince and colleagues, such an activity can be adapted to an online synchronous, asynchronous, or blended contexts. These studies suggest that activities at the higher level of the ICAP framework are also likely to require skills similar to those detailed in 21st century frameworks (collaboration, argumentation, etc.; Dede 2010). It is thus likely that designing curricula to support active learning could also support the development of 21<sup>st</sup> century skills.

Further support of the association between active learning and 21st century skill development comes from Lavi, Tal, and Dori (2021) who surveyed recent STEM graduates about the development of 14 specific skills. They classified the skills into three sets: (1) key competencies, (2) STEM-specific skills, and (3) STEM-general skills. Key competencies included creativity, collaboration, communication, and entrepreneurship. STEM-specific skills were engineering design, experiment and testing, STEM knowledge application, and systems thinking. Domain-general skills were complex problem-solving, critical thinking, individual learning, and posing questions. Lavi et al. asked recent graduates to elaborate on the pedagogies that contributed to the development of one of the skills. Their analysis revealed that both active and passive pedagogies had a similar, medium-sized effect on all perceived skill development. However, when looking into the development of key competencies and STEM-specific skills, active methods contributed more than passive methods. Likewise, Lopatto (2007) surveyed undergraduate science students and found that those who participated in research work reported a positive learning experience, and increased technical and personal skills (i.e., 21st century skills). Similarly, Buitrago-Flórez et al. (2021) found that active learning improved 11<sup>th</sup> grade students’ computation thinking skills from a pre- to a post-test, domain-specific communication skills, collaboration skills, and creativity. Together, these findings show that higher-level ICAP instructional activities, which include collaboration and novel output production, can support students’ 21st century skill development.

### ***Active Learning in an Online Context: STEM and Non-STEM Subjects***

Active learning and its advantages have been predominantly studied in the physical classroom with fewer studies examining its effect in an online context. In one such work, Koedinger and colleagues (2015) found that learners in a more active version of an introduction to psychology Massive Open Online Course (MOOC) participated more and outperformed MOOC-only learners on the final exam. They further showed that these differences are due to student uptake of available active learning opportunities. Similarly, Soffer and Cohen (2019) found that students’ participation in online learning activities (watching videos, entering the course’s webpage, forum visits) differentiates completers from non-completers in non-STEM online courses. They also found small but significant correlations between students’ active

participation and exam grades. These studies show the importance of providing students with active learning opportunities online.

The work reviewed above points to the importance of designs for active learning in online education, but does the same apply to STEM fields that require specific training in problem-solving and advanced calculations? Several studies suggest that the answer is yes. For example, Chen et al., (2018) surveyed students' perceptions of designs for learning in online STEM courses. They found that the perceived efficacy of the course's activities and assessments were positively and significantly associated with students' satisfaction. For example, students perceived frequent formative quizzes as a practice that improved their final exam score. Similarly, Cho et al., (2021) found that course design contributed to students' learning outcomes for some, but not all exams. They further found a positive and statistically significant correlation between students' video viewing time and exam scores. These findings highlight the importance of students' prior preparation and participation with online resources to their success in the course. Similar results were found for students at the secondary level who studied geometry online following the transition to emergency remote teaching during the COVID-19 pandemic (Ruiz-Palmero et al., 2023).

Despite these conclusive findings, the road to active learning for all online learners is still long. Cinque (2017) pointed to the challenges in developing an instructional platform that will support 21st century skill development online and will "fit all" learners (e.g. MOOCs). Additional work points to specific barriers for the implementation of active learning online. Hadi Mogavi and colleagues (2021) mapped barriers that may hinder the use of active pedagogies in online learning. Their list of barriers starts from technical issues such as time-zone differences and bandwidth but extends to include mental exhaustion, low self-efficacy, and even sexual harassment. These findings suggest that it may be challenging to support students' 21<sup>st</sup> skill development in an online context. Thus, active learning opportunities may be less effective. For example, Usher and colleagues (2021) found that students' innovation scores were higher in a F2F version of a course compared to its online version.

As demonstrated above, designs that support active learning and 21<sup>st</sup> century skill development are promising in a face-to-face context. However, there are still open questions around the degree to which such designs support skill development in an online context in STEM subjects. It is of interest to evaluate whether there are specific designs that contribute to specific skills within STEM education. The current work begins to address this gap through the following research questions:

(RQ1) What is the relationship between different designs for active online learning and the development of key 21<sup>st</sup> century competencies in STEM courses?

(RQ2) What is the relationship between designs that support active learning, 21<sup>st</sup> century skill development, and students' satisfaction of STEM courses?

To answer these questions, we conducted an institute-wide survey asking undergraduate students about their experiences during the Spring 2020 term. We recognize that the Spring 2020 term, taking place between March and June of 2020, was not a typical one. Specifically,



instructional designs during that term were often responsive to developments with the pandemic and might have been less careful. Therefore, the topic of this paper is not the rate or adoption of active learning in the emergency online semester. However, the scale of the shift to online learning allows us to study the relationship between online instructional design and skill development. Here we begin by documenting learning designs and opportunities for active learning during that period, to better understand the context for this work. We then continue to evaluate the relationships among these designs, reported skill development, and overall student satisfaction.

## Method

### *Design*

We used a survey to map teaching and learning practices during the Spring 2020 term at the Technion, Israel Institute of Technology. The survey asked students to choose one “particularly challenging” course they took and to fill out the survey about that course. Students were instructed to choose a STEM course that included lectures (either synchronous or asynchronous) and to avoid referring to lab-based courses or workshops. Notably, students did not report the course’s name or subject. To address potential biases resulting from this survey design, we grouped responses by the overall characteristics of the courses as explained in the next section under “Course Characteristics.” This grouping allows the evaluation of course designs within STEM disciplines and beyond specific subject matters. In addition, we invited several instructors, administrators, and students to review the survey to evaluate its face validity (similarly to Chen et al., 2018). The survey was revised based on their feedback.

The survey was delivered using Qualtrics Experience Management Software and distributed via email to the university undergraduate community. The survey was administered a few months after the term was over, so grades had already been submitted.

### *Materials*

The survey included five components: (1) learning design, (2) 21st century skill development, (3) learning experience, (4) demographics, and (5) course characteristics.

#### Learning Design

Learning design questions targeted the frequency of use of active learning in different educational contexts (similarly to Chen et al., 2018). Students reported the frequency of educational activities in the course on a four-point scale (“Never” = 0; “Sometimes” = 1; “Often” = 2; “Always” = 3). Twelve designs in four categories were included: preparatory activities before lectures (readings and videos; quizzes and exercises), lecture activities (discussions and clicker questions, groupwork in breakout rooms), individual and group home assignments (short and long-term), and tutorial activities (demonstrations, individual work, groupwork, and recordings instead of a synchronous tutorial). See Appendix A for the items and Table 1 for the classification of activities into common features.

#### 21st Century Skills

Students rated the degree to which the course contributed to the development of their 21st century skills on a 5-point Likert scale (adopted from Lavi et al., 2021). The 15 items were: 1)

knowledge application, 2) intercultural communication, 3) posing questions, 4) critical thinking, 5) entrepreneurship, 6) creativity, 7) self-directed learning, 8) complex problem-solving, 9) multidisciplinary collaboration, 10) written communication, 11) verbal communication, 12) experimenting and testing, 13) systems thinking, 14) engineering design, and 15) ethical awareness (see Appendix B). The last item, ethical awareness, was added in the current work. To avoid survey fatigue, each participant received seven randomly selected items out of the 15. This design generated data that was missing completely at random. These missing data were handled using the full information maximum likelihood framework, as explained in the Data Analysis section.

### **Learning Experience**

Students rated the overall quality of the course on a 5-Point Likert scale. See Appendix B.

### Demographics and Course Characteristics

We collected the following demographic information: gender, student seniority, GPA, student discipline (grouped into: Science and Mathematics, Engineering, or “Other”), and language proficiency (main language used at the institution). Course context variables were the course’s discipline (Sciences and Mathematics, Engineering, or “Other”), number of students registered to the course (1= up to 10 students; 2 = 10-25 students, 3 = 25-100 students; 4 = +100 students), whether the course was elective or compulsory, and whether the course was a “service course,” i.e. compulsory Sciences and Mathematics foundation for non-science majors.

### *Academic Context*

The Technion, Israel Institute of Technology is a large technological university, specializing in science, engineering, and medicine with strong ties to industry. During the Spring 2020 term, 10,759 undergraduate students (40% women) were enrolled to the different faculties: 69% Engineering, 5% Sciences and Mathematics, and 26% in other faculties (e.g., medical school, architecture).

### *Procedure*

Data was collected via two email invitations sent by the office of undergraduate studies on November and December of 2020. To encourage participation, we raffled 5 gift cards worth ~\$50 each. The survey was delivered after the review and approval of the Institutional Review Board. Additionally, the first page of the survey included an informed consent form

### *Sample*

Our sample is made of 744 students who answered all relevant survey items. Gender: 43% identified as women and 57% as men. This is rather representative of the institute’s population, with 40% women enrolled at the undergraduate level. Student discipline: 89% were Engineering students, with the rest distributed over the other disciplines. This shows a slight overrepresentation of Engineering students compared to the 69% of Engineering students enrolled in the institution. Seniority: 17% were first year students and for them, the Spring 2020 was their first or second term as undergraduate students. GPA: 56% reported their GPA is above 85 (B+ or higher), 40% reported it to be between 70 and 85 (C to B), and four percent reported it to be less than 70 (C- or lower). Language proficiency level: 93% of the responders had either

native language or full proficiency in Hebrew. Ethnicity/race data was not collected to not trigger stereotype threat (Steele, 2011) and in accordance with guidelines for best practices in the field of inclusive designs for research (e.g., The Centre for Teaching, Learning and Technology, The University of British Columbia, n.d.).

#### Course Characteristics Descriptive Statistics

Eighteen% of students reported they are referring to an elective course, while 82% referred to compulsory courses; 54% referred to large-enrollment courses (+100 students); 36% referred to medium-sized courses (26 -100 students enrolled), and 10% referred to courses with less than 26 students. Twenty-seven % of respondents referred to service courses.

## **Data Preparation and Analysis**

### ***Data Preparation of Course Characteristics Variables***

We excluded courses from “Other” faculties from analysis due to a low number of responses (10% of survey respondents) and high diversity in faculties (e.g., education, medicine, architecture). While architecture is a STEM profession, and taught at our university, courses delivered at the Faculty of Architecture include a variety of courses such as studio courses and design courses. Since survey respondents did not report course names, we had no way of knowing if they were referring to a course similar to other STEM courses or unique to the faculty.

### ***Student Background***

The “Student Seniority” variable was restructured to distinguish first year students and students of other academic years. Additionally, as there is little variance in students’ discipline (89% Engineering students), we excluded students’ discipline from the analysis.

### ***Analysis of Learning Design***

There are many forms for active online learning varying in their operational definitions (Chi et al., 2018), and the 12 survey items asking about learning design only sampled this space. The goal of this work is to identify features of productive designs, rather than to perform a competition between specific implementations. To be able to generalize beyond specific classroom implementations, active learning designs were grouped based on whether they included or not seven common design features. These features were group work, individual work, synchronous work, asynchronous work, long-term work, short-term work, and the use of resources only. Our classification looked into each type of survey item and categorized it to either include or not the above-mentioned features. So, for example, preparatory readings and videos were classified as a type of activity that includes individual work, asynchronous work, is short-termed, and can include the use of resources only. Long-term group homework on the other hand, was classified as including groupwork, asynchronous work and long-term work. This grouping allowed us to study the features of different activities, beyond the specific implementation of the activity in a given classroom.

Table 1 presents this classification of learning activities into active learning design features. For each such raw variable (the rows in Table 1), we report the mean and SD of

frequency of our sample (e.g., mean frequency of quizzes, mean frequency of TA demos etc.). Further, for each column (e.g., activity feature), we report the mean and SDs for that feature within the sample and its maximum possible value based on the items included in the survey. In both cases these values are based on the reported frequency in the survey (0=never, 1=Sometimes, 2 =Often, 3=Always).

**Table 1**

*Classification of Learning Activities into Learning Constructs*

| Instructional context                               | Type of activity               | <i>M (SD)</i> | Group work  | Ind. work   | Sync. work  | Async. work | Long term   | Short term  | Resources only |
|-----------------------------------------------------|--------------------------------|---------------|-------------|-------------|-------------|-------------|-------------|-------------|----------------|
| Preparatory activities                              |                                |               |             |             |             |             |             |             |                |
|                                                     | Readings and videos            | 0.65 (1.16)   | 0           | 1           | 0           | 1           | 0           | 1           | 1              |
|                                                     | Quizzes and exercises          | 0.48 (1.02)   | 0           | 1           | 0           | 1           | 0           | 1           | 0              |
| Lecture activities                                  |                                |               |             |             |             |             |             |             |                |
|                                                     | Class discussions              | 0.59 (0.99)   | 0           | 1           | 1           | 0           | 0           | 1           | 0              |
|                                                     | clicker questions              |               |             |             |             |             |             |             |                |
|                                                     | Groupwork in breakout sessions | 0.14 (0.52)   | 1           | 0           | 1           | 0           | 0           | 1           | 0              |
| Homework                                            |                                |               |             |             |             |             |             |             |                |
|                                                     | Short-term individual work     | 2.01 (1.26)   | 0           | 1           | 0           | 1           | 0           | 1           | 0              |
|                                                     | Long-term individual work      | 0.83 (1.18)   | 0           | 1           | 0           | 1           | 1           | 0           | 0              |
|                                                     | Short-term groupwork           | 0.25 (0.74)   | 1           | 0           | 0           | 1           | 0           | 1           | 0              |
|                                                     | Long-term groupwork            | 0.54 (1.07)   | 1           | 0           | 0           | 1           | 1           | 0           | 0              |
| Tutorials                                           |                                |               |             |             |             |             |             |             |                |
|                                                     | Individual work                | 0.47 (0.84)   | 0           | 1           | 1           | 0           | 0           | 1           | 0              |
|                                                     | Groupwork in breakout sessions | 0.10 (0.47)   | 1           | 0           | 1           | 0           | 0           | 1           | 0              |
|                                                     | TA demos                       | 2.59 (0.72)   | 0           | 0           | 1           | 0           | 0           | 1           | 1              |
|                                                     | Recordings only                | 0.73 (1.17)   | 0           | 1           | 0           | 1           | 0           | 1           | 1              |
| Mean for activity beyond instructional context (SD) |                                |               | 1.03 (1.72) | 5.69 (3.59) | 3.73 (2.04) | 5.42 (3.21) | 1.35 (1.60) | 7.80 (3.94) | 3.77 (1.97)    |
| Max possible value                                  |                                |               | 12          | 21          | 15          | 21          | 6           | 30          | 9              |

## Data Analysis

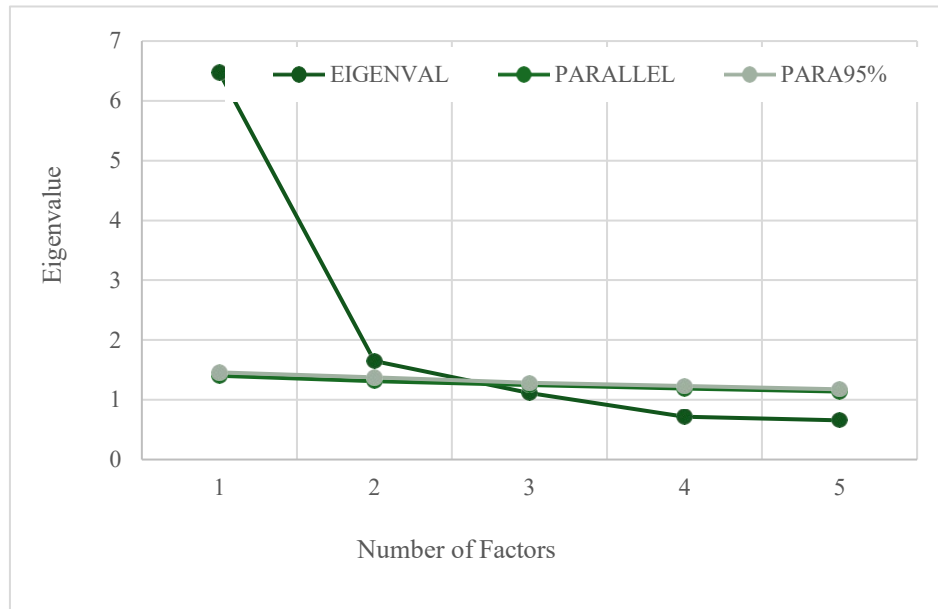
### *Analysis of 21<sup>st</sup> Century Skills*

The survey included 15 items asking about specific 21<sup>st</sup> century skills, with each participant receiving seven randomly selected items out of the 15. This procedure produced data that was missing completely at random (Bar, 2017). To address this, we used the Exploratory Structure Equation Modeling (ESEM) procedure in Mplus V.8.3 (Stalikas et al. 2018) which works within the Full Information Maximum Likelihood Framework (FIML; Enders, 2010; Cham et al., 2017) and uses correlated data to extract the factor scores regardless of the missing values.

To reduce the number of items into parsimonious indicators, we used an exploratory and confirmatory factor analysis (EFA, CFA). In this process, a first exploratory lookup at the data indicated two to three potential factors, yet the three-factor option received higher goodness of fit ( $\chi^2=72.02$ ,  $df=63$ ,  $p=.204$ ) and advanced the two-factor solution. See Figure 1 for eigenvalue test versus parallel analysis. The parallel analysis was set to 100 simulation repeats and shows superior value in the intersection with the actual eigenvalue between two and three factors. We applied the preliminary results to the exploratory structural equation (ESEM) modeling procedure and readjusted loadings with the *Target* rotation option. This yielded three factors, for which we had loadings, and consequentially, confirmed this factor structure within a confirmatory framework (CFA). Table 2 shows EFA and CFA loadings and model goodness-of-fit. These results were within required thresholds and provided construct validity to the three factors. However, correlations between factors were high which challenged desired distinct factors. We used the Average Variance Extracted (AVE) measure for internal consistency versus the Maximum Shared Variance (MSV), to determine discriminant and convergence validity (Henseler, et al., 2015). The maximum shared variance which is the squared largest correlation was slightly lower in comparison to the AVE across the three factors, which suggested discriminant and convergence validity, beyond the construct validity.

### **Figure 1**

*Parallel Analysis Versus Scree Plot to Determine Optimal Number of Factors*



Final factors were labeled: i) Communication and collaboration (ii) Domain-general skills, and iii) STEM-specific skills. See Table 2 for the CFA results and variables loading on each factor. Notably, these factors echo similar grouping by Lavi and colleagues (2021). Table 2 presents the results of EFA and CFA with final factor loadings.

**Table 2**

*Exploratory and Confirmatory Factor Loadings*

| Item                                       | Factor 1  | Factor 2 | Factor 3 | CFA   |
|--------------------------------------------|-----------|----------|----------|-------|
| <b>F1: Communication and collaboration</b> |           |          |          |       |
| Intercultural communication                | 0.879***  | -0.028   | 0.013    | 0.782 |
| Entrepreneurship                           | 0.469***  | 0.155*   | 0.194**  | 0.719 |
| Multidisciplinary collaboration            | 0.621***  | 0.012    | 0.160*   | 0.706 |
| Verbal communication                       | 0.660***  | 0.171**  | -0.022   | 0.740 |
| Experimenting and testing                  | 0.413***  | 0.055    | 0.347*** | 0.692 |
| Ethical awareness                          | 0.533***  | 0.203**  | 0.019    | 0.674 |
| <b>F2: Domain general skills</b>           |           |          |          |       |
| Posing questions                           | -0.018    | 0.639*** | 0.199**  | 0.773 |
| Critical thinking                          | 0.039     | 0.704*** | 0.021    | 0.734 |
| Creativity                                 | -0.035    | 0.784*** | -0.029   | 0.717 |
| Self-directed learning                     | -0.135    | 0.626*** | 0.017    | 0.533 |
| Complex problem solving                    | -0.252*** | 0.631*** | 0.302*** | 0.677 |
| Written communication                      | 0.088     | 0.500*** | 0.160*   | 0.673 |
| <b>F3: STEM-specific skills</b>            |           |          |          |       |
| Knowledge application                      | 0.047     | -0.003   | 0.705*** | 0.692 |
| Systems thinking                           | 0.056     | 0.229**  | 0.496*** | 0.747 |
| Engineering design                         | -0.071    | -0.021   | 0.821*** | 0.690 |
| AVE                                        | .587      | .537     | .583     |       |
| MSV                                        | .472      | .543     | .543     |       |

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\*\*\*  $p < .001$ , \*\*  $p < .01$ , \*  $p < .05$ .

EFA Goodness-of-fit:  $\chi^2 = 72.02$ ,  $df = 63$ ,  $p = .204$ ; CFI = .997, TLI = .995; RMSEA = .010, 95% CI [.00, .02]; SRMR = .024; CFA Goodness-of-fit:  $\chi^2 = 186.31$ ,  $df = 87$ ,  $p = .001$ ; CFI = .966, TLI = .959; RMSEA = .028, 95% CI [.023, .034]; SRMR = .048;

Correlations: F1 WITH F2  $r = .643$ ,  $p < .001$ ; F1 WITH F3  $r = .687$ ,  $p < .001$ ; F2 WITH F3  $r = .737$ ,  $p < .001$ .

### ***Explaining Variance in Skill Development***

To answer our research questions, we conducted several multiple linear regression (MLR) analyses using stepwise inclusion criteria in IBM's SPSS Statistics 18. Our interpretation of the MLRs is based on common approach (e.g., Ziglari, 2017), where each variable's beta coefficient gives the change to Y-HAT given a one unit change in the variables (p. 14) and R<sup>2</sup> gives information about the explained variance to Y by the different predictors (p.15).

For RQ1, we fitted three separate MLR models, one for each of the three 21st century facets as dependent variables. All models included three groups of Independent Variables: (1) learning design features (as explained in Table 1), (2) course context: service course, elective or compulsory, course size, and course discipline, and (3) student attributes: GPA, gender, seniority, and language.

For RQ2, we used a model with overall satisfaction with the course as the dependent variable, and the following variables as independent variables: (1) the three 21st century skill facets, (2) learning design features, (3) course context, and (4) student attributes.

## **Results**

### **RQ1: Active Learning and 21<sup>st</sup> Century Skill Development**

#### **Communication and Collaboration Skills**

Nineteen% of the variance in students' development of communication and collaboration skills is explained by the model. Specifically, the more individual and group work ( $\beta = + 0.13^{***}$  and  $\beta = + 0.15^{***}$  respectively), the more likely students were to report an improvement of this set of skills. However, short-term work ( $\beta = - 0.05^{***}$ ) as well as asynchronous work ( $\beta = - 0.06^{***}$ ) had a small yet significant negative beta coefficient, suggesting that the more short-term work and the more asynchronous work, the less students feel improvement of their communication and collaboration skills. As for student attributes, the lower their language skills ( $\beta = - 0.11^{***}$ ) and the lower their GPA ( $\beta = - 0.09^*$ ), the more likely they are to report these skills improved. Additionally, students are more likely to report improvement of this skillset in smaller courses ( $\beta = - 0.10^{**}$ ). See Table 3 for the full model.

**Table 3**

*Communication and Collaboration Skills Explained by Learning Design Features, Student Attributes, and Course Context*

| Factor 1: Communication and collaboration            |                                                  |                |                   |              | 95% confidence interval for B |               |
|------------------------------------------------------|--------------------------------------------------|----------------|-------------------|--------------|-------------------------------|---------------|
|                                                      | Unstandardized B/ beta in for non sig. variables | Coefficient SE | Standardized Beta | Sig.         | Lower bound                   | Upper bound   |
| Constant                                             | 0.719                                            | 0.194          |                   | 0.000        | 0.34                          | 1.10          |
| Learning design features:                            |                                                  |                |                   |              |                               |               |
| Individual work                                      | <b>0.13</b>                                      | <b>0.019</b>   | <b>0.689</b>      | <b>0.000</b> | <b>0.09</b>                   | <b>0.16</b>   |
| Groupwork                                            | <b>0.15</b>                                      | <b>0.018</b>   | <b>0.398</b>      | <b>0.000</b> | <b>0.12</b>                   | <b>0.19</b>   |
| Short-term work                                      | <b>- 0.05</b>                                    | <b>0.013</b>   | <b>- 0.284</b>    | <b>0.000</b> | <b>- 0.07</b>                 | <b>- 0.02</b> |
| Long-term work                                       | - 0.11                                           | -              | -                 | 0.164        |                               |               |
| Synchronous work                                     | - 0.13                                           | -              | -                 | 0.164        |                               |               |
| Asynchronous work                                    | <b>- 0.06</b>                                    | <b>0.016</b>   | <b>- 0.310</b>    | <b>0.000</b> | <b>- 0.10</b>                 | <b>- 0.03</b> |
| Resources only                                       | 0.02                                             | -              | -                 | 0.685        |                               |               |
| Student attributes:                                  |                                                  |                |                   |              |                               |               |
| GPA                                                  | <b>- 0.09</b>                                    | <b>0.039</b>   | <b>- 0.073</b>    | <b>0.029</b> | <b>- 0.16</b>                 | <b>- 0.01</b> |
| Gender (0=M; 1=W)                                    | - 0.03                                           | -              | -                 | 0.956        |                               |               |
| Seniority (0= 1 <sup>st</sup> year; 1 = other years) | - 0.04                                           | -              | -                 | 0.864        |                               |               |
| Language (0=poor; 4=Native)                          | <b>- 0.11</b>                                    | <b>0.035</b>   | <b>- 0.109</b>    | <b>0.001</b> | <b>- 0.18</b>                 | <b>- 0.04</b> |
| Course context:                                      |                                                  |                |                   |              |                               |               |
| Service course                                       | - 0.04                                           | -              | -                 | 0.680        |                               |               |
| Elective or compulsory                               | 0.04                                             | -              | -                 | 0.771        |                               |               |
| Course size                                          | <b>- 0.10</b>                                    | <b>0.033</b>   | <b>- 0.101</b>    | <b>0.003</b> | <b>- 0.16</b>                 | <b>- 0.03</b> |
| Course discipline (0 = Sci & Math; 1 = Eng.)         | 0.07                                             | -              | -                 | 0.797        |                               |               |
| Regression summary                                   |                                                  |                |                   |              |                               |               |
| Explained variance ( $R^2$ )                         | 0.19                                             |                |                   |              |                               |               |
| N                                                    | 744                                              |                |                   |              |                               |               |

### **Domain General Skills**

Ten% of the variance is explained by the model. Courses that include individual work, long-term work, and synchronous work ( $\beta = + 0.02^*$ ,  $\beta = + 0.07^{***}$ , and  $\beta = + 0.08^{***}$ , respectively) are more likely to contribute to students' domain general skills. Further, first year students are more likely to report growth in these skills ( $\beta = - 0.22^*$ ). Additionally, students in



smaller courses are also more likely to report the development of this skillset ( $\beta = -0.14^{**}$ ). See Table 4.

### Table 4

*Domain General Skills Explained by Learning Design Features, Student Attributes, and Course Context*

| Factor 2: Domain-general skills              |                                                  |                |                   |              | 95% confidence interval for B |               |
|----------------------------------------------|--------------------------------------------------|----------------|-------------------|--------------|-------------------------------|---------------|
|                                              | Unstandardized B/ beta in for non sig. variables | Coefficient SE | Standardized Beta | Sig.         | Lower bound                   | Upper bound   |
| Constant                                     | - 0.10                                           | 0.130          |                   | 0.428        | - 0.36                        | 0.15          |
| Learning design features:                    |                                                  |                |                   |              |                               |               |
| Individual work                              | <b>0.02</b>                                      | <b>0.010</b>   | <b>0.087</b>      | <b>0.042</b> | <b>0.001</b>                  | <b>0.04</b>   |
| Groupwork                                    | 0.05                                             | -              | -                 | 0.251        |                               |               |
| Short-term work                              | - 0.02                                           | -              | -                 | 0.836        |                               |               |
| Long-term work                               | <b>0.07</b>                                      | <b>0.019</b>   | <b>0.133</b>      | <b>0.000</b> | <b>0.03</b>                   | <b>0.11</b>   |
| Synchronous work                             | <b>0.08</b>                                      | <b>0.017</b>   | <b>0.186</b>      | <b>0.000</b> | <b>0.04</b>                   | <b>0.11</b>   |
| Asynchronous work                            | - 0.02                                           | -              | -                 | 0.836        |                               |               |
| Resources only                               | - 0.04                                           | -              | -                 | 0.440        |                               |               |
| Student attributes:                          |                                                  |                |                   |              |                               |               |
| GPA                                          | - 0.03                                           | -              | -                 | 0.365        |                               |               |
| Gender (0=Men; 1=Women)                      | - 0.06                                           | -              | -                 | 0.108        |                               |               |
| Seniority (0= 1st year; 1 = other years)     | - <b>0.22</b>                                    | <b>0.085</b>   | <b>-0.095</b>     | <b>0.011</b> | <b>- 0.38</b>                 | <b>- 0.05</b> |
| Language (0=poor; 4=Native)                  | - 0.03                                           | -              | -                 | 0.379        |                               |               |
| Course context:                              |                                                  |                |                   |              |                               |               |
| Service course                               | - 0.04                                           | -              | -                 | 0.346        |                               |               |
| Elective or compulsory                       | - 0.02                                           | -              | -                 | 0.595        |                               |               |
| Course size                                  | - <b>0.14</b>                                    | <b>0.047</b>   | <b>-0.110</b>     | <b>0.003</b> | <b>- 0.23</b>                 | <b>- 0.05</b> |
| Course discipline (0 = Sci & Math; 1 = Eng.) | 0.05                                             | -              | -                 | 0.216        |                               |               |
| Regression summary                           |                                                  |                |                   |              |                               |               |

|                                         |      |
|-----------------------------------------|------|
| Explained<br>variance (R <sup>2</sup> ) | 0.10 |
| N                                       | 744  |

### STEM-Specific Skills

The model explains 15% of variance. Individual work, groupwork, and long-term activities increase the likelihood of students to report an improvement of this skillset ( $\beta = +0.10^{***}$ ,  $\beta = +0.09^{***}$ , and  $\beta = +0.06^{**}$ , respectively). Further, asynchronous activities are associated with a decrease in the development of this skillset ( $\beta = -0.08^{***}$ ). Additionally, students are also more likely to report growth in small courses ( $\beta = -0.10^*$ ) and Engineering courses ( $\beta = +0.21^{***}$ ). See Table 5.

**Table 5**

*STEM-Specific Skills Explained by Learning Design Features, Student Attributes, and Course Context*

| Factor 3: STEM-specific skills                             |                                                     |                   |                      |              | 95%<br>confidence<br>interval for B |                |
|------------------------------------------------------------|-----------------------------------------------------|-------------------|----------------------|--------------|-------------------------------------|----------------|
|                                                            | Unstandardized<br>B/ beta for non<br>sig. variables | Coefficient<br>SE | Standardized<br>Beta | Sig.         | Lower<br>bound                      | Upper<br>bound |
| Constant                                                   | - 0.25                                              | 0.084             |                      | 0.003        | - 0.42                              | - 0.09         |
| Learning design features:                                  |                                                     |                   |                      |              |                                     |                |
| Individual work                                            | <b>0.10</b>                                         | <b>0.02</b>       | <b>0.48</b>          | <b>0.000</b> | <b>0.07</b>                         | <b>0.13</b>    |
| Groupwork                                                  | <b>0.09</b>                                         | <b>0.02</b>       | <b>0.20</b>          | <b>0.000</b> | <b>0.05</b>                         | <b>0.12</b>    |
| Short-term work                                            | - 0.04                                              | -                 | -                    | 0.790        |                                     |                |
| Long-term work                                             | <b>0.06</b>                                         | <b>0.02</b>       | <b>0.14</b>          | <b>0.001</b> | <b>0.03</b>                         | <b>0.10</b>    |
| Synchronous<br>work                                        | -.020                                               | -                 | -                    | 0.790        |                                     |                |
| Asynchronous<br>work                                       | <b>- 0.08</b>                                       | <b>0.02</b>       | <b>-0.36</b>         | <b>0.000</b> | <b>-0.12</b>                        | <b>-0.05</b>   |
| Resources only                                             | 0.031                                               | -                 | -                    | 0.546        |                                     |                |
| Student attributes:                                        |                                                     |                   |                      |              |                                     |                |
| GPA                                                        | - 0.05                                              | -                 | -                    | 0.165        |                                     |                |
| Gender (0=Men;<br>1=Women)                                 | - 0.05                                              | -                 | -                    | 0.134        |                                     |                |
| Seniority (0= 1 <sup>st</sup><br>year; 1 = other<br>years) | - 0.05                                              | -                 | -                    | 0.152        |                                     |                |
| Language<br>(0=poor;<br>4=Native)                          | - 0.04                                              | -                 | -                    | 0.245        |                                     |                |
| Course context:                                            |                                                     |                   |                      |              |                                     |                |
| Service course                                             | 0.01                                                | -                 | -                    | 0.833        |                                     |                |

|                                                    |               |             |              |              |               |               |
|----------------------------------------------------|---------------|-------------|--------------|--------------|---------------|---------------|
| Elective or compulsory                             | -0.01         | -           | -            | 0.748        |               |               |
| Course size                                        | <b>- 0.10</b> | <b>0.04</b> | <b>-0.09</b> | <b>0.016</b> | <b>- 0.17</b> | <b>- 0.02</b> |
| Course discipline<br>(0 = Sci & Math;<br>1 = Eng.) | <b>0.21</b>   | <b>0.06</b> | <b>0.14</b>  | <b>0.000</b> | <b>0.09</b>   | <b>0.32</b>   |
| Regression summary                                 |               |             |              |              |               |               |
| Explained variance ( $R^2$ )                       | 0.15          |             |              |              |               |               |
| <i>N</i>                                           | 744           |             |              |              |               |               |

See Appendix C for the full correlation matrix between all variables.

## RQ2: Active Learning, 21st Century Skill Development, and Student Satisfaction

The model explains that 27% of variance in students' overall satisfaction with the course. Students are more likely to report the course was good when they felt the courses contribute to the development of their domain-general skills ( $\beta = +0.78^{***}$ ), and when the course includes synchronous activities ( $\beta = +0.07^{***}$ ). Further, students with a higher GPA ( $\beta = +0.25^{***}$ ) are more likely to be satisfied with the course. Further, students are less likely to be satisfied with the course in courses that support the development of STEM-specific skills ( $\beta = -0.22^*$ ) and in courses that are not elective ( $\beta = -0.22^*$ ). See Table 6.

**Table 6**

*Student Satisfaction as a Function of Skill Development, Learning Design Features, Student Attributes, and Course Context*

|                                 | Student satisfaction with the course          |                |                   |              | 95% confidence interval for B |             |
|---------------------------------|-----------------------------------------------|----------------|-------------------|--------------|-------------------------------|-------------|
|                                 | Unstandardized B/ beta for non sig. variables | Coefficient SE | Standardized Beta | Sig.         | Lower bound                   | Upper bound |
| Constant                        | 2.69                                          | 0.19           |                   | 0.000        | 2.29                          | 3.04        |
| 21 <sup>st</sup> century skills |                                               |                |                   |              |                               |             |
| Communication and collaboration | -.03                                          | -              | -                 | 0.63         |                               |             |
| Domain-general skills           | <b>0.78</b>                                   | <b>0.09</b>    | <b>0.59</b>       | <b>0.000</b> | <b>0.53</b>                   | <b>0.70</b> |
| STEM-specific skills            | <b>-0.22</b>                                  | <b>0.11</b>    | <b>-0.14</b>      | <b>0.04</b>  |                               |             |
| Learning design features:       |                                               |                |                   |              |                               |             |
| Individual work                 | .05                                           | -              | -                 | 0.20         |                               |             |
| Groupwork                       | - 0.04                                        | -              | -                 | 0.21         |                               |             |
| Short-term work                 | .026                                          | -              | -                 | 0.56         |                               |             |
| Long-term work                  | - 0.01                                        | -              | -                 | 0.73         |                               |             |

|                                                      |               |             |              |              |              |             |
|------------------------------------------------------|---------------|-------------|--------------|--------------|--------------|-------------|
| Synchronous work                                     | <b>0.07</b>   | <b>0.02</b> | <b>0.13</b>  | <b>0.000</b> | <b>0.03</b>  | <b>0.11</b> |
| Asynchronous work                                    | .012          | -           | -            | 0.72         |              |             |
| Resources only                                       | -0.05         | -           | -            | 0.16         |              |             |
| Student attributes:                                  |               |             |              |              |              |             |
| GPA                                                  | <b>0.25</b>   | <b>0.07</b> | <b>0.13</b>  | <b>0.000</b> | <b>0.13</b>  | <b>0.39</b> |
| Gender (0=Men; 1=Women)                              | 0.00          | -           | -            | 0.91         |              |             |
| Seniority (0= 1 <sup>st</sup> year; 1 = other years) | - 0.04        | -           | -            | 0.20         |              |             |
| Language (0=poor; 4=Native)                          | 0.03          | -           | -            | 0.37         |              |             |
| Course context:                                      |               |             |              |              |              |             |
| Service course                                       | 0.02          | -           | -            | 0.52         |              |             |
| Elective or compulsory                               | <b>- 0.23</b> | <b>0.10</b> | <b>-0.08</b> | <b>0.02</b>  | <b>-0.39</b> | <b>-0.2</b> |
| Course size                                          | .030          | -           | -            | 0.39         |              |             |
| Course discipline (0 = Sci & Math; 1 = Eng.)         | -0.01         | -           | -            | 0.68         |              |             |
| Regression summary                                   |               |             |              |              |              |             |
| Explained variance ( $R^2$ )                         | 0.27          |             |              |              |              |             |
| N                                                    | 738           |             |              |              |              |             |

Table 7 further shows the changes to explained variance with the addition of each variable that contributed significantly to the model. As seen by the table, the greatest contribution to  $R^2$  was by the domain-general skillset. However, the additional variables increased it by a total of four percent.

**Table 7**

*Changes to  $R^2$  with the Addition of Variables (Stepwise Inclusion Criteria)*

| Model number | Variables in the model                    | $R^2$ | R Square Change | F Change | df1 | df2 | Sig. F Change |
|--------------|-------------------------------------------|-------|-----------------|----------|-----|-----|---------------|
| 1            | Domain-general skills                     | 0.234 | 0.234           | 225.351  | 1   | 736 | 0.000         |
| 2            | Domain-general skills + GPA               | 0.250 | 0.016           | 15.443   | 1   | 735 | 0.000         |
| 3            | Domain-general skills + GPA + Synch. Work | 0.262 | 0.012           | 11.925   | 1   | 734 | 0.001         |

|   |                                                                                                    |       |       |       |   |     |       |
|---|----------------------------------------------------------------------------------------------------|-------|-------|-------|---|-----|-------|
| 4 | Domain-general skills + GPA +<br>Synch. Work + elective/required<br>course                         | 0.267 | 0.005 | 4.509 | 1 | 733 | 0.034 |
| 5 | Domain-general skills + GPA +<br>Synch. Work + elective/ required<br>course + STEM-specific skills | 0.271 | 0.004 | 4.384 | 1 | 732 | 0.037 |

## Discussion

This study surveyed students about active online learning, 21st century skill development, and satisfaction in postsecondary STEM education during the Spring 2020 term. We found that opportunities for active learning online contributed to the development of students' 21st century competencies. The development of said competencies in turn increased students' satisfaction with the course.

Similarly to Lavi et al. (2021), we identified three main facets that encompass 15 common 21st century skills, providing further validation for their instrument. This study also demonstrates the important role active learning has in skill development even when learning takes place remotely and online, in an emergency response situation. Thus, our findings extend prior work (e.g., Buitrago-Flórez et al., 2021; Lopatto, 2007) to an online remote context. We next review our results in the context of the ICAP framework and the active learning literature, discuss the study limitations, and provide design recommendations.

### *Active Learning Designs That Are Associated with Skill Development*

RQ1 focused on the association between learning design features and 21st century skill development. The regression models explained 10 to 19% of the variance in skill development. These percentages are non-trivial, considering that these models did not include the topic of the class, the type or content of activity, or the identity and proficiency of the lecturer. These findings are consistent with the vast literature pointing to the advantages of active learning for skill development (Buitrago-Flórez et al., 2021; Christensen & Knezek, 2015; Lopatto, 2007; Lavi et al., 2021).

Our analysis shows that long-termed activities are associated with skill development more than short-termed activities. Such activities are more likely to rank higher on the ICAP framework, as they are more constructive in nature and require students to generate outputs on their own and practice these over a prolonged period of time (e.g. as in a project due at the end of the term). Thus, these activities also likely give more room to practice the target skills. Not surprisingly, it is not merely being active that supports the development of these skills, but the opportunity to practice them over time.

Other elements that were strongly associated with skill development are self- or group-activities. It is interesting that there was almost no difference between these two, not even on the development of communication skills. One explanation may be that students work in groups even on individual activities. As discussed by Chi and colleagues (2018), the benefit of the activity depends not only on its design, but on students' engagement with it. Future work will

need to look into how students engage with individual activities in an online context. Instructors often complain about students submitting identical assignments – this may be another hint at students’ choice to work collaboratively, with its benefits.

Notably, asynchronous activities were negatively associated with 21st century skill development. One clear aspect is the relative lack of support compared with synchronous activities. Still, the negative value is interesting, given the strong and positive association with long-term activities, such as projects, which are often asynchronous. This may be a statistical artefact. Long-term activities are beneficial especially when synchronous (such as Problem-Based Learning). While still beneficial also asynchronously, there is some penalty associated with that implementation.

The only type of activity that was not associated with any skill development is the provision of resources. This, indeed, is not an activity in and of itself. Resources can afford, but not require, active learning. While using such resources may be beneficial for learning at the domain level (and such analysis is outside the scope of the current study), it seems to have no bearing on the development of 21st century competencies.

One of the main contributions of this study is the focus on design features (e.g., long-term vs. short-term; synchronous vs. asynchronous) as opposed to specific activities or technologies (e.g., clickers vs. quizzes; Zoom vs. Teams). Such focus allows the consideration of the features of an activity and the purpose it is set to serve in terms of skill development. Thus, our analysis highlights the importance of the fit between the instructional context and the desired learning outcome beyond specific activities or assignments. If for example, the goal is to support the development of critical thinking and creativity skills, both found in the “domain-general” skillset, our analysis suggests using learning activities that are long-termed, synchronous, and individual. However, the choice of whether to use projects, reports, or portfolios depends on the instructor’s preferences, the class’s content, and the constraints of the course.

### ***Other Notable Relationships***

Several other patterns can be noticed in the results. First, when student characteristics were significant it was only in favour of the less privileged students. Students with low GPA and lower language skills reported higher improvement of communication and collaboration skills. First year students reported higher improvement of domain-general skills. These are very important findings. Several studies have pointed at the growing gaps due to the shift to online learning (e.g., Stöhr et al., 2020). Other studies have shown that active learning pedagogies reduce these gaps (e.g., Theobald et al., 2020). These results suggest that while online learning introduces equity challenges (Means, & Neisler, 2021), they also present opportunities for skill development, especially for those who need it the most. Furthermore, we found no effect to gender although gendered differences often emerge in the context of STEM education (e.g., Ballen et al., 2017). It is possible that as various 21<sup>st</sup> century competencies are not domain specific, they do not present the same gendered-differences. Future work will be helpful in discovering if and how active learning methods contribute to this pattern.

Another interesting yet unsurprising finding is that the course’s size explains variance in students’ 21st century skill development, across the different skill sets. It is likely that

instructional activities that invite active learning are easier to facilitate in smaller classes. It is thus reasonable to assume that students in smaller courses were more likely to enjoy the benefits of instructional designs that invite active learning.

We further found that the course's discipline contributed to explained variance in skill development. Engineering courses are more likely to support the development of communication and collaboration skills, and STEM-specific skills compared to sciences or mathematics courses. It may be that engineering courses have hands-on components, while science courses are more theoretical and are thus lecture-based.

Another interesting observation is that there were very little differences between the three skill facets. This is surprising, as the factor analysis showed that these facets are very distinct; hence, we did not anticipate a high correlation between them. It seems that while they are, indeed, supported differently by different courses, drawing clear relationship between features of active learning and specific facets may not be obvious. It may also be that clear relationships between some designs and specific skills (of the list of 15) were washed out during the dimension reduction process.

### ***Course Satisfaction***

Our results show that almost 30 percent of the variance in students' satisfaction with the course is explained by the model. Unsurprisingly, students are more satisfied with elective courses—courses they choose to take. Further, students appreciated more courses that supported the development of domain-general skills. Within these facets were skills such as critical thinking and asking questions, creativity, self-directed learning, and complex problem-solving. These experiences and activities are ones also found at the higher levels of the ICAP framework (Chi et al., 2018). Interestingly, we found that students were less likely to be satisfied with courses that highlighted STEM-specific skills: engineering design, systems thinking, and knowledge application. These skills are ones that may require students to deeply engage with the course content but not necessarily to interact with others or produce novel output. These results show that enabling students to practice learning activities higher on the ICAP taxonomy impacts their satisfaction with the course.

### ***Limitations***

Our research aimed to gain insights into the relationship between learning design and 21st century skill development in the context of higher online STEM education and at an institutional level. To achieve this aim, we targeted the entire student population at the Technion, that is, we invited over 10K undergraduate students to participate in our survey. Alas, only about 20 percent of students opened and answered at least one survey question. This number shrunk in the process of data cleanup and analysis, making our final sample over 700 students. In terms of response rate, 744 students make only seven percent of all undergraduate students in our institution. While this is a small response rate, prior work suggests that our sample is nonetheless sufficient. For example, Fosnacht and colleagues (2017) found that in higher education survey studies, when the sample is between five and ten percent of the population and larger than 500 participants it can be considered representative of the population. Furthermore, according to Holtom et al. (2022), when considering response rate, it is important to consider the responses' validity, their representativeness of the target population and the researchers' work process and

methodological decision-making. As we invited students to participate in the study by sending two email invitations to the entire student body there are likely no biases resulting from this method. This is supported by the representativeness of our sample of the student body in terms of demographics. Finally, as seen in the results, we successfully replicated prior findings, further supporting the validity of the study and sampling method.

Furthermore, in terms of the sample's adequacy in addressing the RQs, according to Hair and colleagues (2010), MLR analysis requires 15-20 cases for each independent variable entered into the model. Our most complex analysis includes 18 independent variables with 738 cases (Table 6). This makes the minimum number of participants between  $15 \times 18$  to  $20 \times 18 = 225 - 300$ . Our sample meets this criterion, and all other levels of analysis satisfy these requirements with an appropriate sample size to answer our RQs.

Another limitation to consider is that our survey design did not include demographic questions asking students about their ethnicity, race or religion. Thus, the study does not allow a discussion of the implications of designs for active learning, 21st century skills development, and these student attributes. This was a deliberate decision made in accordance to best practices for inclusive research design (e.g., The Centre for Teaching, Learning and Technology, The University of British Columbia, n.d.) and in an attempt not to trigger a stereotype threat in study participants (e.g., Steele, 2011). Future work can help consider if such data can help gain a more nuanced understanding of the interaction between demographics and learning design on 21st century skill development in online STEM education.

Finally, it is important to remember that the Spring 2020 term was unique in the quick response it required of teaching staff. This likely produced less than optimal designs for learning, so it is possible that our findings offer an underrepresentation of the actual contribution of designs for active learning to 21st century skill development in the context of online STEM education.

### ***Summary and Design Implications***

The study suggests several design considerations. Its first lesson learned is that active learning in STEM education works—also online, also as an emergency response, and across course contexts. It further suggests that certain features of active learning are more beneficial. Patterns for productive implementation include groupwork, individual work, synchronous activities (as in lecture or tutorial activities) and long-term endeavours such as group projects. Such activities all could be facilitated in a digital environment (Prince et al., 2020).

When considering these benefits, more work would be helpful in mapping barriers to the implementation of such designs in remote or hybrid STEM education (cf. Børte et al., 2020). For example, universities should make these tools readily available to instructors, including integration into their instructional technological landscape, and provide technical and pedagogical support. Such infrastructure will reduce the overload for both instructors and students, and support more common application of these pedagogies.

This study has two unique properties that support generality of its results. First, to improve the external validity of our results and generalize beyond a specific use of a task or a



technology, we classified the twelve designs into design features that could be relevant in other contexts. Future work will need to evaluate whether such predictions about other types of activities hold. Second, the study did not ask learners to draw direct links between activities, active learning, skill development or their satisfaction with the course. Instead, we asked learners for their overall course evaluation, to avoid analyzing students' opinions about the different designs. Alas, these choices also introduce a limitation. For example, it may be that there are aspects of active learning that are not included in this analysis. Notably, this analysis focused on *learning designs* that invite active learning. Students may apply active learning also on other designs, such as when listening to a lecture. Similarly, correlation is not causation. It is possible that instructors that offer active learning opportunities are more engaging instructors in general. Further, our survey asked about a "particularly challenging course." Less challenging courses were likely underreported in the survey. Last, these results may be specific to STEM disciplines.

While these concerns are valid, results show clear association between active learning opportunities and self-reported skill development. At one level, this is to be expected. For example, students who had a chance to practice groupwork should have improved their collaboration skills. Results of this study corroborate this intuition in data. However, results go deeper than that, for example, by showing the benefit of synchronous activities, possibly due to the supported environment. Results also generalize these findings across STEM disciplines and specific activity implementation. Thus, this study is a call for action—to offer more active learning in online settings in higher STEM education.

## **Statements and Declarations**

### **Competing interests**

The authors have no relevant financial or non-financial interests to disclose.

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### **Ethics**

This work was reviewed and approved by the Institutional Behavioral Sciences Research Ethics Committee.

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# Development of Computer-Assisted Language Learning Literacy Framework for Foreign Language Teachers

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## Abstract

The burgeoning interest in integrating technology into language education has necessitated language teachers to enhance their competencies and literacies. Consequently, a pressing need arises for a framework tailored to meet teachers' evolving requirements. To address this imperative, I conducted two studies within two distinct teaching contexts. The first study, a phenomenological inquiry, entailed interviews with 12 foreign language teachers in Iranian higher education. Its objective was to delineate the principal components of the computer-assisted language learning (CALL) literacy framework along with its influential factors. Subsequently, the second study aimed to validate the emergent framework from the initial inquiry. This validation was accomplished by utilizing the Delphi method involving ten Persian language experts. The findings elucidated that CALL literacy manifests as a dynamic interplay between language literacy, teaching literacy, and digital literacy. Moreover, influential factors affecting teachers' CALL literacy were identified to encompass academic degrees and qualifications, cognitive abilities, communicative competence, intercultural competence, managerial competence, creativity, and cultural responsiveness. Importantly, these factors were observed to be intricately nested within the contextual milieu. The implications drawn from these findings extended to both language teachers and teacher educators, offering valuable insights into the cultivation and enhancement of CALL literacy within educational settings.

**Keywords:** Computer-assisted language learning (CALL) literacy framework, language teachers, CALL integration, TPACK model, phenomenological study, Delphi method

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## Background

In the 21st century, digitalization has become an intrinsic component of our social, political, economic, and pedagogical landscapes. From a language education perspective, the advancement of technology and its integration into the teaching of foreign languages have sparked considerable inquiry within language academia over the past decades (Son et al., 2024). This inquiry has precipitated the emergence of computer-assisted language learning (CALL) as a focal point (see Bax, 2003; Levy, 1997; Levy & Hubbard, 2005). As pivotal figures in the realm of language education, teachers have found themselves compelled to enhance their skill sets to align with technological advancements. This necessitates the acquisition of more critical new literacies, thereby enabling them to become more competent teachers.

The plethora of new literacies, including technoliteracy (Erben, 1999), multiliteracies (Gee, 1992), and electronic literacy (Warschauer, 1999), among others, transcend traditional reading and writing abilities. Many of these literacies exhibit overlap in their definitions. For the purpose of this study, the researcher adopted a specific conceptualization, using digital literacy to denote “the ability to use information and communication technologies to find, evaluate, create, and communicate information, requiring both cognitive and technical skills” (Digital Literacy Task Force, 2013, p. 2).

A critical aspect often overlooked in discussions on digital literacy is the realization that merely incorporating technology into teaching practices does not inherently bring about transformative changes. In other words, the role of digital literacy in language education extends beyond the mere utilization of technology tools and devices; its essence lies in empowering language teachers to leverage technology effectively to fulfill students’ ultimate objectives, namely language learning. However, research in CALL has consistently highlighted a significant challenge faced by teachers: the lack of digital literacy (e.g., Anas et al., 2022; Bilki et al., 2023; Cote & Milliner, 2018; Dashtestani, 2019; Hazaea et al., 2021; Kohnke, 2021; Meskill et al., 2022). For instance, in a recent mixed-methods study conducted by Anas et al. (2022), 14 English language teachers in Indonesian higher education were investigated to discern their perspectives on enhancing their digital literacy. The findings from teachers’ self-evaluations and focus group interviews revealed disparities between what teachers know, think, and believe and their classroom practices. Researchers identified the lack of digital literacy as a primary obstacle hindering teachers’ growth regarding utilizing technology in their practices and professional development.

In addition to the challenges posed by the lack of digital literacy, language teachers have encountered a myriad of obstacles stemming from the intricacies of integrating CALL, particularly during COVID-19, when teachers were forced to teach online (Stickler, 2022), such as learners’ limited engagement, learners’ experience of anxiety and boredom, the provision of effective feedback to students, fostering meaningful communication and collaboration with students, assessment practices, managing and organizing classes, addressing teachers’ cognitive challenges, and the inadequacy of CALL teacher education and professional development initiatives (Bahari, 2023; Demir & Kayaoğlu, 2022; Ekmekçi, 2023; Jiang et al., 2022; Li, 2020; Tafazoli & Picard, 2023; Taghizadeh & Ejtehad, 2023; Xu et al., 2021). These

challenges span various domains, including individual teacher factors, contextual factors, and CALL teacher education (see Hong, 2010).

A major obstacle is the limited engagement of learners. Taghizadeh and Ejtehad (2023) emphasize that numerous students encountered difficulties in staying engaged in online environments due to the absence of immediacy and personal connection found in face-to-face interactions. This lack of engagement frequently resulted in decreased participation, lower motivation, and ultimately, subpar learning outcomes. An additional critical concern pertains to the anxiety and boredom experienced by learners. For instance, Demir and Kayaoğlu's (2022) research revealed that the abrupt transition to online learning led to heightened levels of anxiety among students, mainly stemming from their unfamiliarity with digital platforms and the solitary nature of studying from home. Similarly, Jiang et al. (2022) observed that the repetitiveness of prolonged screen exposure contributed to feelings of boredom, ultimately reducing students' motivation and involvement in the learning process.

Providing effective feedback has presented a significant challenge in online learning. Ekmekçi (2023) highlighted that the synchronous nature of many online platforms has hindered timely and meaningful feedback, which is essential for student development. Without immediate feedback, students often struggle to correct errors and enhance their language skills effectively. Furthermore, fostering meaningful communication and collaboration in a virtual environment has proven to be difficult. Ekmekçi (2023) also noted that while online learning platforms offer various communication tools, they often fall short in replicating the natural interactions of physical classrooms. This lack of real-time communication has impacted on the development of language proficiency, which relies on interactive and spontaneous exchanges.

Finally, the existing inadequacies in CALL teacher education and professional development initiatives have left many educators ill-prepared to address these challenges. According to Li (2020) and Tafazoli and Picard (2023), current teacher education programs inadequately cover the practical skills required to effectively incorporate technology into language teaching. This lack of training has further compounded the difficulties teachers face, as they often have to navigate new digital tools with minimal guidance or support.

In light of the above-mentioned real-world challenges faced by language teachers in integrating CALL, it becomes apparent that relying solely on digital literacy may not suffice for teachers to effectively navigate the complexities of today's digital landscape. Teachers need to equip themselves with a spectrum of literacies that enable them to comprehend and engage with emerging technology-based discourses in language education. Furthermore, the dynamic nature of technology underscores the need for continuous alignment between teachers' literacy development and evolving technological advancements, presenting a significant hurdle in the planning of teacher education initiatives. Hence, there arises a necessity for teachers to cultivate a new literacy – one that amalgamates digital literacy, language literacy, and language teaching methodologies literacy. This integrated literacy framework takes precedence over merely mastering the technical aspects of new technologies. Recognizing this demand, there has been a call for the development of a comprehensive framework for language teachers' professional development, one that enhances their literacy across the intersecting domains of technology, language proficiency, and teaching methodologies. This composite literacy is termed as CALL literacy, denoting the synergistic interplay between technology, language



proficiency, and teaching methodologies. Consequently, the objective of this study is to ascertain:

RQ1: What are the components of CALL literacy framework?

RQ2: What are the influential factors on the effective CALL literacy framework?

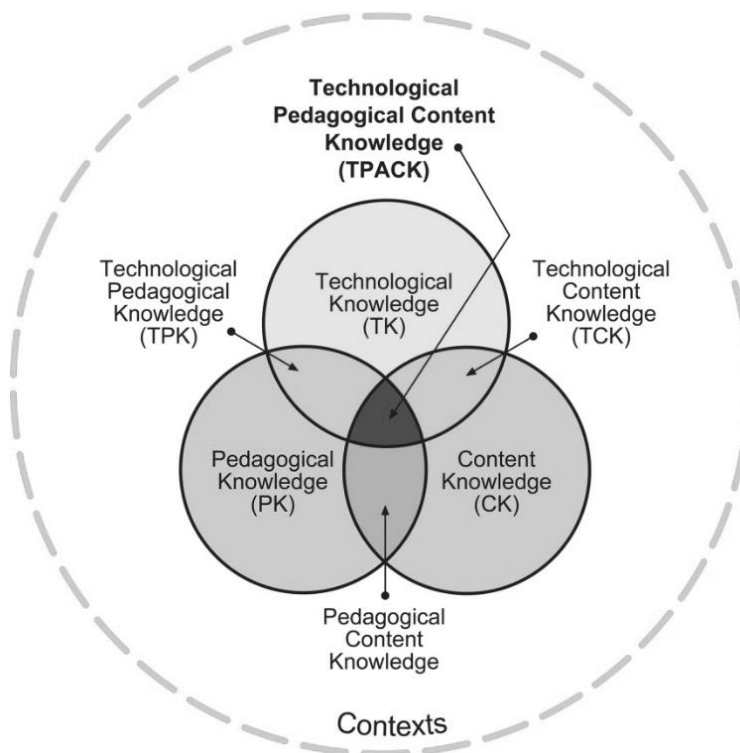
RQ3: To what extent can the emerged framework be applied in a different language context?

## Revisiting the TPACK Model: A Critical Perspective

The Technological Pedagogical Content Knowledge (TPACK) model (Mishra & Koehler, 2009) is a commonly used and influential framework in education, particularly in language education (e.g., Celik, 2023; Crosthwaite et al., 2023; Hu et al., 2023; Kohnke et al., 2024; Park & Son, 2022; Rienties et al., 2022; Schmid et al., 2020; Tafazoli & Meihami, 2023; Tseng et al., 2022). TPACK focuses on teachers' integration of technology and positions itself as an effective approach to subject and content teaching with technology (Koehler & Mishra, 2009). Figure 1 illustrates the TPACK framework and the interconnections between its three main components of knowledge.

**Figure 1**

*TPACK Framework (Adapted from <http://tpack.org>)*



The TPACK model comprises teachers' three primary knowledge domains: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). Through their interconnections, these domains give rise to new knowledge constructs, namely pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK). Ultimately, the convergence of these interconnected knowledge domains culminates in the formation of TPACK, which is defined as the "knowledge that goes beyond all three core components" (Koehler & Mishra, 2009, p. 66). While Koehler and Mishra provided definitions for each knowledge domain, their use of general terms in descriptions has been identified as one of the principal pitfalls of the TPACK framework.

Content knowledge (CK), as defined by Koehler and Mishra (2009, p. 63), encompasses "teachers' knowledge about the subject matter to be learned or taught." This includes a breadth of understanding outlined by Shulman (1986), comprising concepts, theories, organizational frameworks, evidence, proof, and established practices in the field. However, while Koehler and Mishra proposed this model to be applicable across all disciplines, its broad and general definitions may not adequately capture the nuanced and diverse nature of language education. In the context of language education, the complexity of content knowledge is evident. Tsui (2011) offers a more refined definition tailored to second language teachers, describing it as "teachers' knowledge of the underlying systems of language (including phonological, lexical, grammatical, and discursal features of L2), and their meta-linguistic knowledge" (p.28). Furthermore, scholars like Borg (2015) and Andrews (2007) advocate for a focus on subject matter cognition rather than mere subject matter knowledge, emphasizing the involvement of teachers' beliefs and cognitive factors in their professional practice. Therefore, one significant drawback of integrating the TPACK model into language education lies in its lack of specificity regarding sub-components and implementation of the aforementioned knowledge. Additionally, the model developers, Punya Mishra and Matthew J. Koehler, have acknowledged that TPACK may face challenges in practical implementation within the classroom (see Brantley-Dias & Ertmer, 2013; Koehler et al., 2015).

Another significant weakness of the TPACK model is its oversight of the importance of teachers' culture and context (see Adam, 2015). The intricate relationship between language and culture is undeniable, with "language acts as a carrier of culture" (Wei, 2005, as cited in Tafazoli & Egan, 2022, p. 66). Numerous studies on the integration of CALL underscore the pivotal roles played by contextual and cultural factors in determining the successful adoption of technology by teachers (e.g., Caldwell, 2020; Dashtestani, 2014; Hong, 2010). For instance, Dashtestani's (2014) mixed-methods study involving 208 EFL teachers and 15 teacher educators in Iran revealed, through in-depth interviews and questionnaires, that besides teachers' lack of expertise, skills, and training, cultural resistance to the use of CALL materials emerges as a primary barrier to CALL integration. Similarly, Abbitt (2011) has criticized the TPACK model for its lack of clarity regarding the concept of context and has advocated for further revisions of the model to address this deficiency.

To revisit the TPACK model and develop a framework tailored to the genuine needs and challenges faced by language teachers, the researcher conducted two qualitative studies: 1) A phenomenological study was conducted with a cohort comprising 12 foreign language teachers specializing in English, French, German, and Arabic. The aim was to discern the

components of the CALL literacy framework and identify influential factors impacting CALL literacy development. 2) Subsequently, a Delphi method study was employed, involving ten TPSOL (Teaching Persian to Speakers of Other Languages) experts. This phase aimed to determine the extent to which the emerged CALL literacy framework could be adapted and implemented across diverse language teaching contexts.

## Methods

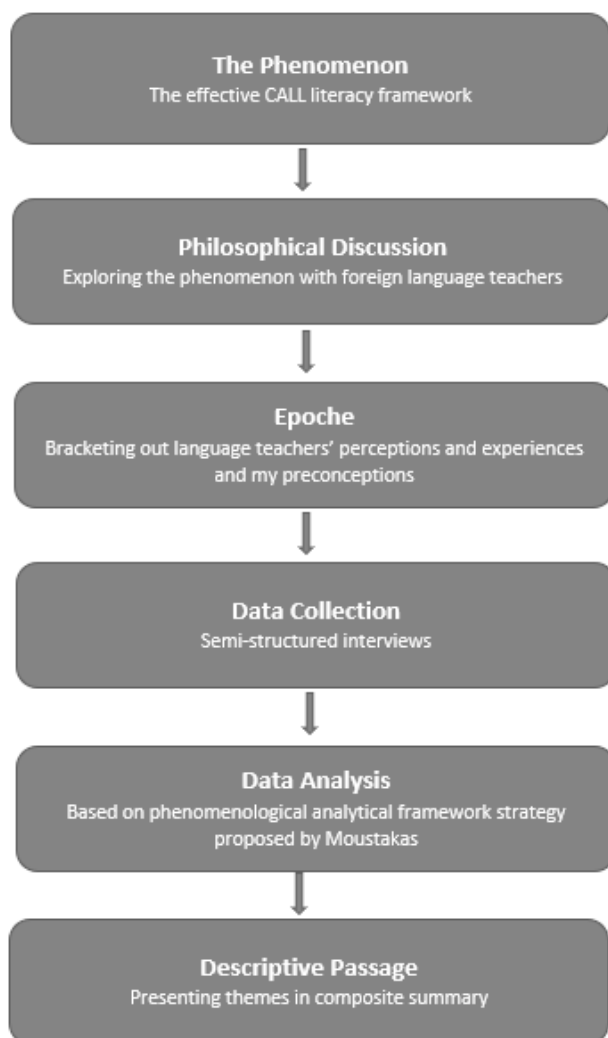
### *Study 1: Phenomenology*

#### Research Design

To address the phenomenon of multilayers of CALL literacy and establish an effective framework based on the foreign language teachers' lived experiences, I employed a phenomenological approach. Phenomenology is an appropriate approach to investigate and describe participants' lived experiences, particularly in understanding specific phenomena (Creswell, 2013). Figure 2 provides an overview of how I applied the phenomenological approach.

**Figure 2**

#### *Stages of the Study Based on Phenomenological Approach*



## Participants

The study received approval from The University of Newcastle's Human Research Ethics Committee (HERC), permitting the recruitment of eligible participants from a university in Iran. The selected university houses various foreign language departments, including English, German, French, Arabic, and Italian, within the Department of Foreign Languages. Participants were purposefully selected (Creswell, 2013), targeting faculty members and foreign language teachers with experience in both face-to-face and online teaching. A total of 12 foreign language teachers e-signed the consent forms and participated in the interviews. This number of participants is deemed acceptable in phenomenology, ensuring data saturation in qualitative research (Creswell, 2013). Table 1 provides an overview of the recruited participants' demographic information.

**Table 1**

### *The Participants' Demographic Information*

| Name<br>(Pseudonym) | Age | Gender | Academic<br>Degree | Foreign<br>Language | Teaching experience<br>(Years) |
|---------------------|-----|--------|--------------------|---------------------|--------------------------------|
| Habib               | 51  | Male   | PhD                | French              | 21                             |
| Javid               | 38  | Male   | MA                 | French              | 12                             |
| Sara                | 35  | Female | MA                 | German              | 3                              |
| Reza                | 62  | Male   | PhD                | English             | 22                             |
| Eli                 | 54  | Female | PhD                | French              | 19                             |
| Kia                 | 45  | Male   | PhD                | English             | 9                              |
| Babak               | 40  | Male   | PhD                | Arabic              | 10                             |
| Sama                | 37  | Female | PhD student        | English             | 3                              |
| Hamid               | 52  | Male   | MA                 | English             | 14                             |
| Mahsa               | 35  | Female | PhD                | German              | 7                              |
| Dina                | 44  | Female | PhD                | Arabic              | 8                              |
| Arad                | 30  | Male   | PhD student        | English             | 3                              |

## Data Collection

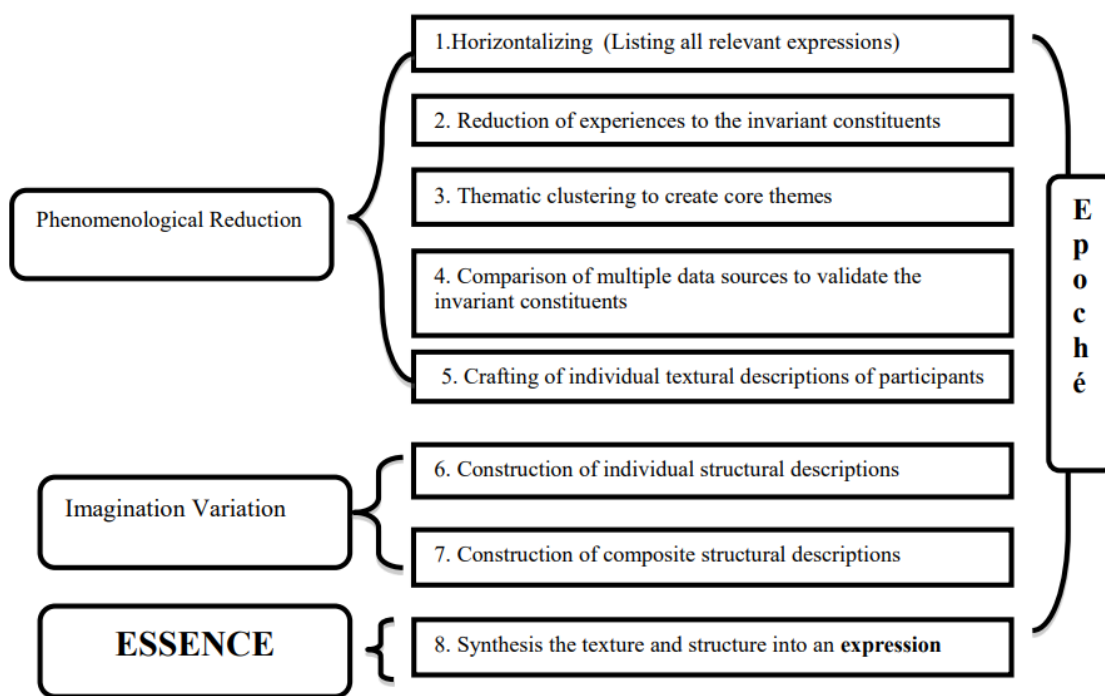
To comprehensively understand the complex lived experiences of foreign language teachers, an in-depth investigation was imperative. Therefore, I employed semi-structured interviews to elicit detailed, meticulous, and methodical descriptions of phenomena (Roulston, 2010). Open-ended questions were used to allow for thorough and free sharing of experiences (Moustakas, 1994). Due to COVID-19, the interviews were conducted remotely via Zoom and recorded with participants' consent. All of the interviews were conducted in the Persian language. Each session lasted between 45 to 60 minutes. My focus was on active listening, and follow-up questions were used to clarify any issues and gain deeper insights (Vagle, 2018).

## Data Analysis

In the data analysis phase of the study, I adhered to Yüksel and Yıldırım's (2015) steps of phenomenological analysis, which are grounded in Moustakas' (1994) phenomenological analytical framework strategy. Accordingly, I prepared the data, reduced them phenomenologically, engaged in imaginative variation, and finally disclosed the essence of the experience (Figure 3).

**Figure 3**

*The Steps of Data Analysis (Yüksel & Yıldırım, 2015, p.11)*



During the data preparation phase, I commenced by adopting the principles of ‘Epoché, setting aside any preconceptions or biases towards the phenomenon under investigation. Subsequently, in the initial step of phenomenological reduction (i.e., horizontalizing), I sifted through the data, omitting duplicate and irrelevant verbatims while retaining the horizons or textural meanings. Following this, I progressed to the second step, wherein I identified various sub-themes by clustering the horizons. Each sub-theme encapsulated a singular meaning derived from multiple horizons. Moving to the third step, I clustered the relevant sub-themes into cohesive “core themes of the experience” (Moustakas, 1994, p. 121). The fourth step involved comparing the emerging themes with existing literature to ensure their accuracy and transparent representation. Next, narratives were employed in the fifth step to elucidate the meaning units, enhancing their comprehensibility.

In the subsequent phase of imagination variation, I embarked on two key activities. Firstly, I constructed structures based on the textural descriptions and imaginative variation. Secondly, I integrated these structures into the end of each paragraph to formulate a structural description, aiding the comprehension of the phenomenon.

In the “essence” phase, I synthesized all narratives (i.e., textures and structures) into an expression representative of the collective experiences of the participants. This facilitated a

deeper understanding of the essence of the phenomenon based on lived experiences. The “findings” of the data analysis are presented in the subsequent section utilizing “verbal counting” (Sandelowski, 2001, p. 236). This approach involves using qualitative descriptors such as a few (less than 20%), some (21% to 50%), many (51% to 70%), the majority (71% to 90%), and most or almost all (91% to 100%) instead of providing specific numerical figures regarding participant response.

## ***Study 2: The Delphi Method***

### Research Design

The third research question delves into the extent to which the emerged framework can be applied in diverse language contexts. For this phase of the research, a different approach was adopted to solicit the perspectives of experts in the field. Their wealth of experience and expertise was leveraged to validate the emerging framework from the literature review and teachers’ lived experiences in the first study. I selected the Delphi method for its dependability and systematic approach to gathering expert opinions (Linstone & Turoff, 1975). To overcome various COVID-19, time, and cost constraints, I utilized an online approach for enhanced communication. The Delphi method aligned perfectly with this phase of the study, enabling the researcher to shape policy, define terms, and make informed decisions by comprehensively understanding various perspectives and considerations related to implementing the framework (Nworie, 2011).

### Research Context and Participants

The study is situated at an international TPSOL center in Iran, which is known for its extensive array of on-site and virtual TPSOL courses catering to language learners from diverse backgrounds. This institution has one of the largest TPSOL departments in Iran, consisting of dedicated academic and professional staff. There is no predetermined number of experts for the Delphi study. According to Hsu and Sandford (2007), to achieve a ‘representative pooling of judgments’ and ensure an adequate response rate, ten experts were deemed sufficient for the purpose of this study. Maintaining the anonymity of the experts was prioritized, with each panel member afforded an equal opportunity to share their opinions in a democratic and confidential environment, thus minimizing the influence of dominant members (Anastasio & Morgan, 1972). Experts were chosen through purposive sampling to ensure the panel comprised individuals with above-average knowledge of the issue (Helmer, 1966). The meticulous approach to panel selection also serves to safeguard the study against researcher bias. Details regarding the experts and their required qualifications are presented in Table 2.

**Table 2***Experts' Required Experiences*

| Teacher                                                                        | Researcher                                                                                                                                                       |
|--------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| - Had experience in teaching TPSOL                                             | - Has conducted research related to educational technologies in TPSOL                                                                                            |
| - Had experience in using educational technologies in the classroom.           | - Has authored publications in the area of educational technologies in TPSOL                                                                                     |
| Manager                                                                        | Policymaker                                                                                                                                                      |
| - Had experience as a university- and institute-level administrator or manager | - Had experience or have a position in developing university/institute- or national-wide regulations for the use of educational technologies in TPSOL classrooms |
| - Had experience as a syllabus and curriculum designer in TPSOL                | - Has participated in national-wide panels with a focus on educational technology implementations in TPSOL                                                       |

In the final stage, ten experts were carefully selected to comprise the expert panel. Table 3 indicates the experts' demographic information.

**Table 3***Expert Panel's Demographic Information*

| Name<br>(Pseudonym) | Age | Gender | Academic Degree | Position           |
|---------------------|-----|--------|-----------------|--------------------|
| Kian                | 49  | Male   | PhD             | Policymaker        |
| Hafiz               | 53  | Male   | PhD             | Policymaker        |
| Yalda               | 38  | Female | PhD             | Manager            |
| Omid                | 42  | Male   | PhD             | Manager            |
| Hiva                | 41  | Female | PhD student     | Researcher         |
| Asoo                | 33  | Female | PhD student     | Researcher/teacher |
| Shervin             | 41  | Male   | MA              | Teacher            |
| Khodanoor           | 35  | Male   | PhD student     | Teacher            |
| Adel                | 29  | Male   | MA              | Teacher            |
| Peyman              | 32  | Male   | MA              | Teacher            |

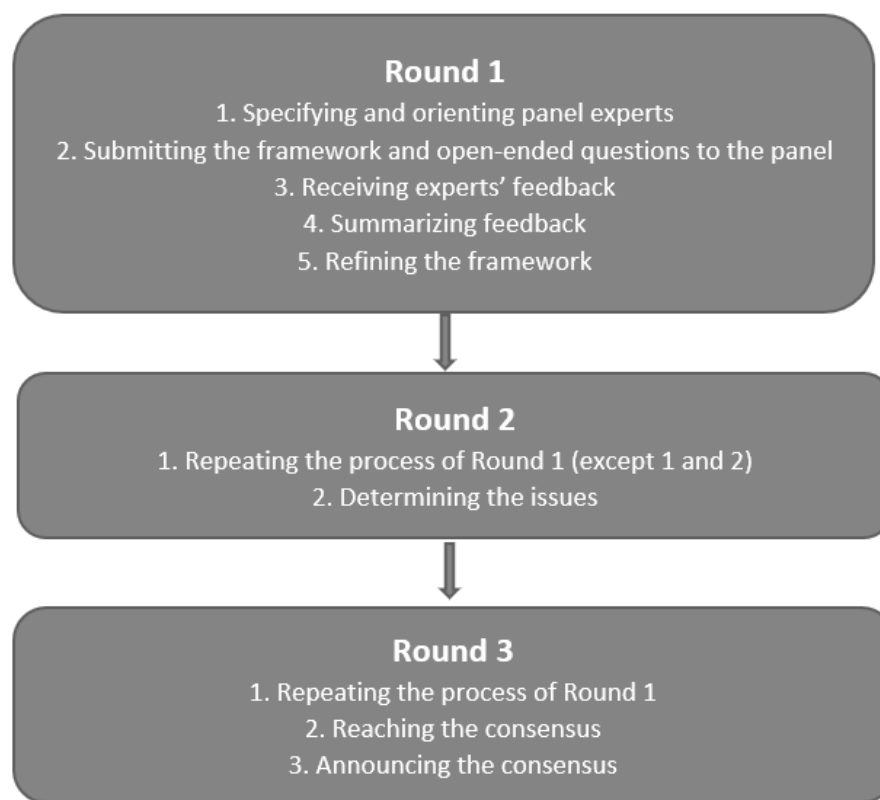
Procedure, Data Collection and Analysis



After assembling the panel of experts, I presented the developed CALL literacy framework to the panel along with a detailed explanation. Subsequently, I sought their input regarding the accountability and applicability of the framework in TPSOL. The data collection and analysis in the Delphi method were structured into three rounds: 1) soliciting opinions, 2) identifying key issues, and 3) managing opinions as guided by Keeney et al. (2001) (see Figure 4).

**Figure 4**

*Three Rounds of the Delphi Method for Study 2 (Inspired by Salkind, 2007)*



Following the identification and assignment of panel experts, a thorough briefing was conducted to ensure their familiarity with the research objectives. An open-ended questionnaire was then distributed in Persian, which requested their opinions and included demographic information. To ensure the questionnaire's reliability, feedback was obtained from two Education experts regarding its accountability and clarity, resulting in necessary edits. The open-ended questions within the questionnaire addressed the following key areas:

- Please explain which part of the framework lacked clarity.
- Please explain which part of the framework causes concern about applicability.

- Please explain how this framework is applicable in TPSOL.
- Please share if you have any other questions or concerns about this framework.

After receiving comments and responses, the framework underwent refinement and the refined version was submitted for the second round, during which the most significant modification took place. The meticulous consideration of responses by the inter-rater and myself ensured the interpretive validity. This same process from the first round was repeated for the second round. Finally, in the third round, consensus was announced. The findings of the two studies are presented in the next section.

## Findings

The findings of the study are categorized into three main sections: 1. Components of CALL literacy, 2. Influential factors on effective CALL literacy, and 3. Consolidation of experts' opinions.

### ***Components of CALL Literacy***

According to data analysis, I identified three primary components: a) language literacy, b) teaching literacy, and c) digital literacy. However, it became apparent that it was challenging to delineate distinct boundaries between each component based on the teachers' lived experiences. Rather, teachers perceived CALL literacy as an integrated and comprehensive skill, wherein the integration of language literacy, teaching literacy, and digital literacy was inevitable. Consequently, during their discussions, the interconnection of these components emerged naturally. The only component that could be partially distinguished was language literacy, particularly concerning target language proficiency.

### **Language Literacy/Proficiency**

The study's findings revealed unanimous agreement among all participants regarding the crucial importance of target language proficiency for the success of foreign language teachers. Many teachers emphasized that possessing native-like speaking and pronunciation skills is essential to serve as a good role model for language learners. Arad illustrated this by stating that "*students perceive a good teacher as someone who speaks like Barack Obama.*" Similarly, Mahsa emphasized the expectation for teachers to have pronunciation similar to that in foreign language movies and series. In contrast, Reza suggested that being a non-native speaker might actually make one a better teacher, emphasizing the importance of proficiency levels ranging from B2 to C2 across all language skills. Additionally, Hamid shared a significant anecdote from an Applied Linguistics conference, where students prioritized the speaker's pronunciation over his expertise, highlighting the weight placed on language proficiency by learners.

The sub-theme of *knowing the subject* exhibited significant overlap with language literacy, making it challenging to differentiate between the two. For example, while grammar is considered a language skill, a few teachers referenced it as a subject matter that a teacher must master. Mahsa exemplified this, expressing the need to improve her proficiency in German grammar, which is crucial for effective language instruction.

### Teaching Literacy

Participants unanimously agreed on the multifaceted nature of a literate language teacher. Essential abilities and skills included lesson planning, assessing learning, understanding learners' needs, providing feedback, and managing the classroom effectively.

Regarding the importance of *lesson planning skill*, Kia highlighted the need for teachers to anticipate potential challenges and respond effectively with well-structured plans, especially in the face of technology glitches in online teaching. Dina expressed her struggle with sequencing and timing tasks within lesson plans, acknowledging the demanding nature of the job and lamenting instances where she felt her students' time was wasted due to inadequate planning. Javid showcased his strength in connecting various activities coherently to enhance student learning and learning strategies, referring to it as his "*superpower*" despite his experience, emphasizing the ongoing process of reflection on lesson plans.

The *ability to assess students' learning*, also known as 'assessment literacy,' was emphasized by the participants. Habib emphasized the necessity of accuracy in assessing language learners, noting that competence lies in precision, especially in evaluating students' online activities. Javid stressed the significance of understanding the differences between online and face-to-face teaching, emphasizing the need for teachers to be knowledgeable about online assessment principles and practices. Sara echoed this sentiment, underlining the essential skill of utilizing various online testing and assessment tools effectively.

Many teachers stressed the importance of *understanding learners' needs*. Babak emphasized selecting educational tools aligned with students' requirements. Sama highlighted the necessity of basing tools, materials, and tasks on learners' needs to avoid inefficiency. Kia noted the importance of aligning syllabi with students' 21st-century skills and the need for occasional modifications. Additionally, all teachers emphasized the critical role of *classroom management* in effective teaching. Eli admitted struggles with control in online teaching, feeling inadequate due to difficulties managing the setting and time. Reza echoed these challenges, expressing disbelief in establishing and maintaining discipline in online classes. In contrast, Sara viewed her ability to make appropriate decisions in challenging situations as a hallmark of effective teaching.

*Providing appropriate feedback* emerged as another essential skill for an efficient teacher. For example, Kia stressed the importance of analyzing students' errors and offering constructive feedback, highlighting it as essential for literate online teaching. Eli shared her approach to providing feedback on student writing, describing a process involving the use of Google Docs for peer corrective feedback, which she then reviewed and marked. Although some skills were mentioned less frequently, they are still worth mentioning. These include the ability and skill to "use inclusive materials and practices," "develop students' 21<sup>st</sup>-century skills," "facilitate effective interactions in the classroom," "motivate students," and "promote student autonomy."

### Digital Literacy

Concerning digital literacy, analysis of participants' responses revealed several keywords commonly cited, including digital tools, digital content, netiquette, and e-safety.

*Digital tools* are a top priority for language teachers, viewed from two primary perspectives: knowing how to use them effectively and selecting the most appropriate one for teaching purposes. Mahsa emphasized the need to master online tools and integrate them effectively into teaching, considering technical issues and content alignment. Habib expressed a desire to learn more about digital tools to enhance teaching effectiveness. Kia highlighted the challenge of selecting suitable tools amidst numerous options.

Foreign language teachers also underscored the importance of digital literacy by emphasizing the role of *digital content*. Sama stressed the efficiency of preparing digital content aligned with teaching strategies. Kia highlighted the evolving role of language teachers as content developers for online teaching. Hamid emphasized the need for teachers to assess the potential effectiveness and cultural appropriateness of digital content and tools. Teachers also emphasized the significance of *netiquette* and *e-safety* in ensuring a safe and respectful online teaching and learning environment. Babak emphasized adherence to online conduct rules and respectful communication. Arad stressed professionalism in online teaching, emphasizing politeness and professionalism. Eli highlighted the importance of respecting copyright rules. Dina emphasized e-safety, including protecting private information and promoting secure connections and antivirus use.

### ***Influential Factors on Effective CALL Literacy***

To gain a comprehensive understanding of effective CALL literacy for teachers, I also elucidated the influential factors based on foreign language teachers' interviews, including education and training, cognitive abilities, communicative competence, intercultural competence, managerial competence, creativity, and cultural responsiveness.

Almost all teachers stressed the eminence of relevant *education and training*. For instance, Reza emphasized the significance of holding academic degrees in foreign languages, noting its correlation with CALL literacy. Arad stressed the necessity of CALL training, especially for online teaching, even in the absence of formal coursework. Hamid emphasized the value of language qualifications such as CELTA, DELTA, and TESOL for training in online teaching.

Many teachers believe that CALL literacy and qualifications are intertwined with *cognitive abilities* and *communicative competence*. Kia emphasized the need for critical thinking, problem-solving, and planning skills in teaching through technology. Sama highlighted the importance of verbal and non-verbal communication strategies to engage students effectively. Javid recognized the significance of facial expressions and gestures in effective communication, particularly in speaking courses.

Culture was deemed a vital element in language education by some teachers, which referred to *intercultural competence* and *cultural responsiveness*. Hamid stressed the importance of cultural responsiveness in selecting appropriate materials and content, while Reza emphasized the need for cultural competency to prepare students for a multicultural setting. Dina highlighted the importance of building strong relationships with students from various ethnicities and incorporating their social and cultural values into teaching.

Finally, a few teachers focused on *managerial competence* and *creativity* as additional influential factors. Babak described teachers as managers with numerous responsibilities, including sourcing materials, time management, student encouragement, decision-making, and maintaining discipline. Mahsa emphasized creativity as essential for handling unforeseen challenges during online teaching, while Sara highlighted the need for spontaneity and adaptability in lesson planning and teaching methods.

### ***Consolidation of Experts' Opinions***

In Study 1, a preliminary version of the competence framework was developed. Each round of the Delphi method involved refining competencies that did not meet the consensus criteria based on feedback from the experts. After three rounds, the preliminary framework was enhanced and reinforced according to the experts' opinions. The final validated framework comprised nine competencies, organized into two main sections representing the knowledge domains of a competent CALL teacher, as illustrated in Figure 5. These competencies embody the objectives that all language teachers should aim to attain.

## Discussion

The objectives of this study were to determine the main components of the CALL literacy framework and its influential factors. Additionally, the study aimed to validate the framework that emerged from the first study through the Delphi method with Persian language experts.

The study's findings revealed that CALL literacy is the interplay between language literacy, teaching literacy, and digital literacy. However, it should be noted that CALL literacy should be considered as a whole, and distinguishing between the components is not advisable. Language literacy/proficiency is regarded as one of CALL literacy's main components, which is often overlooked in the CALL literature. This oversight may be due to the assumption that foreign language teachers inherently possess sufficient proficiency in the target language. I believe that due to the dynamicity of CALL literacy, each teacher from A1 to C2, according to the Common European Framework of Reference for Languages (Council of Europe, 2001), can benefit from CALL literacy; however, as the finding suggested, the more proficient teacher in the target language, the higher CALL literacy level he possesses.

Moreover, the study found that teachers considered subject knowledge to be intertwined with language literacy, further underscoring the complex nature of CALL literacy. This finding is particularly relevant in the context of non-native language teachers, challenging prevailing notions about the necessity of native-like language proficiency. While the CALL literature has been largely silent on this aspect, debates surrounding foreign language proficiency levels persist in applied linguistics and foreign language education. However, the adequate level of language proficiency, which is also called the threshold level (e.g., Richards, 2010), is still vague (see Tsang, 2017). This finding is in contrast with the vast majority of discussions about native-like mastery and speakerism (see Canagarajah, 1999; Holliday, 2006), in which researchers believe that foreign language teachers are not necessarily native speakers and there is no need to have native-like ability to be a good teacher (e.g., Richards, 2017).

As mentioned above, one of the critical insights from this study is the recognition of language literacy as a core component of CALL literacy. While the TPACK framework provides a broad definition of content knowledge (CK), this study delves into the specifics of language literacy, focusing on metalinguistic awareness, phonological, lexical and grammatical knowledge, and the effective teaching of these elements in diverse settings. Language literacy in CALL goes beyond mere subject matter knowledge, encompassing the complexities of second language acquisition theories, the sociolinguistic aspects of language teaching, and the adaptability of teaching methods across different linguistic and cultural backgrounds. This nuanced understanding is crucial for language educators, particularly in non-native language environments, where they face challenges that extend beyond content delivery. This aligns with the call for more tailored pedagogical approaches, as discussed by Tsui (2011) and Borg (2015).

Teaching literacy is another crucial component that shapes CALL literacy, encompassing various aspects, such as lesson planning, assessing learning, understanding learners' needs, providing appropriate feedback, managing the classroom, using inclusive materials and practices, developing students' 21st-century skills, making effective interactions

in the classroom, motivating the students, and boosting students' autonomy. These findings corroborate with previous studies in CALL, which emphasized the importance of lesson planning (e.g., Crosthwaite et al., 2023), assessing learning (e.g., Xu et al., 2021), understanding learners' needs (e.g., Gacs et al., 2020), providing appropriate feedback (e.g., Ekmekçi, 2023), managing the classroom (e.g., Demir & Kayaoğlu, 2022), developing students' 21st-century skills (e.g., Shadiev & Wang, 2022; Stickler et al., 2020), making effective interactions in the classroom (Demir & Kayaoğlu, 2022), motivating the students (Demir & Kayaoğlu, 2022), and boosting students' autonomy (Demir & Kayaoğlu, 2022; Jiang et al., 2022; Taghizadeh & Ejtehad, 2023) for effective language teaching in technology-enhanced environments.

However, what is often overlooked in CALL studies is the necessity of using inclusive materials and practices which take into account students' diverse backgrounds and characteristics. This entails considering factors such as language and social background, cognitive, academic, and physical abilities, behaviors, disabilities, age, gender, race, ethnicity, religion, beliefs, and sexual orientation. While there are relatively few studies that focus specifically on inclusive CALL, to my best knowledge, only two journal articles on Massive Open Online Courses (Barcena et al., 2020; Read et al., 2021) and an edited book titled "Inclusive language education and digital technology" (Beltrán et al., 2013) give prominence to the significance of inclusive CALL materials and practices.

Teaching literacy within the CALL literacy framework goes beyond the general pedagogical knowledge (PK) in TPACK. This study emphasizes that teaching literacy includes specific competencies essential for language instruction, such as differentiated instruction, scaffolding, and fostering communicative competence. Importantly, this component also underscores the importance of inclusive teaching practices, acknowledging students' diverse backgrounds, including language, culture, cognitive abilities, and physical abilities. These inclusive practices are critical in language education, where student backgrounds can significantly influence learning outcomes.

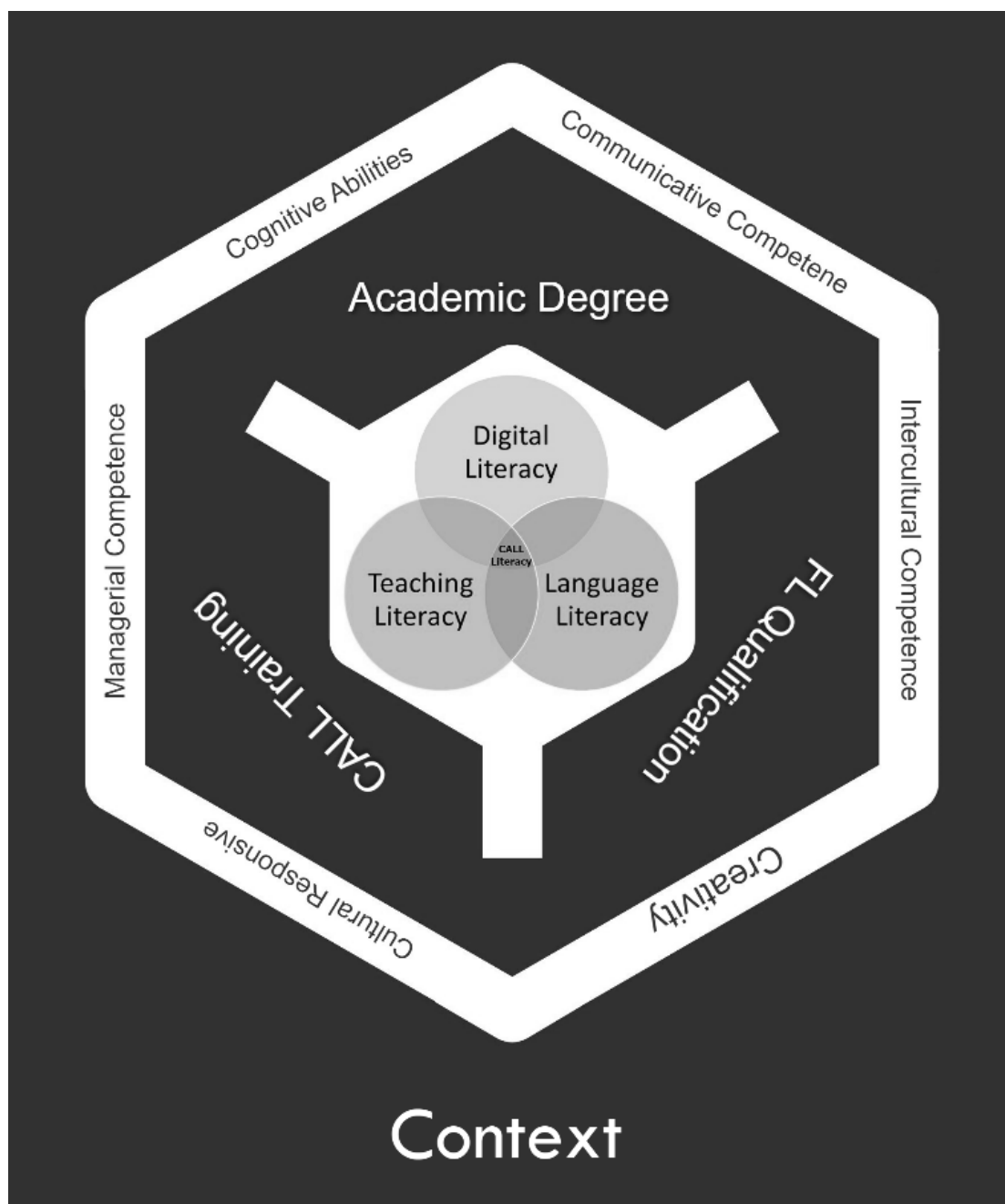
Finally, the third component is digital literacy, encompassing proficiency in utilizing digital tools, creating digital content, adhering to netiquette, and ensuring e-safety. This finding underscored the crucial role of digital literacy for foreign language teachers in effectively integrating technology into their teaching practices. CALL teachers must possess the skills to utilize and select appropriate digital tools, sometimes even creating digital content themselves. Additionally, it is essential for them to adhere to netiquette guidelines and prioritize e-safety to uphold a safe and respectful atmosphere in the online environment. The importance of digital literacy highlighted in this study aligns with the views of CALL researchers who have identified a lack of digital literacy as a significant challenge for teachers in leveraging technology effectively (e.g., Anas et al., 2022; Cote & Milliner, 2018; Dashtestani, 2019; Hazaea et al., 2021). I believe that the importance of being a digitally literate teacher extends beyond the scope of teaching and provides opportunities for equitable access and participation in various CALL professional development initiatives worldwide. Teachers with high digital literacy would be able to develop their 21st-century skills through various channels. Figure 5 illustrates the main components of the CALL literacy framework and the influential factors on effective CALL literacy.

Digital literacy within the CALL literacy framework extends beyond mere technological knowledge (TK) as defined in TPACK. It encompasses not only proficiency in using digital tools but also the critical ability to select and evaluate digital resources, create pedagogically sound digital content, and uphold ethical standards in online environments, including netiquette and e-safety. The findings emphasize that digital literacy is not solely about technology use; it involves leveraging technology to enrich language learning, which demands a deep understanding of both the tools and the pedagogical strategies that best support language acquisition. This correlates with the broader literature that underscores the difficulties language teachers encounter in attaining digital literacy, essential for successful technology integration in language classrooms.

### **Figure 5**

*CALL Literacy Framework*





Following the second research question and aiming to avoid oversimplification of the TPACK model, I delved into the influential factors shaping effective CALL literacy. As depicted in Figure 5, CALL literacy is influenced by various factors such as academic degrees (e.g., BA, MA, PhD), foreign language qualifications (e.g., TESOL, DELTA, CELTA), and participation in CALL training courses. These credentials and qualifications interact with cognitive abilities, communicative competence, intercultural competence, managerial

competence, creativity, and cultural responsiveness. All these abilities, skills, competencies, and literacies are nested in the context.

The finding disclosed that CALL teacher education and training are necessary for CALL teachers. However, consistent with prior research, language teachers expressed dissatisfaction with the availability and relevance of existing courses (e.g., Li, 2020). Additionally, limited attention has been given in the literature to the significance of academic degrees, foreign language qualifications, and CALL in the literature. Notably, among the identified influential factors, the importance of teachers' managerial competence has been overlooked in CALL studies and warrants further exploration. On the other hand, factors such as teachers' cognitive abilities (e.g., Bahari, 2023), communicative competence (e.g., Stockwell & Ito, 2023), intercultural competence (e.g., Wu, 2023), and cultural responsiveness teacher (e.g., Cheng et al., 2022) have received considerable attention within the CALL community, and researchers widely acknowledge their significance in effective language teaching and learning.

The study also acknowledged two notable limitations of the TPACK framework as outlined in the literature: the lack of specificity regarding sub-components and the omission of cultural and contextual factors. Through the development of the CALL literacy framework, this study offers a more comprehensive and refined comprehension of the knowledge domains crucial for language teachers.

Firstly, sub-components within each knowledge domain are explicitly detailed in this framework. For example, within digital literacy, the sub-components include not just the use of digital tools but also the creation of digital content and adherence to ethical standards. These sub-components are particularly relevant in language education, where the mere presence of technology does not guarantee successful learning outcomes. Instead, the effective integration of technology requires teachers to be both digitally literate and pedagogically competent in utilizing these tools to meet language learning objectives. This focus on sub-components addresses the critique that TPACK's broad definitions may not adequately capture the complexities of language teaching (Brantley-Dias & Ertmer, 2013; Koehler et al., 2015).

Secondly, the CALL literacy framework explicitly incorporates cultural and contextual factors as influential elements in effective language teaching. The study's findings highlight that language teaching cannot be divorced from the cultural context in which it occurs. This is particularly true in CALL, where the integration of technology into language teaching is often mediated by cultural attitudes toward technology, the language being taught, and the educational context (Dashtestani, 2014). The framework's emphasis on cultural responsiveness and intercultural competence ensures that language teachers are not only technically proficient but also culturally sensitive, which is essential for successful language education in diverse settings (Adam, 2015).

## Conclusion

The COVID-19 pandemic has accelerated the integration of technology in language education (Stickler & Emke, 2023), promoting increased interest among teachers in acquiring CALL literacy to enhance their effectiveness. Recognizing this demand, the study aimed to delineate the main components of CALL literacy among foreign language teachers based on their lived experiences.

The findings revealed that CALL literacy entails the interplay of language literacy, teaching literacy, and digital literacy, with influential factors including academic degrees and qualifications, cognitive abilities, communicative competence, intercultural competence, managerial competence, creativity, and cultural responsiveness—all contextualized within the teaching environment. This study holds significance for both teachers and teacher educators. For teachers, it offers insight into the essential literacies and competencies needed to enhance their proficiency as CALL instructors in both online and traditional classroom settings. For teacher educators, the findings serve as a practical guide for designing CALL teacher education and professional development courses, enabling them to tailor their instructional approaches to better meet the needs of pre-service and in-service language teachers.

While the study yields valuable insights into CALL literacy, it is essential to acknowledge its potential limitations. The framework developed for CALL literacy may be influenced by the specific context of foreign language teachers in Iran, warranting further investigation across diverse linguistic and cultural contexts. Additionally, employing a phenomenological approach limited the data collection to interviews with language teachers, suggesting the need for diverse data collection methods such as observation, demonstration, and recording to capture a broader spectrum of perspectives. Finally, future research endeavors should focus on validating the CALL literacy framework with teachers in specific foreign language contexts to delineate any potential variations.

## Conflicts of Interest Statement

The author declares no potential competing interests with respect to the research, authorship, and/or publication of this article.

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# Sequentially Structured Online Dissertation Model: Implications for Timely Completion Among Online Psychology Doctoral Students

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## Abstract

Research suggests that supportive programmatic structure can assist online doctoral student success, including time to complete the dissertation. However, completely online doctoral students have unique characteristics and needs and are underrepresented in the research literature; therefore, research exploring programmatic factors as related to learning outcomes in this population is warranted. This study investigated differences in time to completion among 3 cohorts of online non-clinical psychology doctoral students: those who experienced a traditional dissertation model, those who experienced a sequentially structured dissertation model, and a transition cohort. We used institutional data from a non-profit, completely online, primarily doctoral-granting university for all doctoral students who completed their psychology PhD from 2013-2020 ( $n = 430$ ). Analyses indicated time to completion was significantly lower for the sequentially structured cohort compared to the traditional ( $p < .001$ ,  $d = .70$ ) and transition cohorts ( $p < .01$ ,  $d = .43$ ). There was no statistically significant difference between the traditional and transition cohorts ( $p = .09$ ). Overall, these results suggest mechanisms of the sequentially structured model support conscientious student progress with structured proximal goals and mentor feedback loops to guide progress and support timely completion.

**Keywords:** Online doctoral program, timeliness, doctoral success, psychology doctoral students

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As many non-traditional students must balance substantial life responsibilities (e.g., families and careers; Berry & Hughes, 2020), online education offers flexible educational course scheduling that has been found to improve knowledge, skills, and competences (Fresen, 2018; Holton, 2018; Dos Santos, 2020). During the Covid-19 pandemic, most universities in the US shifted to partially or fully online courses. For many dissertation students, this shift involved online mentorship, data collection, and defense, introducing new hardships (Niño & Martinez, 2021). More than 61% of students working on their dissertation during the pandemic reported a negative impact of the pandemic on their progress, with data collection the most likely element impacted (Donohue et al., 2021). Covid-19 may also have impacted students' perceptions of their doctoral journey, specifically increasing concerns about the professional and societal value of obtaining a PhD (Atkinson et al., 2022). Even after the immediate challenges of Covid-19 passed, institutions, professors, and students have had to mitigate pandemic-related interruptions to their educational goals (Daniel, 2020).

Even prior to the pandemic, attrition rates for doctoral programs were of concern. Data from previous research suggested a 40-70% average attrition rate for doctoral programs (Gardner & Gopaul, 2012; Spaulding & Rockinson-Szapkiw, 2012), with an additional 10-20% increase for online students (Allen & Seaman, 2011; Marshall, Greenberg, & Machun, 2012). Despite improvement in time to doctoral completion (e.g., from 1996-2016 decreased from 16 to 12 years for an EdD), the social sciences and humanities average 11.9 years (National Science Foundation [NSF], 2018). One specific "bright spot," comparably, is that students majoring in psychology generally had an 8-year average time to completion compared to 9.6-year average for Humanities (NSF, 2018). It is logical to assume that as program completion takes longer, perhaps beyond a certain threshold of reasonable time-to-completion, students are less likely to complete due to potentially unmanageable debt, overwhelming stress, learned hopelessness, or a variation on these and other issues. In association with high attrition from doctoral programs, timely completion of the dissertation has become a central concern, but the need to complete "on time" often competes with outcome quality (Green & Bowden, 2012).

Timeliness is important in many ways, for students, dissertation committee chairs (also referred to in the literature as faculty supervisors or faculty advisors), programs, and universities (Wao & Onwuegbuzie, 2011) and may be linked to funding for students and universities (Green & Bowden, 2012). Increased time to program completion is linked with increased costs and increased financial responsibility (Hardre & Hackett, 2015) and combined with a lack of financial support challenges students' ability to complete their program (Holly & Caldwell, 2012; Kim & Otts, 2010; West et al., 2011). Students who take longer are less likely to complete, resulting in expenses for both students and institutions (Boone et al., 2020). This investment of financial, intellectual, and temporal resources yields little or no return for the student or university if graduation does not occur, while mean earnings by postsecondary degree level suggest obtaining these post-graduate degrees leads to better labor market outcomes (Lovenheim & Smith, 2022).

Timeliness is also relevant to doctoral student success regarding perceived student progress. For doctoral students, the perception of being behind schedule on dissertation research progress (Barry et al., 2018) or feeling uncertainty about their progress relative to program expectations or requirements (Cornwall et al., 2019) increases stress and anxiety, and may lead

to loss of focus resulting in non-completion of the dissertation (Young et al., 2019). Barry et al. (2018) noted that most doctoral students perceived high levels of stress that contributed to lack of academic productivity, procrastination, and loss of motivation. If lack of progress leads to increased stress, which in turn is linked to procrastination and lack of productivity, supporting timely completion for doctoral students is a key consideration. Further, student perception of progress may be linked with burnout and intention to drop out for doctoral candidates (Prieto et al., 2022). In this way, timeliness may be key to persistence. Depression, anxiety, and stress are significantly higher among doctoral students who self-report being behind schedule when compared with students who report being “on schedule” for their dissertation research (Barry et al., 2018).

Graduate institutions may struggle to assist online doctoral students to make consistent progress on and complete their doctoral research, particularly institutions with open enrollment policies (Burrus et al., 2019). Combined with increased popularity of online doctoral programs (Perrotta & Bohan, 2020) and the switch to online courses due to the pandemic, the importance of identifying best practices and aligning programmatic formatting for timeliness and success of online doctoral students post-pandemic is clear (Rashid & Yadav, 2020). However, student progression toward dissertation completion is not easily influenced by institutions or students striving to improve it. Some authors have argued that universities may not have much ability to influence time to degree as the academic discipline has the strongest influence (Barnes & Randall, 2012). Churchill et al. (2022) investigated predictors of stratified time-to-degree for doctoral students (on-time, on-time plus 18 months maximum, on-time plus 18 months minimum) and found that while gender and age were not predictive, part-time status for both domestic and international students was associated with a higher proportion of students completing on-time. Field of study was also significant, with Health students significantly more likely to be on time (43.3%), followed by Humanities, Arts, and Social Sciences (HASS; 29.9%), then STEM students (11.8%). However, Churchill et al. (2022) also suggested identifying variables associated with time-to-completion which are modifiable as a best practice for universities striving to influence student success.

In this context, identifying best practices within one online university could provide a roadmap for diverse approaches to supporting timely student progress toward completion in online graduate education for other institutions, based on modifiable conditions. For instance, doctoral programs can vary widely by institution in their structure and specific program requirements (Castelló et al., 2017), and research suggests that some aspects of program structure may influence doctoral students’ timely completion and success (Bagaka’s et al., 2015). Timeliness is important for doctoral student satisfaction, stress, burnout, and attrition (Barry et al., 2018; Prieto et al., 2022; Young et al., 2019). However, timeliness also needs to be embedded in a context where quality is assessed, with some researchers suggesting the importance of rubrics and other methods to reduce evaluation subjectivity (Kumar et al., 2023).

Online doctoral programs are increasingly in demand due to accessibility, practicality, and the recent pandemic. According to the National Center for Education Statistics (NCES, 2022), in Fall 2020, 51.8% of postbaccalaureate (master’s and doctoral level) students exclusively took distance education courses. Online learning provides a vehicle for students to engage with instructors regardless of physical distance separating the student from a college or university, while the internet and computers serve as conduits to support the process of learning virtually (Gillett-Swan, 2017; Vancell, 2018). Growing evidence suggests that online education outperforms traditional or grounded education in students’ degree completion (e.g., Shea & Bidjerano, 2014). Compared with a more

traditional motivation of attaining a PhD to seek an academic or scholarly research-oriented career, many online doctoral students are seeking knowledge, credibility, or advancement opportunities in a current career (Gardener, 2009; Parker et al., 2020).

Nontraditional students (NTSs) are increasingly represented among online doctoral students (NCES, 2018). NTSs have careers, are older, female, are part-time students with family responsibilities, and ultimately may not be seeking full-time faculty positions (Kumar et al., 2013; Offerman, 2011). Of doctoral students enrolled in completely online degrees in 2015-2016, 42% were over the age of 30, 37% were part-time students, 34% were employed, and 44% were married with dependents (NCES, 2018). NTSs, specifically, have benefitted from flexible educational course scheduling at online institutions that have been found to improve their knowledge, skills, and competencies (Fresen, 2018; Holton, 2018; Dos Santos, 2020). The opportunity of online education that appears to meet a need among NTSs may account for a 42% increase in representation of NTS students which increased from 38% to 84.2% from 2009 to 2017 (Cheng & Yi, 2018; NCES, 2018). Indeed, in addition to fully online universities, traditional (grounded) higher education institutions have implemented online learning opportunities to attract NTSs, which led to 40 million NTSs being enrolled in online classes in 2016 (Dos Santos, 2020; Marine, 2020; Paulsen & McCormick, 2020).

NTSs often carry substantial life responsibilities, such as families and careers (Berry & Hughes, 2020). NTSs engaged in online education must balance competing demands such as coursework, household tasks, parenting, and other familial responsibilities (Blau & Drennan, 2017; Kara et al., 2019). Sapir (2021) also reported that NTSs often carry the financial burden for their education. The NTS label also applies to immigrants, first-generation students, and students with low income (Chen, 2020). For these nontraditional online doctoral students, finding a balance between work demands, family responsibilities, and social life (including socialization opportunities with faculty) to fulfill the requirements of being an online doctoral student is challenging (Akojie et al., 2019; Lim et al., 2019). Conflicting demands can negatively impact online doctoral completion (Bergman et al., 2014; Brown, 2017), time to completion, and can have negative physical and emotional effects including burnout (Rockinson-Szapkiw, et al., 2017). Doctoral completion is challenging in and of itself but may be more difficult for online students who have no access to a physical campus and associated support services (Lim et al., 2019). Students who enroll in online doctoral programs may not understand the requirements and expectations of doctoral programs (Lee, 2020; Roumell & Bolliger, 2017) and have reported that their preparation for doctoral-level work (particularly scholarly writing) was insufficient (Parker et al., 2020).

Despite these challenges, online doctoral programs allow access to higher education for adults with full-time employment pursuing advancement in their current employment or who are not able to attend a traditional graduate program due to geographic or familial responsibilities without accepting negative impacts on current professional and personal roles (Kung, 2017; Lee, 2020). Online doctoral students seek a flexible and “family conducive” environment for pursuing their doctoral degree (Thacker, 2021). Women enrolled in online doctoral programs identified flexibility and access in addition to cost as the primary factors influencing their choice of program and university (Scarpena, 2016). Evidence suggests online doctoral degrees may be particularly more accessible for underserved students (such as first-generation doctoral students; Williams et al., 2019).

Online students must rely on technological systems for communication and academic management (email, video, and virtual learning environment or platform) (Orellana et al., 2016), and persistence in online doctoral programs has been linked to both program design and student knowledge and use of the online environment (Levich & Shaw, 2014). It is important to examine methods that enable online students to succeed in doctoral programs, especially as they enter the challenging dissertation phase and lack tangible resources (i.e., lab space, access to participants) (Marston & Gopaul, 2020). To accommodate the unique needs of online doctoral students, researchers emphasize the need for structure and guidelines to set expectations and reduce challenges associated with asynchronous communication (Kumar & Johnson, 2019). To address a lack of research experience among online doctoral students with no opportunity to observe mentors' research practices, scaffolding is key to developing student research skills (Kumar & Johnson, 2019).

Doctoral supervision or mentorship needs for online students are unique due to limited social contact (Deshpande, 2017; Wilson & James, 2022) and may require more strategic attention (Roumell & Bollinger, 2017). The mentor-mentee partnership may be particularly important for the success of online doctoral students (Brill et al., 2014), as faculty play a central role in guiding doctoral students during the tenuous dissertation phase and the mentoring relationship becomes a "link to an otherwise absent yet critical experience of academia" (Pollard & Kumar, 2021, p. 267). A qualitative study of doctoral graduates experiencing online education during the pandemic suggested that doctoral students were dependent on faculty/chair guidance for their decision-making regarding doctoral persistence (Hurt et al., 2022). Through their association and relationships with faculty, students will likely receive resources and support that enable degree completion (Boone et al., 2020; Newberry & DeLuca, 2013).

Online students credit support and encouragement from their dissertation chair in overcoming self-doubt and persisting in their doctoral program, particularly through "regular check-ins" and encouragement (Torres et al., 2021). Inadequate dissertation committee support can negatively impact both motivation and progress towards completion (Locke & Boyle, 2016), but access to and regular interaction with faculty, a sense of care, and perceived trust contribute to student success (Bagaka's et al., 2015; Hoffman, 2014; Rockinson-Szapkiw et al., 2016). Faculty members play a role in online doctoral student persistence and motivate students by clarifying program requirements, providing university resources and individualized coaching, and building relationships with students (Boone et al., 2020). Online doctoral students report that specific mentor/faculty strategies were key to their dissertation progress and completion, including appropriate technology use, frequent and timely communication, timeliness of feedback, constructive guidance, and moral support.

A recent literature review suggested that individual student characteristics are less reliable predictors of online doctoral persistence compared with institutional factors (Lehan et al., 2021). Online doctoral students identify institutional and departmental supports as critical for persistence (Motte, 2020; Spaulding & Rockinson-Szapkiw, 2016). Levitch and Shaw (2014) concluded that department/program leadership system impacted retention for online doctoral students. Support services such as academic advising, career services, and library resources seem important to online doctoral student success (Fiore et al., 2019; Rockinson-Szapkiw et al., 2016), as do the quality of academic supports and assistance (Ivankova & Stick, 2007). Online doctoral students suggested that information literacy support, institutional resources and workshops, and early scaffolding of research interests in the doctoral coursework were key aspects of program design that supported dissertation completion (Kumar & Coe, 2017). However, some types of institutional support may not impact online doctoral student retention. One study of online doctoral students

found that students receiving virtual research consultations had significantly higher GPA in dissertation courses compared to matched samples but were not more likely to complete their program (Mohr et al., 2022). Other online doctoral students reported mixed experiences with various university support services: positive and timely experiences with some services (writing support) but not others (methodology support, IRB support; Torres et al., 2021).

Balancing dissertation quality and rigor while supporting doctoral students' sense of progress, belongingness and satisfaction with their program is important yet challenging. Individual characteristics do not consistently predict doctoral time to completion, retention, or satisfaction, and systemic factors are only slightly more dependable (Churchill et al., 2022); however, there is evidence to suggest that supportive program structure promotes success of NTSs in online doctoral programs (Kebritchi et al., 2023). The following sequentially structured online dissertation model was built intuitively and innovatively by faculty and administrators to incorporate accountability, quality engagement, and sequential scaffolding of academic skills and student dissertation progress. The success of the model over its tenure could implicate modifiable factors that could be targeted for greater emphasis or de-emphasis in the development of best practices. Preliminary evidence from a blinded review by university faculty and outside faculty found no difference in dissertation quality using the Purdue dissertation checklist between dissertations resulting from this university and Dissertation Benchmark Alliance Schools (Author et al., 2020). Initial research supports quality of doctoral learning using this online model which includes deliberate structure and rubrics (Hussey et al., 2021)

### ***Sequentially Structured Online Dissertation Model***

Self-regulation (i.e., goal-setting, reflection, strategizing, modification) by online doctoral students is essential to their success (Ellis, 2019; Li et al., 2018; Shea & Bidjerano, 2018; Stephen et al., 2020), but institutional factors can provide a co-regulating influence on students to keep them focused and progressing (Bohl et al., 2017; Dolch & Zawacki-Richter, 2018; Farr-Wharton et al., 2018; Ngigi & Obura, 2019; Ruot, 2013; Shea & Bidjerano, 2018). This sequentially structured online dissertation model implements mentor feedback and deadlines explicitly within the courses and deliverables approval process; previous research supports interventions to implement intermediate deadlines during the doctoral research sequence increased timely completion rates for European doctoral students (Geven et al., 2018). Further, self-regulation is a concept related to autonomy as proposed in Moore's theory of transactional distance (1993; Giannakoudakis & Giossos, 2018) to be interrelated with course structure and instructor dialogue. Essentially, a sequentially structured online dissertation model encourages self-determination by promoting or co-regulating a mindset of conscientiousness and intentionality that is not emphasized in other institutions. Research implies that a completion mindset where students identify and re-think subsequent steps at each stage with timely completion in mind is necessary for doctoral success (Green & Brown, 2022). Students must constantly keep track of their progress—how far they've come and how far they need to go. Students may be more likely to remain focused on their doctoral goal pursuit because they know there are time limits, and motivation (and corresponding goal setting) has been linked to doctoral persistence (Spaulding & Rockinson-Szapkiw, 2012). By remaining conscientious throughout a structured dissertation experience, students emphasize to themselves that the dissertation is a prominent, valuable goal pursuit.

This model also incorporates regular, timely communication with and feedback from the dissertation chair. Research suggests that aspects of frequent and timely communication, timely feedback (Kumar & Coe, 2017), regular "check-ins" (Torres et al., 2021), and faculty accessibility and responsiveness (Kauffman, 2015) are linked with positive academic outcomes for online doctoral students. This type of dialogue contributes to co-understanding (Giossos et al., 2009) associated with Moore's (1997) theory where the opposite of co-understanding would be increased transactional

distance reflecting a communication gap or “lack of common or mutual perception of knowledge, thoughts, approaches, needs (psychological and educational) and emotions” (p. 3). Postgraduate students’ perception of transactional distance in a blended online setting was associated with negative impacts on the learning process (Kassandrinou et al., 2014), and for postgraduate students in an online program, transactional distance was linked with decreased satisfaction (Gavrilis et al., 2020). However, other research suggests that among distance postdoctoral students, no relationship between autonomy and transactional distance was found (Vasiloudis et al., 2015), which may suggest the presence of a moderator (i.e., learning styles or other individual-level student factors).

Until 2016, this US public nonprofit online doctoral research university utilized a traditional dissertation sequence format based on milestone document completion where students were allowed to continue enrollment in dissertation courses without time limits. In 2016, a sequentially structured online dissertation model was implemented based on successful completion of course-based deliverables, evaluated against a faculty-created rubric by 3-member dissertation committees. Many parties were involved in the development of this new online sequence with an intentional focus on research progression, quality of research, and engaging regular interaction with a committee chair. Candidates make weekly submissions of specified dissertation components to scaffold learning and constructively build dissertation components. Each chapter of the dissertation must meet minimum standards on an associated rubric, as scored by the dissertation committee chair and subject matter expert (SME) for every criterion before a doctoral candidate progresses to the next course sequence block. At the proposal and manuscript stages, a third committee member, the academic reader, evaluates the deliverables based on rubric criterion. The course sequence includes a Prospectus and 4 sequential dissertation course blocks (with up to 12 additional supplemental courses). This process was designed to support online doctoral student progress toward dissertation completion promoting strategic goal setting, sustained commitment, and motivated performance despite challenges and obstacles that may arise.

### ***Theoretical Underpinnings to the Sequentially Structured Online Dissertation Model***

Most universities utilize common stages (i.e., 5 chapters) of the dissertation, but traditional models typically place less emphasis on timely progression toward completion and structure. Once students complete their coursework and enter doctoral candidacy, the structure and guidelines supporting their progress often disappear (Burns & Gillespie, 2018). Researchers suggest that increased structure in the doctoral phase could increase student success (Gittings et al., 2018). As proposed by Moore (1997), research suggests that programmatic structure may be particularly important for online students, as high structure/high dialogue format reduces the professor/student communication gap for online graduate and undergraduate students (Huang et al., 2016). Decreased transactional distance was associated with higher course structure and course interaction among online graduate students (Alotibi & Miller, 2019).

The temporally framed goal progressions of the sequentially structured online model provide a type of “aft wind” nudging the students forward in a time-bound process, which allows them to better evaluate their progress in measurements of time (see Husman & Lens, 1999). Recently, research on doctoral student success has identified self-perception of progress as a key motivational factor (Prieto et al., 2022). Among Australian doctoral students, positive perception of progress has been linked with lower reported stress, anxiety, and depression (Barry et al., 2018). Among UK postgraduate students, positive self-evaluation of academic progress and



preparation was linked with higher well-being, while negative self-evaluation of progress was associated with increased likelihood of depression and poor sleep (Milicev et al., 2021). Prieto et al. (2022) suggest that such findings support the existence of a “progress cycle,” where perceived progress may support positive emotional and mental health outcomes which reinforce productive behaviors, in turn leading to more progress. Further, perceived competence and perceived support from dissertation faculty may foster motivational processes that impact completion and dropout intentions among doctoral students (Litalien & Guay, 2015; Posselt, 2018).

The sequentially structured online model is enhanced for students and institutions alike by implementing accountability measures such as attendance checks, which may serve to promote relatedness to the chair and the institution (see Ryan & Deci, 2017). Relatedness is a sense of “connectedness” or “being known and understood,” identified by Ryan and Deci as a key psychological component of motivation and aligns with Moore’s conceptualization of reduced transactional distance (1997) or co-understanding (Giossos et al., 2009). Social connectedness or integration with faculty has been linked to doctoral completion (Rockinson-Szapkiw et al., 2016), and doctoral students in a cohort program who did not complete identified lack of relatedness during the transition from coursework to dissertation research as a major reason for attrition (Burns & Gillespie, 2018).

The sequentially structured online model also encourages engagement and quality dialogue (Moore, 1997) between chair and doctoral student, presenting the groundwork for a mentor-mentee dynamic, wherein the chair may serve as what Ericsson (2018) might refer to as an expert mentor or what Vygotsky (1979) would refer to as a knowledgeable other. Vygotsky’s (1978) sociocultural theory posits scaffolding as structures and supports to facilitate learning offered by a more knowledgeable other, which has been shown to facilitate doctoral student success (Liechty et al., 2009). This mentor plays an active role in the zone of proximal development—the continuum of individual capability ranging from current mastery to potential mastery with guidance—and scaffolding by facilitating learning (Margolis, 2020) and is integral to the student’s success in academic and often emotionally supportive ways (Liechty et al., 2009). Liechty et al. (2009) further suggest that programs and structures must support sequential mastery for appropriate scaffolding to occur. In the sequentially structured model, scaffolding of learning is supported through the sequential building of dissertation components within the course structure with regular dissertation faculty interactions and review of student work. In a meta-synthesis of 118 studies on doctoral attrition, Bair and Haworth (2004) found degree completion was directly related to the amount and quality of contact between doctoral students and their chairs. The literature suggests that promoting doctoral student’s communication with their dissertation committee is key to program success (Ames et al., 2018), and university administration should evaluate how they can best provide structured and consistent mentorship (Grady et al., 2014).

Finally, the sequentially structured online model promotes student and institutional progress, awareness, and reflection processes due to the consistent sequential course endings and beginnings, such that students, chairs, and other institutional players remain more cognizant of students’ progression over time. Research suggests that doctoral students at high risk for intent to quit may not be identifiable based on socio-demographic or enrollment characteristics (Larcombe et al., 2021), and regular check-ins may be necessary to identify such students. Identifying a student as at-risk sooner is likely to renew their engagement more promptly in goal striving, a key determinant of performance (Ericsson et al., 1993; Locke & Bryan, 1969; Locke

& Latham, 2002; Wood & Locke, 1990), whereas an at-risk student who goes unnoticed may continue to pay substantial tuition without much academic progress. Such students may be more likely to have negative perceptions of their experiences with institutions, which could decrease goal commitment and lead to attrition (Willis & Carmichael, 2011). Goal commitment of doctoral students must be understood and supported by institutions and dissertation chairs if students are to remain motivated to perform until they complete the doctorate; without commitment to goals, students' goals do not imply enhanced motivation or performance (see Locke & Latham, 1990, 1991). Indeed, doctoral student plan commitment and goal commitment, along with supervisor and peer support, are positively associated with study progress (Martinsuo & Turkulainen, 2011) while de-prioritization is associated with non-completion (Burns & Gillespie, 2018).

Students are consistently encouraged to be reflective (Fishbein & Ajzen, 1975) of their doctoral progress and intentional about changes they may need to implement to achieve improved goal task performance. Self-reflexivity toward feedback during dissertation writing must be ongoing, nurtured, and sustained (Muhaimin, 2019). Such reflective processes are emphasized by motivational and psychological principles of intentional behavior as illustrated in (a) deliberate practice, which has been tied to academic performance and expertise (Ericsson (1993), (b) conscientiousness, which has been linked to academic performance (Poropat, 2009) including online doctoral student grade point average (GPA; Walsh, 2020) and (c) mindfulness, associated with improved emotional regulation (Hill & Updegraff, 2012; MacDonald et al., 2020) and self-regulation (Ludwig et al., 2020). The sequentially structured model motivates the student to be cognizant of the "ticking clock" of their courses without adding overbearing pressure to finish in an overly tight, restrictive schedule. Previous research suggests that personal motivation contributes to doctoral student success (Lake et al., 2018). Self-motivation has been shown to be predictive of persistence, particularly for online doctoral students (Ivankova & Stick, 2007); students credit their internal motivation as a key factor in persisting during the transition from coursework to doctoral research (Fiore et al., 2019). Self-determination, perseverance, and resourcefulness in the face of obstacles were identified by doctoral students as contributing to persistence and academic resilience (Chamadia & Qureshi, 2021).

### ***Present Study***

Although psychology doctoral students are represented in the research literature (El-Ghoroury et al., 2012; Kaufman, 2006; McKinzie et al., 2006), they were largely enrolled in fully or partially on ground programs (Henriksen et al., 2014; Wilcox et al., 2021), clinical or counseling psychology programs (Rico & Bunge, 2021; Tigranyan et al., 2021), professional psychology (Borgogna et al., 2021; Graham & King, 2011) or included in samples of all fields of study represented by a university (e.g., Chinta et al., 2019; Churchill et al., 2022; Kelley & Salisbury-Glennon, 2016;) or in samples of social sciences doctoral students (Bagaka's et al., 2015; Castello et al., 2017). Little is known about how programmatic structure impacts dissertation progress for non-clinical online psychology doctoral students in the US. This study is a valuable addition to existing literature as researchers have identified that online doctoral students warrant scholarly attention, as they have unique characteristics and needs (Akojie et al., 2019). Particularly, there is a need for research studying completely online students (rather than those taking one course online or hybrid programs) (McGaha et al., 2020) and research exploring learning outcomes such as time to completion for online doctoral students (Lehan et al., 2021). Prieto

et al. (2022) further recommended research on the role of progress in doctoral education and outcomes. This study, which examines how a sequentially structured online dissertation model impacts time to completion for online psychology doctoral students in the US contributes to this gap in the literature. In line with a growing body of research, we expected that students experiencing a sequentially structured online dissertation model would complete their doctoral program in significantly less time than students experiencing a traditional non-structured model. Further, we predicted that students in the sequentially structured online model would complete their doctoral program in less time than students in the transitional cohort, who only experienced the sequentially structured online model for part of their dissertation work.

## Methods

A quantitative ex-post-facto research design utilized quantitative data to determine how psychology doctoral students' time to completion differed based on dissertation sequence cohort. Ex-post facto, meaning after the fact, is the most relevant approach to the research questions of this study because data had been collected initially for internal data analyses and program analysis. Research was conducted at a completely online public non-profit university located in the western US granting doctoral degrees to a very diverse and underserved student body. Students at this open-enrollment university are largely female, African American, employed full time, and averaging 47 years old per university self-reported data. The university serves largely graduate and post-graduate students, with psychology doctoral students as the sample for the current study.

After acquiring IRB approval, we obtained secondary data from the university office of institutional research for all graduating students from the psychology doctoral program between the years of 2013-2020. Data included time to completion and demographics for all students who completed the psychology doctoral program from 2013 through the end of 2020. This data included all students who successfully completed their degree during those years. However, data on completion time and student demographics could not be linked. Data were provided in separate de-identified data sources, and no consistent identifier linked data in the 2 sources. This meant that demographic data for each de-identified participant were not linked with corresponding time to completion outcomes and so could not be considered as covariates in analysis. The current sample was grouped into 3 cohorts of students (n=430) with 3 distinct online doctoral sequence processes at the university. The 2013-2016 graduating cohort reflected students who experienced the previous dissertation sequence (n=182), a non-structured traditional model. Students graduating between 2017- 2018 reflected a cohort which experienced the transition from the previous sequence to the current sequential sequence (n=124). Students graduating between 2019-2020 experienced only the current dissertation sequence (n=131), the sequentially structured online dissertation model.

Most participants in this study were white (n=246, 57.2%) and female (n = 266, 61.9%), which was consistent with the National Science Foundation Report (2019) demonstrating that women and those who identified as white were the primary recipients of social science and educational doctorates in the US. Participants were also 10% (n=41) Black or African American, 4.7% (n=20) Hispanic or Latinx, 2.3% (n=10) Asian, 0.1% (n=3%) American Indian or Alaska Native, 2.6% reported 2 or more ethnicities (n=11) and 22.8% (n=98) participants did not self-

report their ethnicity. The majority reported their age range as 31-81 years ( $M=55$ ;  $SD=10.02$ ). There were 11 veterans (2.6%) in this sample.

**Table 1**  
*Sociodemographic Characteristics of the Participants*

|                                                  | <i>n</i> | <i>%</i> | <i>M</i> | <i>SD</i> |
|--------------------------------------------------|----------|----------|----------|-----------|
| Non-structured Model Cohort (2013-2016)          | 182      |          |          |           |
| Gender                                           |          |          |          |           |
| Female                                           | 104      | 57.14    |          |           |
| Male                                             | 54       | 29.67    |          |           |
| Unreported                                       | 24       | 13.19    |          |           |
| Age                                              |          |          | 56.40    | 9.48      |
| Ethnicity                                        |          |          |          |           |
| American Indian or Alaska Native                 | 3        | 1.65     |          |           |
| Asian                                            | 4        | 2.20     |          |           |
| Black or African American                        | 8        | 4.40     |          |           |
| Hispanic/ Latinx                                 | 7        | 3.85     |          |           |
| White                                            | 117      | 64.30    |          |           |
| 2 or more reported                               | 1        | 0.55     |          |           |
| Unreported                                       | 42       | 13.10    |          |           |
| Transition Cohort (2016-2017)                    | 124      |          |          |           |
| Gender                                           |          |          |          |           |
| Female                                           | 71       | 57.30    |          |           |
| Male                                             | 38       | 30.65    |          |           |
| Unreported                                       | 15       | 12.10    |          |           |
| Age                                              |          |          | 56.70    | 9.55      |
| Ethnicity                                        |          |          |          |           |
| American Indian or Alaska Native                 | 0        | 0.00     |          |           |
| Asian                                            | 4        | 3.23     |          |           |
| Black or African American                        | 11       | 8.90     |          |           |
| Hispanic/ Latinx                                 | 4        | 3.23     |          |           |
| Native Hawaiian or Other Pacific Islander        | 1        | 0.81     |          |           |
| White                                            | 63       | 51.01    |          |           |
| 2 or more reported                               | 4        | 3.23     |          |           |
| Unreported                                       | 40       | 32.31    |          |           |
| Sequentially Structured Model Cohort (2019-2020) | 131      |          |          |           |
| Gender                                           |          |          |          |           |
| Female                                           | 91       | 69.47    |          |           |
| Male                                             | 40       | 31.03    |          |           |
| Unreported                                       | 0        | 0.00     |          |           |
| Age                                              |          |          | 51.23    | 10.13     |
| Ethnicity                                        |          |          |          |           |
| American Indian or Alaska Native                 | 0        | 0.00     |          |           |
| Asian                                            | 2        | 1.53     |          |           |
| Black or African American                        | 22       | 17.10    |          |           |
| Hispanic/ Latinx                                 | 9        | 6.90     |          |           |
| Native Hawaiian or Other Pacific Islander        | 0        | 0.00     |          |           |
| White                                            | 66       | 50.40    |          |           |
| 2 or more reported                               | 6        | 4.60     |          |           |
| Unreported                                       | 26       | 20.05    |          |           |

## ***Measures***

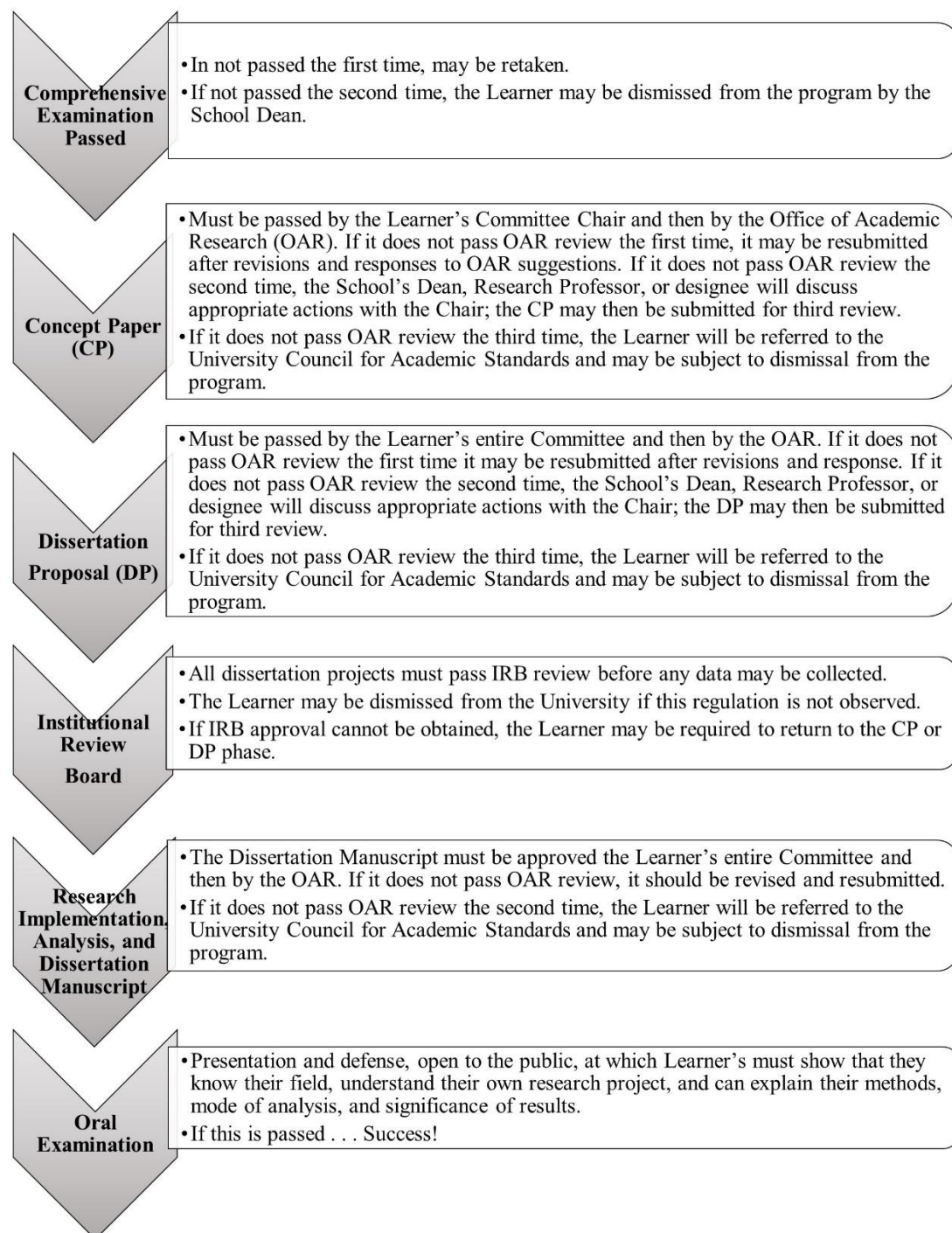
Program data were utilized to collect information on student graduation cohort, dissertation sequence, number of days enrolled in the doctoral program, and demographic data to reflect student characteristics (age, gender, ethnicity).

### **Dissertation Sequence Type**

Prior to 2016, the university utilized a non-structured dissertation model which focused on completion of deliverables. This model reflected common stages used by most universities (i.e. 5 chapters). In 2016 the sequentially structured online dissertation model was implemented, and students who had already begun taking online doctoral courses transitioned to the new model. These students experienced both the previous non-structured model and the new sequentially structured model. Students who began dissertation courses in 2016 experienced only the sequentially structured online dissertation model.

### **Previous Non-Structured Model**

Dissertation courses were 3 credit hours and lasted 12 weeks. Students were required to complete a minimum of 12 credit hours in dissertation courses but were allowed to continue taking dissertation courses until they had reached 7 years from their date of enrollment (in the program), continuing in these courses until oral defense was completed. If the 7-year deadline was reached without successful oral examination, the student would be dismissed from the program. In cases of extenuating circumstances, maximum time to completion could be extended by the Dean. The committee structure included 3 university faculty (1 chair, 2 members). There were 7 milestone deliverables for the previous dissertation sequence (see Figure 2): comprehensive exam, topic paper (abridged literature review, problem statement, purpose statement, and research questions), concept paper (CP; pre-proposal including problem purpose, RQs, research design, theoretical framework), dissertation proposal (DP; builds on CP with clear alignment, scope, more comprehensive literature review, and more developed methodological plan), Institutional Review Board (IRB) application and approval, dissertation manuscript (DM; 5 chapters), and oral examination (telephone, requiring a proctor to certify the student identity; PowerPoint of presentation sent to committee). In addition, specific milestones (CP, DP, DM) were critically reviewed and approved by an outside reviewer.

**Figure 1***Non-Structured Model Dissertation Milestones*

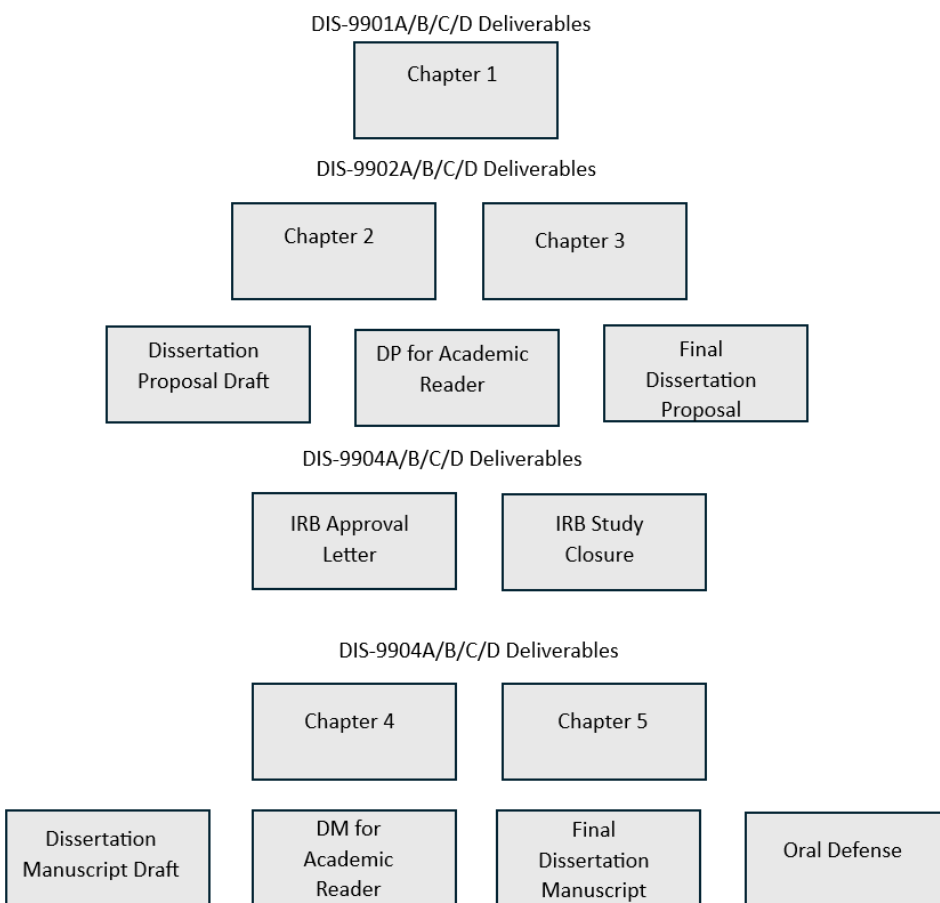
### Sequentially Structured Online Dissertation Model

Developed by faculty and administrators of the university, this model incorporated accountability, quality engagement, and sequential scaffolding of academic skills and student dissertation progress. Online dissertation courses were 3 credit hours. Four blocks of courses are offered with each course block including 1 initial (A) 12-week course, and up to 4 supplemental (B, C, D) 8-week courses. Students were required to complete a minimum of 12 credit hours (A course in all 4 blocks) but if supplemental courses were taken, the required deliverable for each block had to be approved before the end of the supplement D course. If the deliverable was not approved, the student could be dismissed from the program.

The sequentially structured online dissertation model involved three broad stages: preparation and approval of the DP which included chapters 1, 2, and 3; conducting the study's research (IRB approval and data collection); and preparation and approval of the final DM (chapters 1-5), culminating in the dissertation oral defense. Within each course, students submitted progress on specified dissertation components to scaffold learning (course 1: chapter 1). This allowed for ongoing feedback, communication, and an iterative process of revision while constructing components of each chapter. Each chapter of the dissertation must meet minimum standards on an associated rubric, scored by committee chair and SME, for students to progress to the next course sequence block. At the DP and DM stages a third committee member, the Academic Reader (AR), also provides rubric-based evaluation. In this theory-focused dissertation process, the student identifies a researchable problem substantiated through evidence, proposes, and conducts original research.

**Figure 2**

*Deliverables per Dissertation Course Block in the Sequentially Structured Online Dissertation Model*



### Time to Completion

The outcome of interest for this study was number of days students were enrolled in the dissertation sequence of their online doctoral program. Although “enrolled days” is not always an accurate measure of time to completion due to critical life events that might cause prolonged absence (e.g., leaves of absence due to death, pregnancy, etc.), such cases are rare and cannot be controlled. It is reasonable to assume such outlying cases would randomly occur equally in both groups (traditional and sequentially structured). This variable reflected the number of days from a students’ first vested dissertation course start date to the date of successful dissertation defense. In this sample scores ranged from 149-2426 days enrolled in the dissertation sequence (i.e., as a doctoral candidate).

## **Results**

All analyses were calculated using SPSS 22.0 for Windows. Descriptive statistics were calculated to determine the mean scores of days enrolled in the doctoral program. The 182 participants in the previous non-structured dissertation sequence cohort ranged in days to dissertation completion from 303 to 2426 days ( $M = 1043.85$ ,  $SD = 453.74$ ). The 124 participants in the transition cohort ranged in days to dissertation completion from 255 to 2131 days ( $M =$



942.80, SD= 460.72). The 131 participants in the sequentially structured model sequence ranged in days to dissertation completion from 149 to 1807 days ( $M = 760.90$ ,  $SD = 371.67$ ).

Time to completion scores showed unequal variance across groups; therefore, square root transformation was used to obtain equal variances. Levene's test showed that the variances for transformed time to completion scores were not significant,  $F(2, 434) = 1.84$ ,  $p = .159$ , reflecting homogeneity of variance. A one-way analysis of variance showed the effect of cohort was significant,  $F(2, 434) = 17.72$ ,  $p < .001$ . Cohen's  $D$  was calculated, and the effect size for this analysis ( $d = .68$ ) was found to meet Cohen's convention for a medium effect (Lenhard & Lenhard, 2016).

Because cohort group sizes differed slightly, Gabriel's procedure was used to conduct post hoc tests. Results revealed days in the dissertation sequence were significantly lower for the current sequentially structured cohort ( $M = 26.79$ ,  $SD = 6.60$ ) compared to the non-structured model ( $M = 31.55$ ,  $SD = 6.97$ ) ( $p < .001$ ;  $d = .70$ ) and transition cohorts ( $M = 29.81$ ,  $SD = 7.41$ ) ( $p < .01$ ,  $d = .43$ ). The pairwise comparison of the non-structured model cohort and transition cohort was nonsignificant ( $p = .09$ ).

**Table 2**

*ANOVA Comparisons of Number of Days in Dissertation for Model Cohorts*

| Cohort                        | <i>n</i> | Mean  | <i>SD</i> | Gabriel's Procedure Comparisons |            |
|-------------------------------|----------|-------|-----------|---------------------------------|------------|
|                               |          |       |           | Previous Model                  | Transition |
| Non-structured Model          | 182      | 31.55 | 6.97      |                                 |            |
| Transition                    | 124      | 29.81 | 7.41      | .09                             |            |
| Sequentially Structured Model | 131      | 26.79 | 6.60      | < .001                          | < .01      |

## Discussion

The purpose of the current study was to investigate how time to completion for non-clinical online psychology students in a sequentially structured dissertation model differed compared to the previous non-structured model and transitional model cohorts. Timely completion of the dissertation is beneficial in many ways for students, supervisors, programs, and universities (Álvarez-Montero et al., 2014; Ehrenberg et al., 2009; Wao & Onwuegbuzie, 2011). Prolonged dissertation completion can result in the research being outdated and therefore less relevant to the field, additional financial obligations, delayed career advances (Tuckman et al., 1990), and significant additional stress for candidates (Blum, 2010; Kelley & Salisbury-Glennon, 2016), without benefiting students with higher-quality job outcomes or more early career publications (Churchill et al., 2021; Ehrenberg et al., 2010). Perhaps more importantly, programs that emphasize timely completion suffer less attrition (Ehrenberg et al., 2009). Consequently, practices which encourage or support timely completion of great interest and value. Researchers have called for investigation of effectiveness of PhD models, including how

models impact outcomes such as time to completion, quality of dissertations, and building of research capability (Dominguez-Whitehead & Maringe, 2020). Therefore, it was considered necessary to create an online modality that supports timely student progress toward the completion of rigorous dissertation research and investigate the efficacy of this online model on specific time to dissertation completion outcomes. These results suggest a structured, high engagement, dissertation sequence positively impacts time to completion for non-clinical online psychology doctoral students in a context that supports quality dissertations (Author et al., 2020; Hussey et al., 2021). This model aligns with several aspects of transactional distance theory (Moore, 1997), but in ways that may not be immediately evident. Flexible course structure, support for regular quality engagement with the committee chair, and development of autonomy allows for less transactional distance between chair and student. While student autonomy is supported by the flexibility of each course within the sequentially structured online model, the sequential structure of the overall online model serves as a guidepost helping chairs to identify which students may need increased support (less autonomy).

The current findings are particularly interesting, in that the sequentially structured model cohort, which had significantly shorter time to completion compared to both other cohort groups, included doctoral students who graduated in 2019 and 2020. Many of those completing their dissertation in 2020 would have experienced additional challenges conducting research during the COVID-19 pandemic, delaying progress (Covington & Jordan, 2022; Soria et al., 2020). Other challenges such as home schooling children during school lockdowns and working from home had strong impacts on doctoral students (Boone et al., 2020; Levine et al., 2021) including increased anxiety and decreased dissertation productivity due to distractions, stress, and reduced motivation and ability to concentrate (Fraenza & Palermo-Kielb, 2022). These stressors may have been particularly salient for doctoral student mothers (Boon et al., 2020; Levine et al., 2021). In our sample, 69% of the sequentially structured model cohort were female. This may indicate that females were able to thrive within structure, scaffolding, and faculty engagement supported by the model, experiencing shorter time to completion despite pandemic disruptions that would arguably have had deleterious effects, especially for women. However, the current research should be extended to consider time to graduation for students experiencing the sequentially structured model when a largely female doctoral enrollment would not potentially be disproportionately impacted by parenting responsibilities in addition to stressors of a pandemic.

Research suggests up to 60% of graduate students regularly procrastinate academic tasks (Onwuegbuzie, 2004; Rahimi & Hill, 2021). Svartdal et al. (2020) suggest that poor self-regulation is a key contributor to procrastination that is amplified by a “procrastination friendly” academic environment. They also recommend the use of short deadlines whenever possible and focus on development of student self-regulation skills to support student success; higher levels of self-regulating learning have been linked with shorter time to completion for doctoral students (Kelley & Salisbury-Glennon, 2016). Song and Kim (2020) proposed that self-regulated learning can be scaffolded by facilitating graduate students’ “planning, goal setting, self-monitoring, and self-evaluating processes, and to promote learners’ motivation and use of learning strategies in online courses” (p. 251). The sequentially structured model was designed to incorporate short-term scaffolded goals and to emphasize reflectiveness regarding student progress (among students and faculty). This model supports self-regulated academic progress reminiscent of

Ericsson's (1993) deliberate practice that leads to expert performance but also aligns with phases common to self-regulated learning models (Panadero, 2017): planning and goal setting; self-monitoring of effort and time management during task performance; and self-evaluating outcomes and progress, regulating and adapting to improve success. The weekly submissions embedded in the model support regular interaction with faculty, offering the opportunity to develop and maintain relatedness and connection, key psychological aspects of motivation supported by the theory and research surrounding self-determination theory (Ryan & Deci, 2017). Further, the weekly submissions reflect short-term goals (short deadlines) in addition to the intermediate deliverables (chapters of the dissertation) which are the focus of each course block. These chapter deliverables also reflect comparatively shorter-term successes that scaffold overall dissertation completion. In keeping with the core principles of goal theory, transactional distance theory, and previous research (Geven et al., 2018; Locke & Latham, 2002; Kelley & Salisbury-Glennon, 2016; Moore, 1997), it seems likely that implementing short-term and intermediate deadlines, fostering engagement with faculty, and supporting student self-regulation contribute to shorter time to completion for students in the sequentially structured model.

Results of the current study suggest that the sequentially structured online dissertation model presents a format to improve time to completion and produce quality dissertation work, while allowing open enrollment for online psychology doctoral students. As more higher education research students utilize online settings to complete their degree (due to demand or circumstances such as the COVID-19 pandemic), universities must implement best practices to support student success and support faculty in remote teaching. The current findings were limited in that only online psychology doctoral students who successfully defended their dissertation were included. Future research is needed to investigate the impact of this online model on attrition during the doctoral candidacy stage. Another limitation was that the researchers were unable to control for potential effects of students' stage of progress during transition to the sequential model. Future research would benefit from an investigation of the attrition frequency among the graduating cohorts and evaluation of dissertation success across individual level factors (i.e., demographics). Due to the archival nature of the dataset, the research was limited by the inability to consider demographics as covariates, as the multiple data sources did not link demographic data to outcome data. Recent studies have been inconsistent regarding socio-demographic factors, but suggest that gender, employment status, and funding may play a role in doctoral outcomes (Cornwall et al., 2019; Yusuf et al., 2020). Other research suggests near gender parity in time to dissertation completion for online doctoral programs (Chinta et al., 2019), although changes in dissertation chair did increase time to completion for women compared to men. Other US research found no gender differences in mental health, well-being, or work-life balance for doctoral students (Yisuf et al., 2020). Churchill et al. (2022) suggest improving educational outcomes for higher degree research students requires identification of modifiable factors linked with time-to-completion at an institution or program-level. For the online psychology doctoral program at this university, it could be valuable to identify socio-demographic factors which influence student's experience with the sequentially structured model. While socio-demographic factors may not be strengthened or encouraged within a dissertation model, understanding the role of student characteristics may help optimize structural supports of the model that interact with such variables.

Future research could focus on individual factors for success that may be strengthened or encouraged within the sequentially structured model. It remains unclear how a sequentially structured online dissertation model may affect the development of student non-academic characteristics (e.g., goal orientation, motivation, connectedness, mindset, perceived autonomy) that may have played a role in online doctoral student success or timely progression (Chao et al., 2017; Lake et al., 2018; Posselt, 2018; Rockinson-Szapkiw et al., 2016; van Rooij et al., 2021). It is imperative that future research determines how the sequential online model may foster student development of success-related skills and characteristics. Indeed, academic rigor and skill alone may be insufficient to prepare the student holistically to be competent, determined, motivated, and resilient in their goal pursuits (van Rooij et al., 2021; Posselt, 2018; Ryan & Deci, 2017).

Future research on models of online doctoral education should investigate development of conscientiousness and goal setting among students in a sequential model in contrast to traditional or alternative models. In addition to conscientiousness and goal-setting behaviors, variables related to student engagement with chair and institution, such as feelings of relatedness and belonging (van Rooij et al., 2021), should be explored in relation to student effort, focus, strategy evaluation and modification, and regimentation, or structure, all of which were factors that Ericsson (2018) identified among individuals who gained expertise in a skill set. Other research should investigate how engagement-related factors impact loyalty (e.g., student referrals) and goal-completion (e.g., dissertation success), given findings on the importance of peer and mentor relationships for the success and satisfaction of online doctoral students (Kumar & Koe, 2017; Pollard & Kumar, 2021; Torres et al., 2021).

Given the enormity of stress, trauma, and uncertainty facing a modern society struggling to normalize after a pandemic, it is important to develop new strengths in students on paths to earn doctorates, which may support career advancement, entrepreneurship, and social leadership. The sequentially structured online dissertation model appears to develop strengths in students through specific, deliberate goal-directed behavior energized by proximal goal setting (i.e., conscientiousness, goal-setting, motivated behavior), strategic guidance from a mentor (i.e., engagement, one-to-one teaching, co-understanding), progress evaluation and approach modification (i.e., feedback loops, reflection, and attenuation), and social support and community (i.e., relatedness, resourcefulness). There are implications from the current study that the online dissertation process can be improved to mutually benefit all stakeholders—students, faculty, staff, administration, alumni, and communities—while upholding the accessibility, flexibility, and access offered by online open-enrollment doctoral programs.

### **Conflict of Interest Disclosure**

To the best of our knowledge, the named authors have no conflict of interest, financial or otherwise.

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# Investigating the Effects of Direct Instruction and Facilitated Discourse on Social and Cognitive Presence in Blended Learning

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## Abstract

Community of Inquiry—a theoretical framework that consists of three interrelated elements: teaching presence, social presence, and cognitive presence—has been used widely in online and blended learning as an instructional design model to create and sustain conditions that facilitate meaningful learning in a learning community. Teaching presence is often regarded as the most important element for developing and maintaining social and cognitive presence and directing the community for purposeful learning. However, little is known about the effects of sub-dimension of teaching presence on social and cognitive presence. This study examined the effects of two components of teaching presence: direct instruction and facilitated discourse on social and cognitive presence in blended learning. Data was gathered from 466 blended learning students in higher education using the Community of Inquiry Survey. Results from structural equation modelling revealed that social presence has (i) a full mediating effect in the relationship between direct instruction and cognitive presence, and (ii) a partial mediating effect on the relationship between facilitated discourse and cognitive presence. The finding provides valuable insights into how direct instruction and the facilitation of discourse shape social and cognitive presence.

**Keywords:** Blended learning, community of inquiry, teaching presence, social presence, cognitive presence, facilitating discourse, direct instruction

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With the global spread of online and blended learning, one of the key challenges colleges and universities face is to ensure that online teaching compensates for the lack of face-to-face presence of lecturers, and that their online and blended courses have the same quality as the conventional face-to-face programs (Morueta et al., 2016; Rasheed et al., 2020; Zhang et al., 2016). The Community of Inquiry (CoI) theoretical framework (Anderson et al., 2001; Garrison et al., 2000, 2001) was developed to address challenges in developing meaningful learning experiences in online and blended learning environments (Moore & Miller, 2022). The CoI theoretical framework consists of three core elements—teaching presence, social presence, and cognitive presence—that interact and influence each other to create a learning community that supports worthwhile learning experiences. This study aims to explore how direct instruction and the facilitation of discourse influence both social and cognitive presence.

Research suggests that each of the three elements of the CoI framework significantly contributes to develop and sustain a functional community of inquiry (Aslan & Turgut, 2021; Guo et al., 2021; Law et al., 2019; Shea & Bidjerano, 2009). However, teaching presence is often regarded as the most important and crucial of the three CoI presences (Dempsey & Zhang, 2019; Martin et al., 2022), probably because the primary function of teaching presence is to play the lead role in creating and maintaining a favourable climate in the learning community for collaborative inquiry (Garrison, Cleveland-Innes, et al., 2010). Establishing and maintaining a purposeful community of inquiry in online and blended learning begins with teaching presence (Garrison & Cleveland-Innes, 2005; Stillman-Webb et al., 2023), and it provides leadership, structure, and guidance that binds learners and instructors as a learning community without their physical presence (Garrison & Cleveland-Innes, 2005). Teaching presence was shown to have significant influence on learner satisfaction, motivation, learning engagement, perceived learning, and sense of learning community (Adam et al., 2023; Garrison, 2007; Martin et al., 2022; Wang, 2022).

Teaching presence is defined as the design, facilitation, and direction of cognitive and social presence for the purpose of developing an effective learning experience (Garrison, 2007). Teaching presence consists of three sub elements; design and organisation, facilitated discourse, and direct instruction (Anderson et al., 2001). Design and organisation reflects the process of planning including setting the curriculum, designing learning activities, and establishing timelines; facilitated discourse focuses on establishing a learning climate, maintaining interest, motivation, and purposeful collaboration; and direct instruction provides information and direction to members of the learning community and ensures that individuals achieve the intended learning outcomes (Anderson et al., 2001; Caskurlu, 2018).

More than a decade ago, in an article that reviewed the issues identified from research on the CoI presences in learning communities, Garrison (2007) emphasised the importance of teaching presence for a functional community and the significance of the roles of facilitated discourse and direct instruction in online teaching. He argued that “the teaching presence must consider the dual role of both moderating and shaping the direction of the discourse.” Both the roles are crucially important for an effective community of inquiry (p. 69). Shea et al. (2006) found direct instruction and facilitated discourse together contributed the most to predicting a sense of community and learning. Given the importance of direct instruction and facilitated discourse in developing and sustaining an effective community of inquiry, it is of vital

importance to extend our understanding about the roles of direct instruction and facilitated discourse on creating social and cognitive presence. However, up to now, far too little attention has been paid to investigate the effects of direct instruction and facilitated discourse on forming and sustaining a community of inquiry. Hence, this study investigates the effects of direct instruction and facilitated discourse on social and cognitive presence.

## **Review of the Related Literature**

### ***Social Presence***

Social presence is defined as the degree to which participants in a learning community feel connected to each other (Swan et al., 2009). Social presence consists of affective expression, open communication, and group cohesion (Garrison, Anderson, et al., 2010). Affective expression includes learners' sharing emotional expressions, feelings, beliefs, and values, and it reflects the emotional climate of the community and the acceptance of the individual as a member of the learning community; open communication refers to expression of ideas and opinions across the learning community, and it reflects purposeful nature of community; and group cohesion refers to sense of belonging, interaction and identification with other members of the learning community, and it reflects the collaborative nature of community (Akyol & Garrison, 2008; Dempsey & Zhang, 2019; Garrison, Anderson, et al., 2010; Swan et al., 2009). The purpose of social presence in a community of inquiry is to provide a climate for cognitive presence. According to Garrison (2007), "social presence is of less importance if the learning activities are information acquisition" and does not require collaborative inquiry (p.63). He argued that social presence should move beyond establishing socio-emotional presence and personal relationships and should create purposeful relationships to achieve educational objectives of the learning community.

### ***The Mediating Effect of Social Presence on Cognitive Presence***

The CoI framework aims to establish and sustain a learning community for a worthwhile educational experience. Within this framework, social presence plays a crucial role in binding learners into a purposeful community, providing the social means for collaboration and critical discourse necessary to achieve the educational objectives of the learning community. Social presence is a fundamental aspect of collaboration and critical discourse as it facilitates achieving cognitive objectives of learning by mediating critical thinking in a learning community (Mutezo & Maré, 2023). It provides a social, emotional, and collaborative learning climate through the development of interpersonal relationships among the members of the learning community (Annand, 2011). Thus, social presence acts as an essential antecedent for collaboration and critical discourse.

However, as posited by the CoI framework, social presence needs to be guided by teaching presence. It is unlikely that students' social interactions will naturally progress to purposeful educational engagement and critical discourse without such guidance. This conceptualization of the role of social presence is supported by several studies (e.g., Garrison & Cleveland-Innes, 2005; Li, 2022; Mutezo & Maré, 2023; Padmawidjaja et al., 2022; Shea & Bidjerano, 2009). According to these studies, social presence plays a mediating role in the relationship between teaching presence and cognitive presence.

Contrary to the findings that suggest the mediating role of social presence in the relationship between teaching presence and cognitive presence, Kozan (2016) argued that it was cognitive presence that influenced social presence, not the other way round. By comparing several possible models using structural equation modelling, Kozan (2016) demonstrated the possibility of two equally good structural equation models in terms of their fit indices—the first model included social presence as a partial mediator between teaching presence and cognitive presence, and the second one included cognitive presence as a full mediator between teaching presence and social presence. He concluded that it was cognitive presence rather than social presence that mediated the relationship, arguing that the model that included cognitive presence as full mediator between teaching presence and social presence was more parsimonious. More recently, Dempsey and Zhang (2019) re-examined similar models—in one model social presence was hypothesised to mediate the relationship between teaching presence and cognitive presence, and in the second model cognitive presence was assumed to mediate the relationship between teaching presence and social presence. They also found that the two models were equally good, supporting the finding of Kozan (2016). However, by referring to Kline (2015), Dempsey and Zhang (2019) argued that it would not be possible to derive a preferred model based on global fit indices criteria since the fit indices for all equivalent models will be the same. In structural equation modelling, the model preferred should be based on theoretical and conceptual grounds (Collier, 2020), and as Dempsey and Zhang (2019) argued, theoretically it makes little sense to view social presence as a response variable or intended outcome of the community of inquiry. The ultimate purpose of teaching and social presence is to enhance cognitive engagement, therefore, social presence can either be an independent variable or mediating variable.

### ***Cognitive Presence***

Cognitive presence is defined as the extent to which participants are able to “construct and confirm meaning through sustained reflection and discourse” (Garrison & Arbaugh, 2007, p. 161). The practical inquiry model by Garrison et al. (2001) illustrates how cognitive presence is operationalized into the four progressive phases of practical inquiry: triggering event, exploration, integration, and resolution. The first phase of practical inquiry—the triggering event—refers to identification of a problem or issue that needs to be resolved. The second phase—the exploration phase—involves exploring and gaining information regarding the identified problem through critical reflection and discourse. The third phase—the integration phase—involves constructing meaning from the information obtained in the exploration phase. The final phase—the resolution phase—involves selecting and testing the new knowledge to determine its suitability for resolving the identified problem. According to the practical inquiry model, reflection, structured collaborative interaction, and discourse are crucial for higher levels of cognitive presence and deep meaningful learning.

Cognitive presence is an important indicator of the quality of the learning experience in online and blended learning (Sadaf et al., 2021). Deep engagement in learning requires cognitive presence (Kucuk & Richardson, 2019). Cognitive presence indicates the extent to which learners are able to construct knowledge through interaction and guided discourse in the learning community, thus, it reflects the extent to which learning objectives are achieved (Gutiérrez-Santiuste et al., 2015). Learning results from integration of external interactions between the learner and the environment and an internal acquisition process involving cognition (Illeris, 2018). Thus, how meaningful one’s learning experience depends on the level of cognition involved in the learning process.

The practical inquiry model elaborates the cognitive process in learning by demonstrating the key phases involved in the interaction between, what Illeris (2018) described as, the “shared and private world” of the learner. Therefore, in a community of inquiry, the primary purpose of teaching and social presence should be to enhance cognitive presence by providing and facilitating conditions required for practical inquiry. While teaching presence provides structure and leadership, social presence provides a condition for collaborative interaction and a suitable external environment for meaningful learning experience (Garrison, Cleveland-Innes, et al., 2010). Studies demonstrated that both teaching and social presence have significant impact on cognitive presence and learning (Gutiérrez-Santiuste et al., 2015).

### ***Teaching Presence and Its Impact on Social and Cognitive Presence***

In order to better understand the interactive and interrelated nature of the CoI presences and the role of teaching and social presence in developing and enhancing cognitive presence, it is important to note that the framework is based on social constructivist approaches to learning (Castellanos-Reyes, 2020; Garrison, 2007). Social constructivist theorists assert that learning is socially situated and knowledge is constructed as a result of social interaction. In this view, the process of learning works from outside in. A social constructivist approach reflects the importance of social context, the crucial role of communication, and collaboration in the learning process. The role of a teacher as a mentor and a facilitator is to create and use appropriate social context favourable for learning or constructing knowledge, and learning activities provided should be carefully planned and socially supported to stimulate both the social and inner processes of learning. Parallel to this perspective, the role of teaching presence in the community of inquiry theoretical framework is to regulate and bring together social and cognitive presence (Kreijns et al., 2014).

Teaching presence, which originates from course design and continues with what the instructor does to direct and facilitate learning, plays the leading role in developing and maintaining community climate. Existing research recognizes the crucial role played by teaching presence in establishing and maintaining community of inquiry (Shea et al., 2006; Shea & Bidjerano, 2009). Zhang et al. (2016) found that teaching presence has a significant positive effect on constructivist and interactive learning engagement. It has also been shown that teaching presence and its sub-constructs are crucial for establishing a community of inquiry and meaningful learning (Garrison & Cleveland-Innes, 2005a; Zilka et al., 2018). According to Vaughan et al. (2013); teaching presence brings together and directs social and cognitive presence to achieve educational objectives of the learning community. Evidence indicates student perception of teaching presence has a causal effect on social presence and cognitive presence (Garrison & Cleveland-Innes, 2005; Geng et al., 2019; Kozan, 2016; Kozan & Richardson, 2014; Law et al., 2019; Shea & Bidjerano, 2009). According to Wang (2022), sub-constructs of teaching presence explained 53% and 57% of cognitive and social presence respectively.

### ***Direct Instruction and Facilitated Discourse***

Once the design and organisation phase of a course is completed, and its implementation begins, teaching presence consists mainly of direct instruction and facilitated discourse. Direct instruction describes the role of instructor as the provider of intellectual and scholarly leadership through sharing subject matter knowledge with students (Anderson et al., 2001). Direct

instruction includes assessing the accuracy of student understanding, providing feedback in a timely manner, introducing new information, guiding discussions, and scaffolding construction of new knowledge (Garrison, Cleveland-Innes, et al., 2010; Zhang et al., 2016). Through direct instruction, the instructor helps students to focus on relevant issues, and to identify their strengths and areas of improvement in relation to their course objectives (Garrison & Arbaugh, 2007). The assessment and feedback are important components of direct instruction. Assessment informs direct instruction through diagnosing the needs of learners, and timely feedback guides learners towards achieving educational objectives. The other component of teaching presence, facilitated discourse, is conceptualised as the means by which the instructor facilitates students' interaction with subject matter provided and with each other for the purpose of developing personal meaning and understanding (Anderson et al., 2001). Through facilitated discourse, the instructor sets a climate for learning, helps students engage in discussions in a productive way, identify areas of agreement and disagreement, clarify their thinking with course topics, explore new concepts; facilitated discourse also reinforces student contributions (Anderson et al., 2001; Shea et al., 2006).

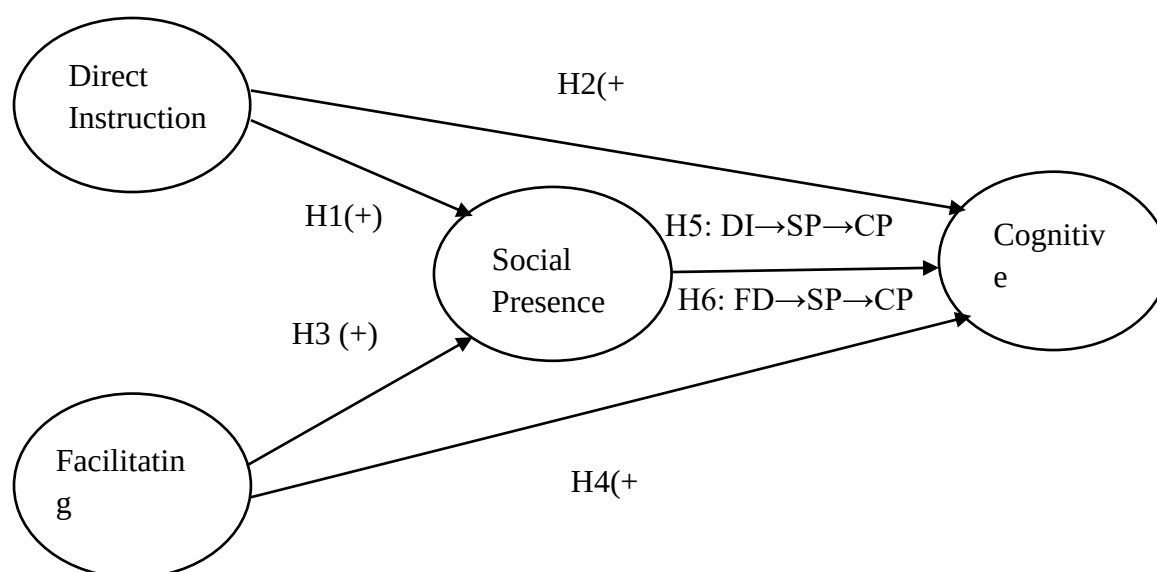
The CoI theoretical framework and existing research suggests that direct instruction and facilitated discourse will have positive influence on social and cognitive presence. According to Hosler and Arend (2012), direct feedback that is specific, timely, and encouraging, and facilitated discussions that keep students motivated and meaningful have strong influence on students' critical thinking. A qualitative analysis in a mixed-method study by Miller (2022) found that feedback—an indicator of direct instruction—provided by the instructor had a positive influence on student perceptions of social presence, however, the quantitative analysis of the study showed no significant change in student perceptions of social presence. In addition, Wang (2022), who examined the relationships among different dimensions of the CoI presences, found that facilitated discourse had a significant positive correlation with cognitive presence, as well as with social presence; direct instruction, on the other hand, exhibited a significant positive correlation with cognitive presence, but not with social presence. Overall, these studies suggest that both direct instruction and facilitated discourse play a role in developing social and cognitive presence in a learning community.

### ***The Current Study***

Drawing from the CoI theoretical framework (Anderson et al., 2001; Garrison et al., 2000, 2001) and existing research on the causal effect of teaching presence on social and cognitive presence (Dempsey & Zhang, 2019; Garrison, Cleveland-Innes, et al., 2010; Garrison & Cleveland-Innes, 2005b; Li, 2022; Moore & Miller, 2022; Mutezo & Maré, 2023; Shea & Bidjerano, 2009; Wang, 2022), this study developed the hypothesised model shown in Fig 1.

### **Figure 1**

*Hypothesised Structural Relationship Among Direct Instruction, Facilitating Discourse, Social Presence and Cognitive Presence*



The study hypotheses were as follows:

- H1: Direct instruction will have a positive direct effect on social presence.
- H2: Direct instruction will have a positive direct effect on cognitive presence.
- H3: Facilitated discourse will have a positive direct effect on social presence.
- H4: Facilitated discourse will have a positive direct effect on cognitive presence.
- H5: Direct instruction will have a positive indirect effect on cognitive presence through social presence.
- H6: Facilitated discourse will have a positive indirect effect on cognitive presence through social presence.

## Research Method

### *Participants*

In this study, blended learning refers to an instructional model that integrates face-to-face and online learning, with over 30% of the content delivered online. The participants were students enrolled in blended learning courses from three higher education institutes in the Maldives. The inclusion criteria were continuing blended learning students who completed one semester of blended learning at the selected institutes. A total of 466 students from various disciplines including education, nursing, hospitality and tourism studies, and business and management participated in the study. The participants age ranged from 18 to 45 years, and 68% were females while 32% were males. The relatively large number of female students in the study was due to the high proportion of females in the study population at the time of data collection. According to the Ministry of Higher Education (2020), 64% of the total percentage of students pursuing higher education were female students during data the collection period.



Participation was voluntary with informed consents. Information about the study and invitation to participate were given through a faculty member and through online invitation with informed consent and the survey link. Table 1 provides demographic information of respondents of this study.

**Table 1**

*Participant Demographics*

| Demographic Profile |              | Frequency (N=466) | Valid Percentage |
|---------------------|--------------|-------------------|------------------|
| Gender              | Female       | 317               | 68%              |
|                     | Male         | 149               | 32%              |
| Age                 | Below 20     | 23                | 4.9%             |
|                     | 21-30        | 258               | 55.4%            |
|                     | 31-40        | 147               | 31.5%            |
|                     | 41 and above | 38                | 8.1%             |

**Measures**

This study used the Community of Inquiry survey questionnaire (Arbaugh et al., 2008) to measure students' perception of direct instruction, facilitated discourse, social presence and cognitive presence. Participants responded to the questionnaire on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree) with a midpoint of neither agree or disagree.

Direct instruction was measured using 3 items (e.g., the lecturer helped to focus discussion on relevant issues in a way that helped course participants to learn), and facilitated discourse was assessed using 6 items (e.g., the lecturer helped the course participants in learning activities in a way that helped me to learn).

Social and cognitive presence were assessed using 9 and 12 items respectively. The social presence scale consists of 3 subcategories and each one of the subcategories was measured using 3 items. The subcategories were "affective expression" (e.g., I was able to form distinct impressions of some course participants), open communication (e.g., I felt comfortable participating in the course discussion), and group cohesion (e.g., I felt comfortable disagreeing with other course participants while still maintaining a sense of trust). Cognitive presence consists of 4 subcategories; each one was assessed using three items. The subcategories were triggering event (e.g., Problems posed increased my interest in course issues), exploration (e.g., I utilised a variety of information sources to explore problems posed in this course), integration (e.g., Combining new information helped me answer questions raised in course activities, and resolution (e.g., I have developed solutions to course problems that can be applied in practice).

**Data Analysis**

First, a preliminary analysis was conducted to prepare data for final analysis. Data was first checked for accuracy and suitability for analysis. Questionnaires with a large percentage of missing information and questionnaires with suspicious missing patterns—such as all extreme values—were not included in the analysis. The resulting sample included 466 students. The percentage of missing data was less than 2.5% and missing data was missing at random. According to Cokluk and Kayri (2011) when the missing data is small, missing data can be

treated with any treatment methods as the result will be similar. This study employed Expectation-Maximization method to estimate the missing data. After the missing data treatment, data was analysed for normality by examining Skewness and Kurtosis indices. All the Skewness and Kurtosis values were within acceptable range, suggesting no serious violation of the normality assumptions.

Second, confirmatory factor analysis containing both first order (direct instruction, facilitated discourse) and second order factor analysis (social and cognitive presence) was conducted to determine the factor structure of the measures via maximum likelihood estimation procedure using AMOS 20 software. Finally, structural relationships among the observed variables was examined using structural equation modelling. Along with the relative chi-square test, this study used fit indices (CFI, TLI, NFI, and IFI) suggested by Bentler and Benett (1980), and values greater than .90 are regarded as an acceptable fit. For the relative chi-square test, a value less than 3 is considered good (Kline, 2015). For the mediation analysis, this study examined the direct effect, and the indirect effect while controlling for the direct effect Hayes (2022), with a bootstrap sample of 5,000 as suggested by Collier (2020).

## Results

The CFA results showed that the measurement model fits the observed data well and confirms the reliability and validity of the measures (relative chi-square test value = 1.427, CFI = 0.986, TLI = 0.984, NFI = 0.954, IFI = 0.986 and RMSEA = 0.030). As shown in Table 2, the factor loadings of items of direct instruction and facilitated discourse, and subconstructs of social and cognitive presence were all greater than 0.70. The average variance extracted (AVE) for each construct was greater than 0.50, indicating sufficient degree of convergent validity (Fornell & Larcker, 1981). Composite reliability values for the constructs were also greater than the accepted minimum of 0.70 recommended by Hair et al. (1998).

**Table 2**

*Standardised Factor Loading, T-Values, and Composite Reliability of Measurement Scale*

| Construct                                                                                                                           | Standardised Factor Loading | t-value |
|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|---------|
| <b>Direct Instruction</b> (CR=.867, AVE=0.685)                                                                                      |                             |         |
| – The lecturer helped to focus discussion on relevant issues in a way that helped course participants to learn                      | .904                        | 19.081  |
| – The lecturer provided feedback that helped me understand my strengths and weaknesses relative to the course goals and objectives. | .802                        | 24.442  |
| – The lecturer provided feedback in a timely fashion                                                                                | .772                        | *       |
| <b>Facilitating Discourse</b> (CR=.931, AVE= .691)                                                                                  |                             |         |
| – The lecturer was helpful in identifying areas of agreement and disagreement on course topics that helped me to learn              | .791                        | 19.429  |
| – The lecturer was helpful in guiding participants towards understanding course topics in a way that helped me clarify my thinking  | .827                        | 20.731  |

|                                                                                                          |      |        |
|----------------------------------------------------------------------------------------------------------|------|--------|
| - The lecturer helped to keep course participants engaged and participating in productive dialogue.      | .860 | 22.024 |
| - The lecturer helped course participants on learning activities in a way that helped students to learn. | .866 | 22.214 |
| - The lecturer encouraged course participants explore new concepts                                       | .815 | *      |
| - Lecturer actions reinforced the development of a sense of community among course participants          | .827 | 25.440 |
| <b>Social presence</b> (CR=.862, AVE= .676)                                                              |      |        |
| - <i>Affective Expression</i> items                                                                      | .787 | 12.596 |
| - <i>Open Communication</i> items                                                                        | .818 | 15.176 |
| - <i>Group Cohesion</i> items                                                                            | .860 | *      |
| <b>Cognitive Presence</b> (CR=.929, AVE= .766)                                                           |      |        |
| - <i>Triggering Event</i> items                                                                          | .834 | *      |
| - <i>Exploration</i> items                                                                               | .905 | 17.769 |
| - <i>Integration</i> items                                                                               | .913 | 18.215 |
| - <i>Resolution</i> items                                                                                | .845 | 15.030 |

\*= Items constrained for identification purposes

C.R= Composite Reliability

AVE = Average Variance Extracted

The result of structural equation modelling showed that relative chi-square was 1.424, which is below the acceptable maximum of 3. The CFI, TLI, NFI and IFI (CFI = 0.986, TLI = 0.984, NFI = 0.954, IFI = 0.986) were all greater than 0.90. Similarly, the RMSEA was .030, which is below the acceptable maximum of .05. The coefficient of determination (R squared) values for the endogenous construct social and cognitive presence suggests that direct instruction and facilitating discourse explained 41% variance in social presence, and direct instruction, facilitating discourse and social presence contributes 69% in estimating cognitive presence.

**Table 3**  
*Results for Hypothesized Relationships*

| Hypothesised relationships                      | Standardised estimates | t-values | P value | Results       |
|-------------------------------------------------|------------------------|----------|---------|---------------|
| H1: Direct instruction → Social Presence        | 0.414                  | 4.229    | < .001  | Supported     |
| H2: Direct instruction → Cognitive presence     | 0.097                  | 1.249    | .212    | Not supported |
| H3: Facilitating Discourse → Social Presence    | 0.253                  | 2.678    | <.01    | supported     |
| H4: Facilitating Discourse → Cognitive Presence | 0.283                  | 3.880    | < .001  | supported     |
| <b>Squared multiple correlation (R-squared)</b> |                        |          |         |               |

|                    |      |
|--------------------|------|
| Social Presence    | 0.41 |
| Cognitive Presence | 0.69 |

The analysis of the structural model, as shown in Table 3, revealed that facilitated discourse had a significant positive direct effect on both social presence (H3) and cognitive presence (H4). The direct instruction had a significant positive direct effect on social presence (H1), however, the effect of direct instruction on cognitive presence was not significant (H2). The mediation analysis of structural models showed (see Table 4) that the indirect effects of direct instruction (H5) and facilitated discourse (H6) on cognitive presence through social presence were both significant. This implies that social presence acted as a full mediator in the relationship between direct instruction and cognitive presence and partial mediator in the relationship between facilitated discourse and cognitive presence.

**Table 4**  
*Results of Mediation Analysis*

| Relationships                                                       | Direct effect | Indirect effect | Confidence interval |       | P value  | Conclusion        |
|---------------------------------------------------------------------|---------------|-----------------|---------------------|-------|----------|-------------------|
|                                                                     |               |                 | Low                 | High  |          |                   |
| Direct instruction →<br>Social presence →<br>Cognitive presence     | 0.097         | 0.228           | 0.115               | 0.381 | p < .001 | Full mediation    |
| Facilitating discourse →<br>Social presence →<br>Cognitive presence | 0.253         | 0.515           | 0.015               | 0.269 | p < .001 | Partial mediation |

## Discussion

Prior studies have investigated combined effects of sub-constructs of teaching presence on social and cognitive presence (Garrison, Cleveland-Innes, et al., 2010; Kozan, 2016; Kozan & Richardson, 2014; Li, 2022; Mutezo & Maré, 2023; Padmawidjaja et al., 2022). This study took a further step by investigating the effects of direct instruction and facilitated discourse of teaching presence on social and cognitive presence. The purpose of the study was to determine how direct instruction and facilitated discourse influence the development of social and cognitive presence. As mentioned earlier, it was hypothesised that direct instruction and facilitated discourse would influence social and cognitive presence, and the effect of direct instruction and facilitated discourse on cognitive presence would be mediated by social presence (Garrison, Cleveland-Innes, et al., 2010).

### ***Effects of Direct Instruction on Social and Cognitive Presence***

With regards to direct instruction, the finding suggests significant indirect effects on cognitive presence through social presence. This means that direct instruction helps students to feel a sense of belonging to the learning community and encourages social interaction which in turn helps them to engage cognitively and collaboratively to construct personal understanding and construction of knowledge. The finding is consistent with conceptualization of direct instruction as defined in the CoI theoretical framework and its role as “sustaining respect and responsibility (social) and inquiry through resolution (cognitive)” (Dempsey & Zhang, 2019, p. 65). The finding supports Shea et al. (2006) who confirmed that strong and active involvement of instructor in direct instruction and facilitated discourse is associated with students’ sense of connectedness and learning, and Akyol et al. (2011) who found students’ perception of direct facilitation is associated with higher level of learning and sense of learning community. Earlier research suggests that the instructor's ability to provide effective direct instruction (e.g., the instructor’s ability to focus discussions on relevant issues and give feedback that help to understand) contributes significantly in their learning (Kupczynski et al., 2010). Overall, in addition to confirming the positive association of direct instruction with social and cognitive presence reported in previous studies, the current study contributes to the literature by revealing the direction of the relationship among these variables and identifying their roles in the relationship. The implication is that instructors aiming to facilitate cognitive presence through direct instruction should recognize the role of social presence in enhancing students' critical thinking and cognitive presence.

Concerning the direct effect, even though the study hypothesized that direct instruction would have a positive direct effect on cognitive presence, the results indicate that there was no significant direct effect from direct instruction to cognitive presence. This means the relationship between direct instruction and cognitive presence was fully mediated by social presence. The finding is consistent with the roles of direct instruction and social presence in a learning community. In a community of inquiry, the role of direct instruction is to provide scholarly guidance, where learning depends heavily on collaborative interaction among the members. The purpose of social presence is to facilitate learning by providing a favorable social climate for these interactions.

Prior studies indicated that teaching presence (the aggregate effect of course design, direct instruction, and facilitated discourse) had both direct and indirect effects on cognitive presence (Garrison, Cleveland-Innes, et al., 2010; Gutiérrez-Santiuste et al., 2015; Mutezo & Maré, 2023; Padmawidjaja et al., 2022). Since these studies investigated the combined effect of teaching presence factors on cognitive presence through social presence, their findings may not contradict the findings of the current study. In fact, the specific effect of each component of teaching presence can differ from the aggregate effect. Further studies could explore the difference between the specific effects of teaching presence and its combined effect on social and cognitive presence.

The study contributes to the literature by investigating the specific role played by direct instruction and revealing social presence as a full mediator between direct instruction and cognitive presence. The finding indicates that elements of direct instruction, such as presenting

content, asking relevant questions, focusing discussions on relevant issues, assessing learning, clarifying misconceptions and providing timely explanatory feedback, enhance students' social presence, which in turn contributes to a meaningful learning experience

### ***Effects of Facilitated Discourse on Social and Cognitive Presence***

The results of this study revealed that facilitated discourse had a direct effect on both social and cognitive presence. This suggests that actively encouraging and managing discussions and interactions among participants directly enhances students' ability to project themselves socially and emotionally in a community (social presence). It helps students feel more connected and engaged with each other, fostering a sense of belonging and interpersonal relationships. Facilitated discourse also promotes deeper thinking, critical analysis, and a better understanding of the material, thereby enhancing the overall learning experience (cognitive presence). The finding implies that when discussions are effectively guided, they not only improve the social dynamics within the group but also enhance intellectual engagement and learning outcomes.

The finding confirms Wang (2022) who demonstrated significant positive correlation between facilitated discourse and social presence and facilitated discourse and cognitive presence. The finding is also consistent with evidence from a number of earlier studies on facilitated discourse (Hosler & Arend, 2012; Kupczynski et al., 2010; Tathahira, 2020; Wang & Liu, 2020). Hosler and Arend (2012), for example, reported that students' perceived level of their critical thinking was positively associated with aspects of teaching, such as, relevant assignment, explanatory and timely feedback, and instructors' active involvement in facilitating discourse that keeps students focused and encourages participation at a meaningful level. Hosler and Arend (2012) argued that facilitating discourse is a "key to engendering critical thinking or cognitive presence" (p.219). These results suggest that in online learning, facilitated discourse is a useful means to encourage students to student interaction, interaction with learning materials, and engagement in collaborative construction of knowledge.

However, in previous research, the positive association between the instructor facilitating discourse and cognitive presence was not always evident. For instance, Costley (2015) compared the effects of three types of instructor posts on students' critical thinking—no instructor posting, posts with direct instruction, and posts that contain facilitated discourse—and found that lack of instructor posting and posting that contain facilitated discourse has no significant effect on students' critical thinking. One possible reason for this might be, according to Tathahira (2020), the use of teaching and learning methods that reflect instructor as the center of learning or the instructor being too dominant in teaching and learning activities. Nonetheless, a key feature that makes a blended or online learning environment more conducive to facilitate critical thinking or cognitive presence is its potential to incorporate student-centred and active learning, rather than time-limited teacher dominant traditional classroom. This suggests that although instructor facilitation is crucial for cognitive presence, teacher interaction should not show their monopoly on power.

Another important finding of this study, regarding facilitated discourse, is the indirect effect of facilitated discourse on cognitive presence through social presence. The finding validates the role of social presence as providing a social climate for inquiry. The finding supports the claim that facilitated discourse is required to maintain focus and engagement of

students in a collaborative learning environment (Anderson et al., 2001). Earlier research has shown that teaching presence has significant indirect effect on cognitive presence through social presence (e.g., Dempsey & Zhang, 2019; Garrison et al., 2010; Mutezo & Maré, 2023). This study adds to the literature by specifically revealing the role of social presence in the relationship between facilitated discourse and cognitive presence. Although, prior studies failed to look into possible indirect or mediating effect of social presence in the relationship between facilitated discourse and cognitive presence as such, evidence from studies such as Garrison and Cleveland-Innes (2005) suggests facilitating discourse is required in order to guide social presence to facilitate cognitive presence and learning, therefore, supporting the possible indirect effect of social presence in the relation between facilitated discourse and cognitive presence as found in this study. Garrison and Cleveland-Innes (2005) argued that social presence alone is not sufficient to stimulate cognitive presence. According to Garrison and Cleveland-Innes (2005), facilitating cognitive presence requires focused critical discourse. They suggest that it is instructor facilitation that guides social presence to stimulate critical thinking and facilitate cognitive process in learning. The finding of this study also supports the claim that facilitated discourse is required to maintain focus, and engagement of students in a collaborative learning environment (Anderson et al. (2001). This evidence suggests that instructor-led facilitation is essential for guiding interactions among learning community members, thereby enhancing social presence, cognitive presence, and meaningful learning.

### ***Limitations***

Despite noteworthy strengths, there are several limitations associated with this study. First, the study relied solely on self-reported measures. Although constructs related to human behaviour such as students' response and perceptions to their learning environment are best measured by self-reports (Howard, 1994), some scholars argues that the self-reports are prone to several kinds of response bias, and findings about correlational and causal relationships may be influenced by the problems of common method variance (Donaldson & Grant-Vallone, 2002). Second, the study sample was not a random sample. Invitation to participate in the study was sent to students who satisfied the inclusive criteria, and as participation was voluntary, those participating in the study may not be an accurate representation of the study population. Further research may be needed to generalise the findings. Moreover, the finding of this study by itself does not allow for the conclusion of causality or directionality between associated variables since structural modelling is not causal modelling. The hypothesised model of the study was based on CoI theoretical framework and prior research on the topic. The analysis of structural modelling only confirmed that the hypothesised model was a good fit to the data. An experimental or quasi-experimental model is needed to further confirm the causality between the associated variables. Another limitation is related to the fact that this study is conducted in a blended learning context with the focus on online learning components of blended learning. In a blended learning class, there is a clear feeling of human connection that significantly differs from a full online class. Therefore, future research should consider conducting similar investigations within fully online settings to provide a more comprehensive understanding of the effects of direct instruction on social and cognitive presence in online learning contexts

### ***Conclusion***

The present study confirms the significance of perceived direct instruction and facilitated discourse for students' perception of social presence and cognitive presence in blended learning. The results also confirm the mediating role of social presence in the effects of direct instruction

on cognitive presence, and the effects of facilitated discourse on cognitive presence. The finding suggests that students' positive perception of direct instruction and facilitated discourse in blended learning is needed to support social presence or for students to interact with each other in a meaningful way that helps them to construct and confirm meaning. Overall, the finding suggests that for effective blended learning, teachers and instructors who facilitate blended learning should use direct instruction and facilitating discourse strategies that help students to feel that they are being directed, guided, and supported in their learning.

**Declarations**

The authors declared no conflicts of interest.

The study was conducted in accordance with the ethical standards and approval of The Maldives National University, Maldives.

Informed consent was obtained from all individual participants included in the study.



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# Predictive Model to Analyze Real and Synthetic Data for Learners' Performance Prediction Using Regression Techniques

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## Abstract

Predicting learner performance with precision is critical within educational systems, offering a basis for tailored interventions and instruction. The advent of big data analytics presents an opportunity to employ Machine Learning (ML) techniques to this end. Real-world data availability is often hampered by privacy concerns, prompting a shift towards synthetic data generation. This study presents an empirical comparison of real, synthetic, and hybrid (real + synthetic) datasets in forecasting learner performance, deploying an array of regression-based ML algorithms, including Random Forest, Gradient Boosting, Support Vector Regression, XGBoost, and K-nearest Neighbor. Our methodology encompasses the generation of synthetic data via generative model, followed by the application of these algorithms to each dataset. The models are evaluated using precision metrics to assess their predictive accuracy. The study reveals that synthetic data can match real data in terms of predictive performance, with hybrid datasets achieving an accuracy of up to 87.76%, highlighting the effectiveness of combining both data types. These findings highlight the potential of synthetic data as an effective alternative when access to actual data is limited, promoting progress in educational technology and ML.

**Keywords:** Learners' performance prediction, educational data analytics, predictive models, privacy preservation, synthetic data generation, regression analysis

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In the dynamic landscape of online education, predicting learner performance has become a cornerstone for adaptive learning environments. Accurate predictions enable educators to implement personalized teaching strategies, leading to improved educational outcomes (Shabnam Ara et al., 2023). While traditional predictive models have relied heavily on real-world data, they face growing constraints regarding data privacy, availability, and comprehensiveness. The evolution of generative modelling has introduced synthetic data as a potential panacea to these challenges, allowing for large-scale, privacy-compliant data generation that mirrors real-world distributions.

Synthetic data, meticulously designed to mirror the statistical characteristics of actual data, offers transformative potential in the research of education. This approach circumvents the privacy and ethical challenges associated with original data while providing an improved dataset for training ML models. Despite its promise, its effectiveness when compared to real data in educational contexts has not been thoroughly explored.

Addressing this gap, our study probes the utility of synthetic data in the context of online learning portals. By deploying advanced regression ML algorithms across real, synthetic, and blended datasets, this research evaluates the predictive accuracy and reliability of synthetic data against its real counterpart. Our investigation is guided by an evaluation of synthetic data's capability to match the predictive accuracy of real data in educational settings. We further examine whether a combined dataset, integrating both real and synthetic data, establishes a more robust foundation for ML models than using either dataset independently. The findings of this research are intended to inform a pathway for leveraging synthetic data in predictive models, aiding stakeholders in educational technology to circumvent data accessibility challenges while maintaining the integrity and reliability of their analytical models.

### ***Contribution***

This research marks a significant stride in educational analytics by evaluating the authenticity of synthetic data against real data in training ML models. It introduces an innovative blend of real and synthetic datasets, revealing an enhanced predictive prowess that such integration can provide. Using the ACTGAN (Adaptive Conditional Tabular Generative Adversarial Network) based algorithm, the paper showcases advancements in generating synthetic data that maintains privacy without sacrificing the data's analytical value. These advancements have practical implications for educators and policymakers, offering data-driven insights for educational improvements while maintaining ethical standards.

### ***Research Questions (RQ)***

RQ 1: Does integrating various feature sets improve the accuracy of predictive models for academic performance?

RQ 2: How do real, synthetic, and hybrid data compare in their effectiveness for predicting learner performance in BL environments?

## **Related Work**

The field of online learning is advancing quickly, with significant attention given to challenges such as data scalability, personalized learning, and privacy protection. ML-based

predictive models play an essential role in creating adaptive learning systems. Yet, concerns over data privacy have led to the rise of synthetic data generation techniques, like Generative Adversarial Networks (GANs), which offer a solution for generating privacy-protected data (Goodfellow et al., 2020). This research expands on existing work by evaluating how real, synthetic, and hybrid datasets perform in predicting learner outcomes within blended learning environments, focusing on improving prediction accuracy while ensuring data privacy. The effectiveness of synthetic data in predictive modelling, particularly in the context of learner performance, is an emerging topic that has garnered interest in recent years. The increasing use of ML techniques in educational technology necessitates a deeper understanding of how different types of data—real, synthetic, and hybrid—contribute to the accuracy and reliability of predictive models. This literature review aims to explore the current state of research related to these topics, focusing on RQ1 and RQ2.

### ***Enhancing Predictive Models***

Several studies have explored the impact of various feature sets on the performance of predictive models in educational settings. For example, Alyahyan et al. (2020) provided a comprehensive analysis of the factors influencing academic success, identifying that combining cognitive, behavioral, and contextual features significantly enhances predictive accuracy. Shabnam Ara et al., 2024 explored parameters that impact learners' performance in BL environments. The findings indicated that factors like geographical area, study medium, frequent logins, active forum participation, and dedicating adequate time to learning activities positively impact learner performance. While sleep is essential for overall well-being, it appears to be less influential on academic outcomes in this specific context.

Namoun et al. (2020) performed a systematic analysis on the application of data mining techniques in predicting student performance. They emphasized the importance of integrating multiple data sources to capture the multifaceted nature of learning processes. The inclusion of both static and dynamic features, such as demographic information and real-time engagement metrics, has been shown to enhance model generalizability. The work by Bujang et al. (2021) also supports this notion, as they developed a multiclass prediction model using a variety of feature sets, including previous academic records, attendance, and engagement levels. Their findings indicate that models that integrate diverse feature sets outperform those relying on a single type of data. Moreno-Marcos et al. (2020) conducted an analysis to determine the factors that influence learners' performance, using learning analytics to gain insights. Their study identified a significant gap due to the insufficiency of data regarding learners' offline behavior. This finding underscores the necessity for comprehensive data collection that integrates both online and offline activities to develop more accurate and holistic predictive models.

Alalawi et al. (2023) performed a comprehensive review of ML application in predicting student performance. Their analysis of 162 research studies highlighted the most commonly used predictive techniques. The top five machine learning algorithms identified were Decision Trees (DT), Artificial Neural Networks (ANN), RF, and Naive Bayes. Tomasevic et al. (2020) compared various supervised ML techniques to forecast student exam outcomes. Their study highlighted the superior performance of ANNs and emphasized the importance of robust data collection and active student engagement. Murray et al. (2021) highlighted the crucial role of regression analysis in educating students about statistical methods. They developed a novel approach using multiple linear regression, which entails generating several multivariate datasets.



Yagci et al. (2022) investigated the use of ML algorithms to forecast students' academic performance. By including factors such as midterm exam scores, department information, and faculty details, their model achieved an accuracy rate of 70–75%. Similarly, Zhao et al. (2020) conducted a study to forecast student achievement using behavioral data. They worked with a relatively small dataset comprising 156 students. Their model reached an accuracy of 86.6%. This result highlights the potential of leveraging behavioral data for accurate academic performance prediction. This research illustrates the utility of ML techniques in educational contexts but also highlights the constraints associated with a limited number of predictors. The moderate accuracy suggests that incorporating additional variables and employing more sophisticated models could potentially improve predictive performance.

The studies reviewed in this section demonstrate that ML models such as RF and XGBoost are effective in predicting academic outcomes when applied to real-world educational data (Zhao et al., 2020; Yagci et al., 2022). However, these studies predominantly rely on real datasets, which can be limited by data privacy constraints as well as availability of large educational datasets. By introducing synthetic and hybrid datasets into the analysis, our study extends this body of work, providing a novel comparison of how real, synthetic, and hybrid data impact the performance of these machine learning models. Our findings reveal that hybrid datasets deliver enhanced predictive performance, effectively bridging the gap between the demand for accurate predictions, the limitations of real-world data availability, and the need to address data privacy concerns.

### ***Underexplored Effectiveness of Synthetic Data***

The application of synthetic data in ML has increasingly attracted attention, particularly in domains where real data is scarce or sensitive, such as education. Goodfellow et al. (2020) introduced GAN as a powerful tool for generating realistic synthetic data, which has since been used across multiple domains, including educational technology. Bethencourt et al. (2023) examined the compatibility and suitability of synthetic data generated by GANs for educational research. Although the study assessed the feasibility of using synthetic data, it did not fully explore the potential benefits and insights such data could provide. The findings highlight the need for methodologies that leverage synthetic data to enhance educational research by maintaining data integrity and predictive accuracy while preserving privacy.

Wang et al. (2020) exemplified the Data synthesizer, a framework for generating privacy-preserving synthetic datasets. Their work is particularly relevant in educational contexts where student data privacy is paramount. Similarly, Zhang et al. (2017) introduced PrivBayes, a technique for sharing private data through Bayesian networks, which has been shown to produce synthetic data that is both useful and privacy-compliant. Sarwat et al. (2022) developed a method combining a Conditional GAN (CGAN) with a deep Support Vector Machine (SVM) to forecast academic achievement. To address the issue of limited student data, they generated synthetic samples using an enhanced CGAN. Their results showed that integrating school and home tutoring improved student performance, and the CGAN-SVM model outperformed existing methods, particularly in sensitivity, specificity, and AUC. This study highlights the potential of CGAN-generated synthetic data in enhancing prediction models for technology-assisted learning. While studies like Flanagan et al. (2022) provide valuable insights, more research is needed to fully understand the conditions under which synthetic data can be as effective—or more effective—than real data. The literature suggests that while synthetic data offers significant advantages in terms of

privacy and data availability, it may not always capture the complexity of real-world educational data.

**Table 1**

*Summary of Related Work*

| Author                      | Objectives                                                                                                                                                                                                                   | Findings                                                                                                                                                              |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Zhao et al. (2020)          | Forecasting academic performance using behavioral data                                                                                                                                                                       | Dataset was very small (156 students). A classification accuracy of 86.6% was achieved.                                                                               |
| Yagci et al. (2022)         | Forecasting students' academic performance through ML algorithms.                                                                                                                                                            | Attained a classification accuracy of 70–75%.                                                                                                                         |
| Moreno-Marcos et al. (2020) | To examine the factors affecting the prediction of learners' performance through learning analytics.                                                                                                                         | Lack of data on learners' offline behavior.                                                                                                                           |
| Garcia et al. (2022)        | To enhance educational data privacy through GAN by generating synthetic educational data.                                                                                                                                    | Focuses only on privacy preservation techniques.                                                                                                                      |
| Bethencourt et al. (2023)   | Explored synthetic data compatibility and GAN's suitability for educational research.                                                                                                                                        | Doesn't fully explore the synthetic dataset's potential benefits and insights.                                                                                        |
| Proposed Work               | Evaluated whether integrating various feature sets improves predictive models for academic performance and compared the efficacy of real, synthetic, and hybrid data in forecasting learner performance in a BL environment. | Combining diverse feature sets improves model accuracy and robustness and Hybrid datasets outperform real and synthetic data alone in learner performance prediction. |

Garcia et al. (2022) explored the application of GANs to generate synthetic educational data with the primary aim of enhancing data privacy. While the study focused on privacy preservation, it did not extensively evaluate the effect of synthetic data on the performance of models. This research highlights the critical balance between maintaining privacy and ensuring accurate performance predictions. These studies emphasize the need for integrating diverse data sources and advanced machine learning techniques to improve academic performance predictions while highlighting the potential of synthetic data to balance privacy and predictive accuracy. Table 1 summarizes the related work.

The application of synthetic data in education is still an emerging area, with studies such as Bethencourt et al. (2023) and Garcia et al. (2022) primarily focusing on its privacy benefits. However, there is limited research comparing synthetic data to real data in terms of predictive accuracy. Our study builds on this by directly evaluating synthetic data alongside real and hybrid datasets, demonstrating that a hybrid approach can significantly improve model accuracy while maintaining privacy. This highlights the untapped potential of synthetic data in educational predictive modelling.

The field of online learning faces several significant challenges that hinder the development of effective educational technologies. Current challenges in online learning research include:

### Data Availability

- limited access to high-quality educational datasets restricts the effectiveness of predictive models
- real-world data is often scarce or incomplete, affecting the robustness of machine learning algorithms

### Data Privacy Concerns

- growing concerns about the privacy of sensitive learner information necessitate solutions that protect data while enabling effective analysis

### Integration of Diverse Data Sources

- difficulty in combining data from various sources (e.g., demographic, behavioral) to create a comprehensive view of learner performance

Our research addresses these gaps through several key approaches. First, it uses hybrid datasets that integrate real and synthetic data, enhancing the robustness of predictions while maintaining data privacy. Second, by employing GANs for synthetic data generation, the study offers a solution to the limitations posed by the availability of real-world data. Additionally, the research provides empirical evidence for enhanced predictive performance by comparing real, synthetic, and hybrid datasets, demonstrating their respective impacts on predictive accuracy in blended learning environments. Finally, the insights derived from this research can inform the development of more effective and privacy-compliant educational technologies, thereby contributing to the ongoing discourse in online learning research.

## **Method**

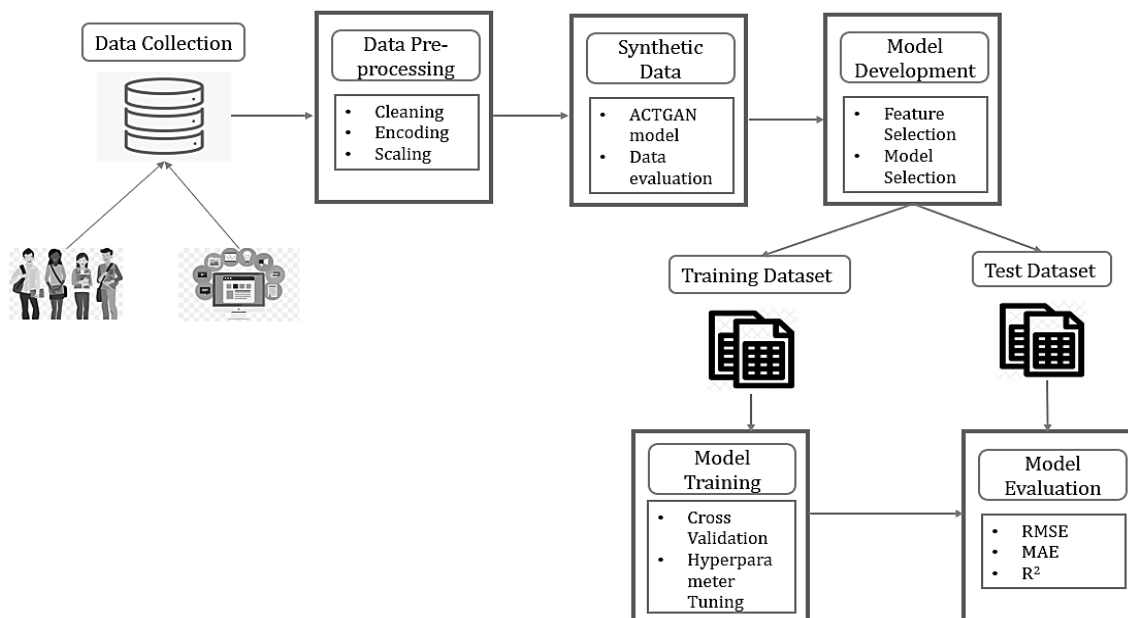
This section provides a detailed overview of the approach used in the study, covering the system architecture, model development, evaluation process, and hyperparameter tuning techniques.

### ***System Overview***

The proposed system architecture, as illustrated in Figure 1, is structured into three distinct phases: data pre-processing, synthetic data generation, and model training and evaluation.

#### Phase 1: Data Pre-processing

**Data Cleaning:** In this step, errors, missing values, and outliers in the dataset were detected and rectified to maintain data quality and integrity. To address missing values, some were either removed or imputed. Out of the initial 338 student records, 8 records were excluded due to significant missing values, and 5 records were corrected using mean imputation. This process resulted in a final dataset consisting of 330 student records.

**Figure 1***System Architecture***Table 2***Data Encoding Methods Employed*

| Encoding Type    | Specification                                                                                                                      | Used on                                                    |
|------------------|------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Binary Encoding  | Applied to binary data with only two categories where the order does not matter.                                                   | 5 features<br>e.g., gender, medium of study, region        |
| Ordinal Encoding | Used for ordinal data where the categories have a meaningful order or ranking, though the intervals between them may not be equal. | 20 features<br>e.g., login frequency, repetition of videos |

1. Dataset Encoding: To facilitate the application of machine learning models, categorical variables were converted into numerical values through encoding techniques as in Table 2.
2. Dataset Scaling: Feature scaling was applied to adjust the numerical feature values to a consistent range, ensuring that all features have equal influence on the model

by removing variations in scale. We normalized the data using the formula below, scaling it between 0 and 1.

$$o' = \frac{o - o_{min}}{o_{max} - o_{min}}$$

where  $o_{min}$  and  $o_{max}$  is minimum and maximum value of feature, and  $o'$  and  $o$  is scaled and original value of feature

### Phase 2: Synthetic Data Generation

In this phase, depicted in Figure 2, synthetic data is produced using the ACTGAN model, a tabular GAN approach, via the Gretel.ai tool. A dataset consisting of 330 student records was used to generate 5,000 synthetic records.

**Figure 2**

*Generation of Synthetic Dataset*

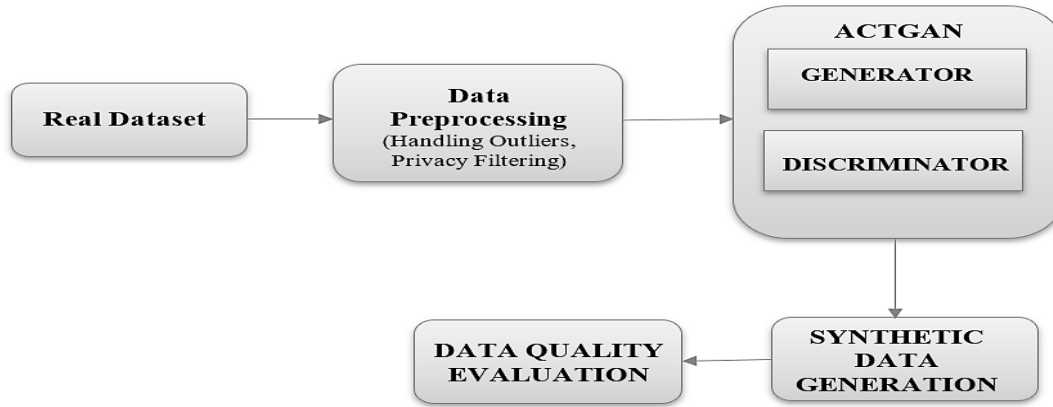


Table 3 details the configuration used for generating synthetic data with the ACTGAN model on the Gretel.ai platform. ACTGAN, a specialized type of Generative Adversarial Network (GAN), is employed here to produce synthetic tabular datasets. The Adam optimizer is chosen for managing the model's training process, renowned for its ability to adapt learning rates for each parameter. The generator, tasked with producing the synthetic data, operates with a learning rate of 0.0001, facilitating gradual and consistent adjustments during training. Meanwhile, the discriminator, which differentiates between real and synthetic data, is configured with a slightly higher learning rate of 0.00033. This setup helps balance the adversarial relationship between the generator and discriminator, leading to improved data generation quality throughout the 50 training epochs.

**Table 3**

*Synthetic Data Configuration*

| System | Gretel.ai |
|--------|-----------|
| Model  | ACTGAN    |

|                             |         |
|-----------------------------|---------|
| Generator Learning Rate     | 0.0001  |
| Epochs                      | 50      |
| Optimizer                   | Adam    |
| Discriminator Learning Rate | 0.00033 |

**Figure 3**  
*Synthetic Data Quality Score*

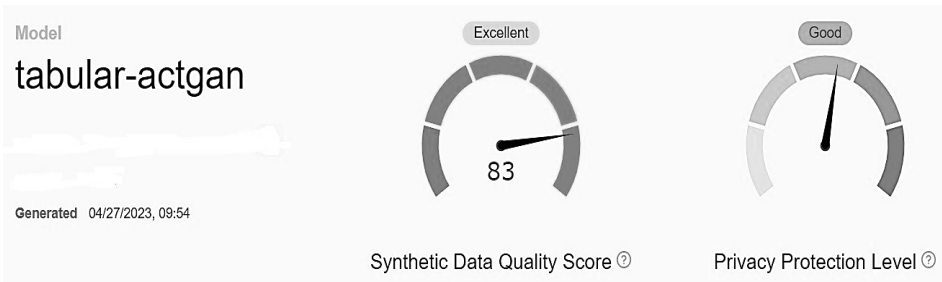


Figure 3 depicts the synthetic data quality score, which reached 83 percent, indicating high data quality and also a robust privacy protection is achieved for the generated dataset. The score is calculated using a weighted combination of multiple quality metrics, such as field distribution stability, field correlation stability, and deep structure stability. The synthetic data quality score indicates how well the synthetic data replicates the statistical characteristics of the original dataset. As such, it serves as a score, suggesting that scientific conclusions drawn from the synthetic data would likely align with those derived from the original data. However, in scenarios where statistical accuracy is less critical, such as in testing or demonstration environments, a lower quality score may still be acceptable.

**Figure 4**  
*Synthetic Data Quality Summary Statistics*



Figure 4 provides an overview of the quality statistics for synthetic data, showing between each pair of fields in the original training data is compared with the corresponding pairs in the synthetic data. The absolute differences between these correlations are averaged across all

field pairs, with a lower average indicating a higher stability score. To visualize these correlations, heatmaps are provided for both the training and synthetic data, along with a heatmap illustrating the differences. Preserving field correlations is crucial when the synthetic data is intended for statistical analysis or ML.

Additionally, deep structure stability has been measured at 85%. This is assessed using Principal Component Analysis (PCA), applied separately to both the original and generated datasets. The similarity of the principal components between the two datasets determines the synthetic quality score, with a closer alignment indicating better quality. As PCA is widely used for dimensionality reduction and visualization in machine learning, this metric offers immediate feedback on the synthetic data's utility.

Lastly, the field distribution stability score is 72%, reflecting how well the synthetic data replicates the distributions of the original data fields. This is measured using the Jensen-Shannon Distance for each numeric or categorical field, where a lower distance score corresponds to higher stability. Bar charts or histograms are used to compare these distributions. Maintaining field distribution integrity is essential, especially depending on the data's intended application.

The synthetic data generated was merged with the original real dataset, resulting in a unified dataset of 5,330 records. This integration provided a more varied and complete dataset for additional analysis. We named this the Hybrid Dataset.

**Table 4**

*Feature Set*

| Feature Category                                          | Attribute Name                                   |
|-----------------------------------------------------------|--------------------------------------------------|
| P1: Learners' Background Data                             | Age                                              |
|                                                           | Gender                                           |
|                                                           | Matriculation Medium of Study                    |
|                                                           | Region Residing                                  |
|                                                           | Family Annual Income                             |
|                                                           | Parental Occupation                              |
| P2: Previous Experience with Digital Learning Environment | Basic Computer Skills                            |
|                                                           | Internet Accessibility                           |
|                                                           | Ease of Use                                      |
| P3: Digital Learning Environment Interaction              | Login Frequency                                  |
|                                                           | Percentage of Online Lectures Viewed             |
|                                                           | Time Spent Viewing Online Lectures               |
|                                                           | Percentage of Activities Completed               |
|                                                           | Average Number of Repetition of Lectures         |
|                                                           | Average Number of Pauses While Watching Lectures |
|                                                           | Number of Practice Tests Taken                   |

|                               |                                                    |
|-------------------------------|----------------------------------------------------|
|                               | Number of Supplementary Study Materials Downloaded |
| P4: Forum Interaction         | Frequency of Questions Asked in Forum              |
|                               | Frequency of Interaction with Peers                |
|                               | Frequency of Interaction with Instructor           |
| P5: Lifestyle Behavioral Data | Frequency of Physical Activity                     |
|                               | Duration of Sleep                                  |
|                               | Smartphone Usage for Study Purpose                 |
|                               | Smartphone Usage                                   |
|                               | Diet                                               |

### Phase 3: Model Development

*Feature set description.* This study consists of 330 students records and encompasses a variety of learner characteristics, including demographic details, previous academic performance, engagement metrics within online learning platforms, and lifestyle habits, collected from the Government Polytechnic of Karnataka, India. The dataset is categorized in five features as P1, P2, P3, P4, and P5. Table 4 shows the feature set used for model development.

*Feature selection.* In the research, feature selection was conducted using both filter and wrapper methods to enhance the predictive precision of the ML models. The filter method was used to evaluate the relevance of features based on statistical measures, identifying the most significant features individually. This approach was particularly useful in the single feature selection phase, where each feature's contribution to the model's performance was assessed independently. Building on this, the wrapper method was employed to evaluate combinations of features by training models on various feature subsets. This method was crucial in the twin, triple, quad, and five feature set selections, where multiple features were grouped together and their combined impact on model performance was analyzed. The wrapper method allowed for a more comprehensive assessment, considering the interactions between features that might not be evident when features are evaluated in isolation.

*Model selection.* In this section, we detail the various models that were employed and compared in the study to evaluate their effectiveness in predicting student performance. The ML models as in Table 5 were selected based on their relevance and prior success in similar educational data mining tasks.

**Table 5**

*Mathematical Representations and Descriptions of Machine Learning Models*

| Model | Mathematical Representation   | Description                                                                                                                                       |
|-------|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| GBRT  | $GB(X) = \sum_{m=1}^M h_m(X)$ | GB builds an additive model by summing predictions from $M$ weak learners. Each $h_m(X)$ represents the prediction from the $m$ -th weak learner. |



|     |                                                                                    |                                                                                                                                                                                                                                                                    |
|-----|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RF  | $RF(X) = \frac{1}{N} \sum_{i=1}^N T_i(X)$                                          | RF is an ensemble technique that combines predictions from $N$ decision trees. Each $T_i(X)$ represents the prediction from the $i$ -th DT, and $RF(X)$ is the average of these predictions.                                                                       |
| XGB | $Objective(N) = \sum_i L(y_i, F_n - 1(x_i)) + \Omega(F_n)$                         | XGB minimizes an objective function combining a loss term $L$ (e.g., Mean Squared Error) and a regularization term $\Omega$ to find the optimal model parameters across $N$ boosting iterations.                                                                   |
| KNN | $KNN(x) = \frac{1}{k} \sum_{i=1}^k y_i$                                            | KNN predicts by averaging the target values $y_i$ of the $k$ nearest neighbors to the data point $X$ .                                                                                                                                                             |
| SVR | Minimize:<br>$\frac{1}{2} \ \omega\ ^2 + C \sum_{i=1}^N (\xi_i + \varepsilon_i^*)$ | SVR seeks to find a hyperplane that reduces the prediction error while keeping the errors within a predefined margin ( $\epsilon$ ). The model balances error minimization and margin constraints using parameters $\omega$ (weights), $b$ (bias), and $C$ (cost). |

*Hyperparameter tuning.* The hyperparameters for various machine learning models were carefully tuned to optimize their performance. Hyperparameters were initially selected based on prior research and initial estimates. To optimize these, we employed both RandomizedSearchCV and GridSearchCV. We started with RandomizedSearchCV to quickly explore a wide range of hyperparameters by sampling a set number of combinations from predefined distributions, allowing for efficient coverage of the search space. After narrowing down to a promising range, we used GridSearchCV for a more exhaustive and systematic evaluation, testing all possible combinations within the defined grid to fine-tune the hyperparameters for optimal model performance. Details of the hyperparameter configurations used are provided in Table 6.

## Evaluation Metrics

To assess the effectiveness of our models, we used a range of established metrics that provide a comprehensive assessment of prediction accuracy and reliability. Table 7 presents these metrics in detail, highlighting the model's strengths and areas for improvement. A lower RMSE and MAE indicate a model with higher accuracy. These metrics, collectively, enabled a robust evaluation of model performance, ensuring that both the accuracy and consistency of predictions were thoroughly assessed.

**Table 6**

### *Hyperparameter Configuration*

| Model | Hyperparameter       | Value |
|-------|----------------------|-------|
| GBRT  | Learning Rate        | 0.1   |
|       | Number of Estimators | 200   |
|       | Maximum Depth        | 3     |

|     |                              |                       |
|-----|------------------------------|-----------------------|
| RF  | Number of Trees              | 100                   |
|     | Maximum Depth                | 10                    |
|     | Criterion                    | Gini Impurity         |
| XGB | Learning Rate                | 0.1                   |
|     | Maximum Depth                | 6                     |
|     | Subsample                    | 0.8                   |
| SVR | Kernel                       | Radial Basis Function |
|     | C (Regularization Parameter) | 1                     |
|     | Epsilon                      | 0.1                   |
| KNN | Number of Neighbors          | 5                     |
|     | Distance Metric              | Euclidean             |

**Table 7***Accuracy Metrics*

| Metric                                                   | Formula                                                                   | Description                                                                                                                                                                   |
|----------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mean Absolute Error (MAE)                                | $\frac{1}{n} \sum_{i=1}^n  p_i - \hat{p}_i $                              | Calculates the average absolute deviations between predicted values ( $\hat{p}_i$ ) and actual values ( $p_i$ ), offering an assessment of the model's mean prediction error. |
| Accuracy measured using R-Squared Co-efficient ( $R^2$ ) | $\frac{\sum_{i=1}^n (p_i - \hat{p}_i)^2}{\sum_{i=1}^n (p_i - \bar{p})^2}$ | It quantifies how well the predicted values ( $\bar{p}_i$ ) from the model align with the actual values ( $p_i$ ).                                                            |
| Root Mean Square Error (RMSE)                            | $\sqrt{\frac{1}{n} \sum_{i=1}^n (p_i - \hat{p}_i)^2}$                     | Quantifies the average extend of the discrepancies between predicted values ( $\hat{p}_i$ ) and actual values ( $p_i$ ).                                                      |

**Implementation Details**

The experiments were carried out using Python 3.10.12 on a computing system equipped with 16 GB of RAM and 8 GB of GPU. For the implementation, the NumPy, Pandas, and Scikit-learn libraries were used for numerical computations, data manipulation, and machine learning algorithms, respectively. The dataset, consisting of both pre-processed real and synthetic data, was stored in CSV files. To prepare the data for model training and evaluation, the `train_test_split` function was employed to partition the dataset, using 80% of the data for training and keeping the remaining 20% for evaluating the model's performance.

**Results**

**RQ 1:** Does integrating various feature sets improve the accuracy of predictive models for academic performance?

To address RQ1, we conducted experiments on real datasets using various combinations of feature sets to evaluate their impact on predictive models for academic performance. We first tested each feature set individually, then explored combinations of two feature sets, three feature sets, and four feature sets. Finally, we assessed the performance when all five feature sets were used together. These experiments were carried out using RF, XGB, KNN, SVR, and GBRT.

### ***Single Feature Set***

Figure 5 presents the RMSE values obtained using individual feature sets on the real dataset. The XGB model recorded the highest RMSE of 19.35 for the “P4” feature set, highlighting its sensitivity to fluctuations within single feature sets. Conversely, the lowest RMSE of 12.3 was achieved by the RF model for the feature set “P3” demonstrating the effectiveness of RF methods when Digital Learning Environment Interaction features were used. SVR was consistent and showed higher accuracy across all single parameter combinations. Overall, the RMSE results for single feature sets show that while certain feature sets offer a reasonable degree of predictive capability, none of the models performed optimally when relying on a single feature set alone.

### ***Twin Feature Set***

When combining two feature sets, SVR consistently delivered strong performance across all pairs, as depicted in Figure 6. The highest performance was achieved by the RF model with the P1 P3 feature set combination, yielding an RMSE of 12.47 showing strength when P1 and P3 features taken together. In contrast, the XGB model performed the worst with the P1\_P4 combination, recording an RMSE of 19, though P4 individually performed better. The addition of a second feature set generally enhanced predictive accuracy, leading to lower RMSE values across most models.

### ***Triple Feature Set***

With the integration of a third feature set, a noticeable improvement in model performance was observed as depicted in Figure 7, particularly in reducing RMSE values. The SVR model achieved the best performance, recording the lowest RMSE of 12.47 for the combination of feature sets P1, P4, and P5. In contrast, the XGB model displayed the highest RMSE of 18.56 for the feature sets P1, P2, and P4. The consistent performance of the SVR model across different feature set combinations underscores the value of incorporating additional data dimensions, which enhances the model’s predictive accuracy.

## **Figure 5**

*Over Single Feature Set*

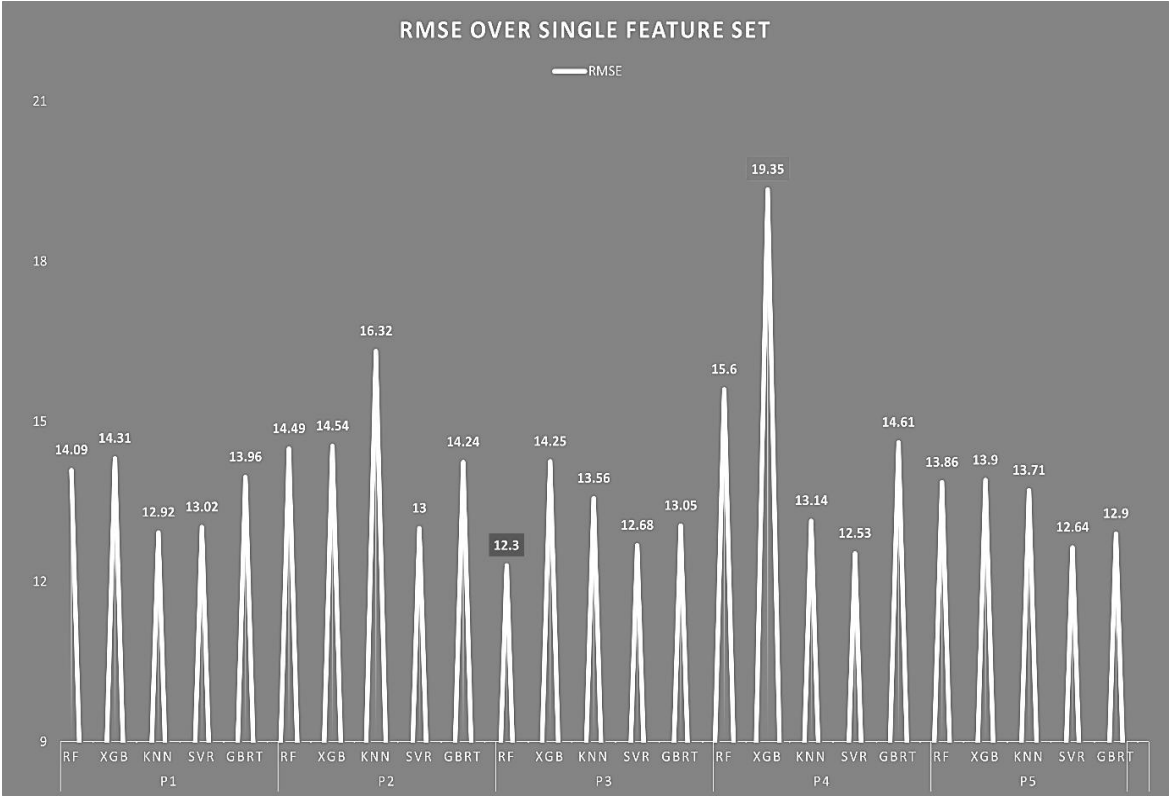


**Figure 6**

*RMSE Over Twin Feature Set*

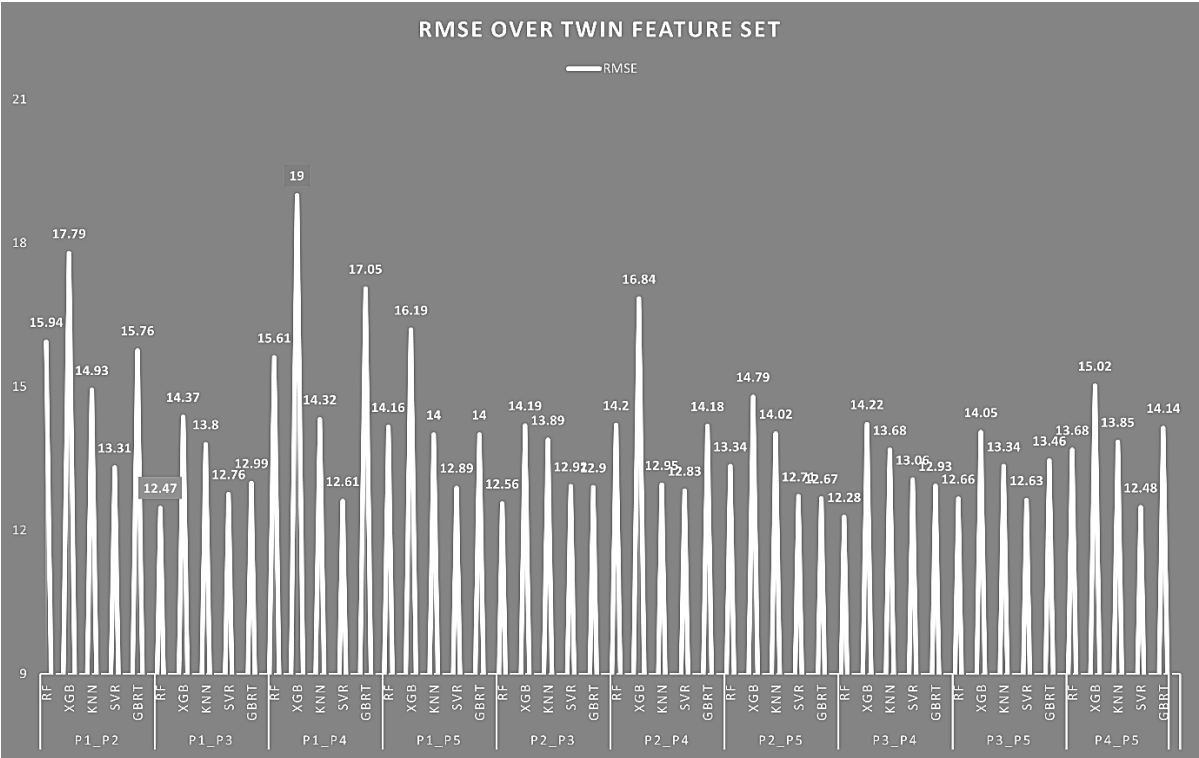


Figure 7

RMSE Over Triple Feature Set

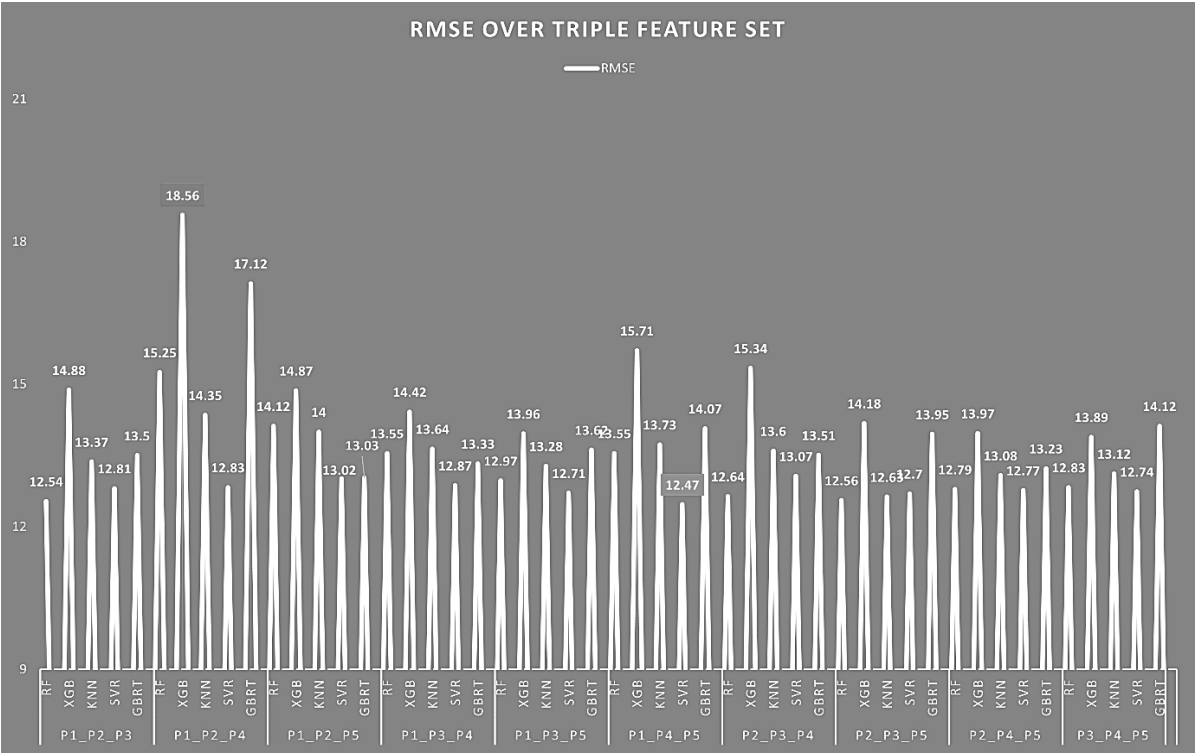
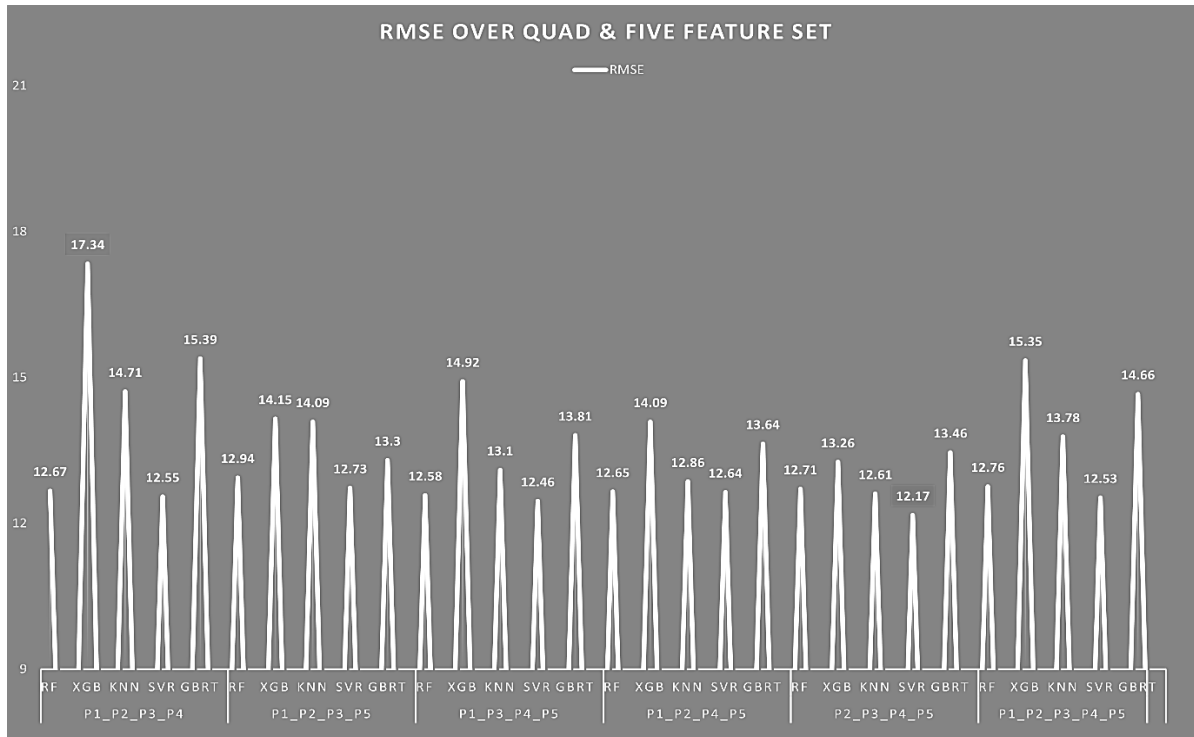


**Figure 8***RMSE Over Quad and Five Feature Set***Four and Five Feature Set**

When combining four or five feature sets as depicted in Figure 8, the SVR model continued to demonstrate strong performance, achieving the lowest RMSE of 12.17 for the feature combination P2\_P3\_P4\_P5. On the other hand, the XGB model recorded the highest RMSE of 17.34 for the combination of P1\_P2\_P3\_P4. The SVR model consistently performed well across all feature set combinations, highlighting its robustness in handling diverse data dimensions.

To summarize the results, we have Figure 9 and Figure 10 depicting average RMSE and average MAE. Average errors decrease significantly for the quad feature set, indicating that this is the optimal feature set for this particular analysis. This reduction in error rates as the number of features increases suggests that a more comprehensive feature set allows the models to capture underlying patterns more effectively, leading to improved predictive accuracy. These results highlight the importance of features that represents learners' appropriately in enhancing model performance, emphasizing that including a well-balanced set of relevant features can significantly improve the learners' ability to generalize from the data.

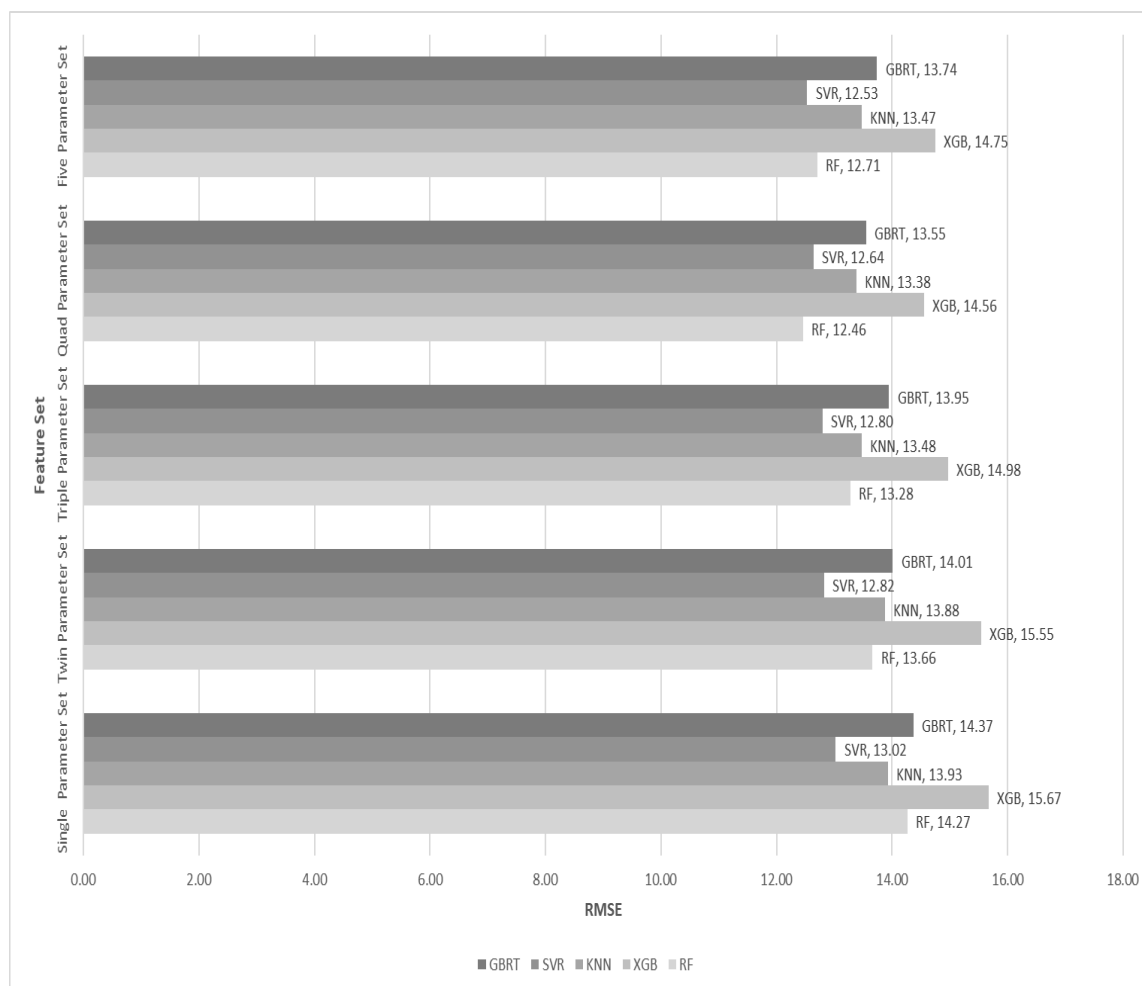
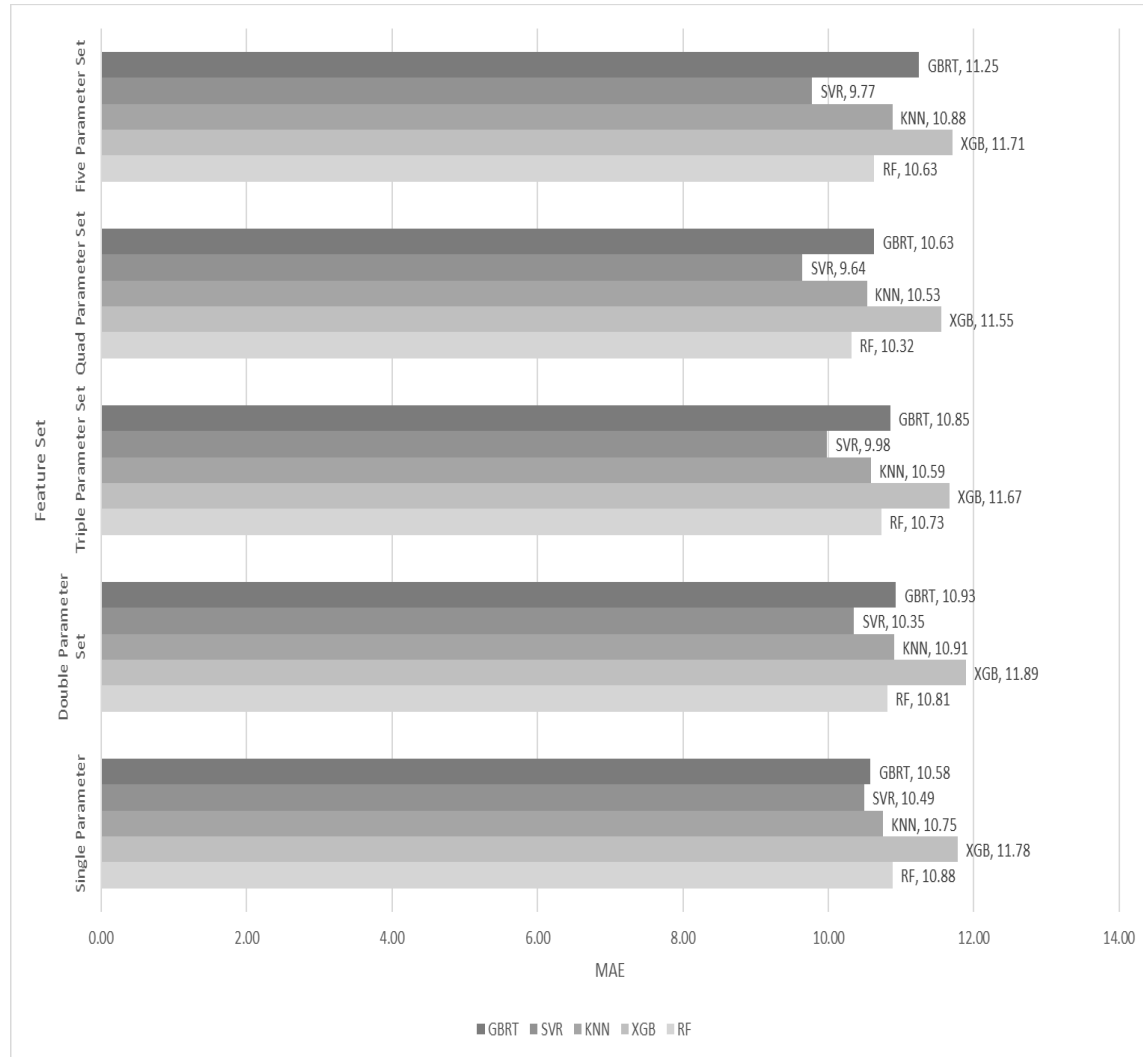
**Figure 9***Average RMSE Variation Over Feature Set*

**Figure 10***Average MAE Variation Over Feature Set*

RQ 2: How do real, synthetic, and hybrid data compare in their effectiveness for predicting learner performance in BL environments?

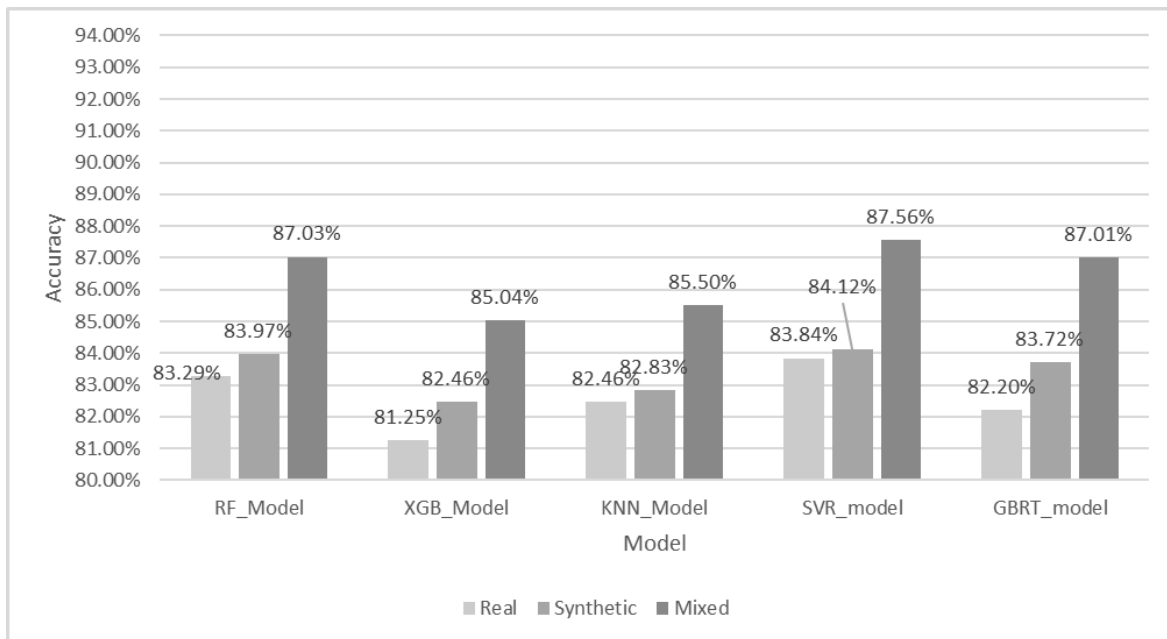
Figure 11 clearly illustrates that the hybrid dataset consistently surpasses both synthetic and real datasets across various machine learning models. This result emphasizes the significant advantage of integrating real and synthetic data to predict learner performance in BL environments. Among the traditional models, the SVR model achieved the highest accuracy of 87.56% using the hybrid dataset, highlighting its superior performance. This suggests that the



hybrid dataset's broader scope and diverse learner data enhance the predictive accuracy of the algorithms. Additionally, the application of feature engineering techniques, such as wrapper and filter methods, further improves the accuracy and reliability of academic performance predictions.

**Figure 11**

*Accuracy Comparison Across Real, Synthetic and Hybrid Dataset*



## Discussion

This study investigates the impact of different feature sets on predicting student performance and evaluates the effectiveness of real, synthetic, and hybrid data in forecasting learner outcomes. The experimental results demonstrate improved performance due to several key factors:

1. **Feature Optimization:** The use of filter and wrapper methods significantly enhanced both the accuracy and efficiency of the model. Additionally, the inclusion of synthetic and hybrid data during feature selection contributed to a more comprehensive and robust feature set.
2. **Dataset Enrichment:** Integrating multi-source student data with synthetic data substantially increased the dataset's depth and diversity. The hybrid dataset, combining real and synthetic data, proved particularly valuable, as it balanced data variety and volume, leading to richer insights and improved predictive performance.

The key findings of this study highlight that a diverse range of learner data—including background information, digital engagement, and lifestyle behaviors—can effectively predict student performance. The hybrid dataset consistently outperformed both real and synthetic datasets due to its greater volume and diversity, which enhanced the performance of all tested algorithms. This indicates that synthetic data can effectively supplement real data and that combining multiple data sources significantly improves predictive accuracy. It is crucial to acknowledge the limitations of this study. The research is restricted to Karnataka, which may restrict the generalizability of the results to other regions. Additionally, while synthetic data was used, it may not completely reflect the intricacies of the original dataset, and the computational resources available might affect the method's scalability.

## Conclusions

This study offers a thorough analysis of actual and generated data using tabular GAN method, for learners' academic score prediction in BL environment. The findings suggest that synthetic data can be an effective substitute for actual data for student score prediction in academics and synthetic data demonstrates comparable performance. Notably, models trained on a hybrid dataset demonstrated even greater accuracy and robustness. Further exploration into innovative data synthesis methods and their impact on long-term performance prediction will be crucial. The success of integrated hybrid data underscores the significance of enhancing data quality and ensuring privacy while enhancing ML applications in education.

## Practical Implications

The findings of this study offer important insights for educational institutions seeking to improve student outcomes performance prediction models. By leveraging a hybrid dataset that integrates real and synthetic data, educational systems can achieve more accurate and reliable predictions. This approach not only improves the personalization of learning experiences but also allows institutions to better identify at-risk students early on. Moreover, the successful integration of synthetic data reduces reliance on large volumes of real data, alleviating privacy concerns and allowing for more flexible data collection practices. The enhanced feature selection process, which incorporates both synthetic and hybrid data, can be applied across different educational contexts, improving the adaptability and scalability of predictive models. As a result, institutions can develop more robust data-driven strategies to support student success and optimize educational outcomes.

## Declarations

### ***Availability of Data and Materials***

The dataset generated and analyzed during the current study is not publicly available due to privacy and confidentiality but are available from the corresponding author on reasonable request.

### ***Competing Interests***

The authors declare that they have no competing interests.

***Funding***

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# What is the De Facto? Implementation of the Flipped Classroom Approach in Higher Education: Veteran Professors' Experiences Over Multiple Years

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## Abstract

The flipped classroom approach is an effective alternative to traditional teaching methods. However, further research is necessary to understand its long-term impact. This qualitative research study delved into the prolonged implementation of flipped learning by conducting interviews with professors from various academic institutions across different countries. The study focused on professors from STEM and Education Sciences disciplines with extensive experience in implementing the flipped learning method and a significant body of scholarly work. The study's findings indicated that educators view this approach as valuable for providing feedback and fostering active learning strategies. However, challenges to its implementation include entrenched traditional teaching cultures, resistance to change, and unprepared students. The research also revealed a lack of theoretical guidance for this method and recommended practical strategies for its effective implementation. The study highlights the importance of providing effective guidance for educators to successfully implement flipped learning and its influence on higher education policies.

**Keywords:** Flipped classroom, flipped learning, higher education, long-term implementation, qualitative study

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The popularity of the flipped learning (FL) approach in higher education has sparked intellectual discussions on research gaps. Despite the exponential growth of research on implementing flipped classrooms (FCs), questions have been raised about the reliability of short-term FC interventions and small sample sizes (Cevikbas & Kaiser, 2022), given the need for longitudinal studies. This gap has created a pressing need for further studies to address such fragmentation and understand the prolonged impact of the FC (Kapur et al., 2022). While a limited number of studies have reflected on multi-year flipped learning implementation, there is an urgent need for more research in this area, which led to the undertaking of this study.

## ***Overview of Relevant Literature***

As per Birgili et al. (2021), FL is a movement, not just a method that aims to establish a teaching approach that prioritizes digital learning over physical classrooms. The increasing number of higher education (HE) students highlights the need to modernize traditional, in-person instruction. The flipped approach offers a pedagogical alternative to conventional classroom methods to engage students in higher-order thinking (Bishop & Verleger, 2013; Bergmann & Sams, 2012). Essential skills for contemporary HE, such as communication, self-paced learning, and interactive instruction, are crucial. Consequently, FL is no longer just a passing trend but a vital requirement (Bishop & Verleger, 2013) as it equips students with such skills.

The FL approach is often considered a subtype of blended learning. In a typical FC setup, students engage in pre-class learning activities such as watching videos, reading materials, or doing online exercises. This frees up more time for collaborative learning tasks during in-class periods (Abeysekera & Dawson, 2015; Bishop & Verleger, 2013). Although there were early publications on FL (Lage et al., 2000), it was not until 2012, when Bergmann and Sams coined the term “Flipped Classroom” that it became more widely known. Before this, empirical articles on flipped pedagogies were scarce. The Flipped Learning Network (FLN) then defined the FC as a pedagogical approach in which direct instruction moves from the group to the individual learning space. This creates a dynamic, interactive learning environment where educators can guide students as they apply concepts and engage creatively in the subject matter. The FC approach is based on four guiding pillars: Flexible Environment, Learning Culture, Intentional Content, and Professional Educator (F-L-I-P).

The active learning experiences developed in an FL environment depend on various roles, uses, and needs. According to Fung et al. (2021), the most distinctive characteristic of the FC is not just the reverse order of the lecture and homework sequence. It aims to improve learning practices and maximize class time by focusing on student-centered interactive activities and individual scaffolding (Bergmann & Sams, 2012). To achieve this, learners must be active constructors of knowledge, use cooperative and collaborative learning to reflect on their learning, and gain meaningful experiences to enhance their overall learning (Erbil, 2020). This approach is rooted in classic educational didactic models and theories, building on the works of Piaget and Vygotsky (Bishop & Verleger, 2013) and integrating learning theories such as constructivism, behaviorism, cognitivism, social learning theory, and connectivism. The FL method, as such, has the potential to offer more than just an alternative approach but rather a value-driven method driven by the timely fusion of technology and pedagogy, prompting a re-evaluation and necessary transformation process (ElGamal, 2022).

In recent years, several qualitative reviews have been published to synthesize the growing literature on FL (O’Flaherty & Phillips, 2015; Zainuddin & Halili, 2016; ElGamal, 2022). These reviews have concluded that FL is associated with increased student achievement, motivation, and engagement. For example, studies have shown that flipped learning effectively enhances students' critical-thinking skills, problem-solving abilities, and overall academic performance. Additionally, FL has increased student engagement and motivation, allowing students to participate actively in their learning.

FL's effectiveness may be underestimated in current studies, which primarily focus on instructors' initial attempts at implementation. According to Lee (2023), only a few studies have looked at the long-term effects of FL. Some research suggests that FL requires a shift in teaching approaches and cultural norms. Therefore, further study of multi-year FL implementations could reveal the extent of these pedagogical and cultural shifts (Lee, 2023). More research is needed to accurately assess its benefits as it continues to be refined. A comprehensive and longitudinal study covering multiple courses requires time to understand FL implementation and determine its effectiveness over time (Cevikbas & Kaiser, 2022; Kapur et al., 2022).

On the other hand, FL is built on multiple theoretical foundations. The prevailing theories surrounding FCs are cognitive load theory and constructivist learning theory (Sweller, 2020). While these classrooms are widely adopted in higher education to support student-centered learning, they have faced criticism for lacking a clear theoretical framework (Koh, 2019). This critique is supported by research demonstrating the effectiveness of active learning without a clear distinction between active learning and the flipped classroom model (Bredow et al., 2021). This study aims to address these limitations and inspire further research. One of its key findings is to identify the theoretical and practical guidance necessary for implementing FCs. Many articles discuss the FC approach, but only a few provide practical guidance for its implementation. This study analyzes expert insights to guide the implementation of FCs in higher education and evaluate their impact. It addresses critics' perspectives on the unique aspects of FCs and explores design decisions, pedagogical lessons, and the role of institutions in practical implementation. The study examines the FC approach in higher education (HE) from various angles, providing critical insights into its theoretical and practical implications.

## **Research Design and Method**

The study adopts a qualitative approach to investigate the experiences of expert professors who have implemented the FC method over several years of trial, error, and modification. Specifically, it uses interviewing as one of the primary methods for data collection and analysis in qualitative research (Sproul, 1988; Maxwell, 2009). Using a qualitative research approach, the study aims to gain a comprehensive understanding of the design and implementation of the FL approach in higher education. Qualitative research allows for capturing changing trends and tracking experts' shifting attitudes. Its flexible nature encourages discussion of experiences and changes, which leads to widely accepted findings across various disciplines. Meanwhile, qualitative education research is widely accepted due to its comprehensive and rich nature, particularly with text-based information such as narratives and insights (AlYahmady & Al-Arabi, 2013; Glickman et al., 2007). Furthermore, interviewing is an efficient method, mainly



when analyzed using the interpretive approach, which seeks to make sense of participants' qualitative experiences by identifying commonalities in interview content (Maxwell, 2009). The interview research design allows researchers to ask immediate follow-up questions as needed, which is impossible with other data collection methods. This current exploratory study uses this capability to gain a deeper understanding of the general and distinctive components of the FL method. Mainly, the study addresses the research questions discussed in the coming section.

### ***Research Questions***

The researcher started the research process with an overarching question: What do expert/veteran professors tell us about their experiences with the long-term implementation of flipped classrooms in the context of higher education? However, this overarching question was guided by the following five sub-questions, which showed the assembly of generated themes.

1. What is the unique value of flipped learning implementation in higher education?
2. How does the flipped classroom operate within the higher education system? How can it induce change in the higher education culture?
3. What design decisions are needed for the effective implementation of the flipped classroom?
4. Is the flipped learning guided theoretically and practically? In what manner?
5. What institutional support is provided and required for the flipped classroom?

### ***Sampling and Data Collection***

In this qualitative study, 13 professors from HE institutions across four continents were recruited and interviewed to represent faculty from different parts of the world. The study found that expertise was more easily identified in Asia ( $n = 5$ ), while Turkey ( $n = 4$ ) provided a unique location in Europe and Asia with a large number of publications (El Gamal, 2022).

Recent research shows that the purposive sample, which is selective, is more efficient (Campbell et al., 2020). Therefore, a mixed non-probability purposive snowball sample of expert professors with extensive experience implementing FCs or with publications in the field was used to select the participants. The sample included professors from STEM and education sciences disciplines, as most published research on FL in the HE context focuses on these two disciplines (El Gamal, 2022). A chain of nominations was created. The first wave of expert invitations went out on January 25th, 2023, which led to a second wave of nominations and referrals from the initial wave of professors. The second wave was distributed on March 13, 2023. By the cutoff date of April 20, there were ( $n = 20$ ) responses, which eventually resulted in ( $n = 13$ ) interviews.

The study included 13 professors, nine full professors, and four assistant professors, with an average teaching experience of 12 years. While Braun and Clarke (2021) argue against using saturation in thematic analysis, Subedi (2021) also suggests that researchers have the freedom to choose the participants for qualitative research, which vary from one to twenty participants depending on the depth of information needed and the nature of the inquiry. Therefore, this study achieved sample saturation with 13 participants, which allows for thorough reflection and in-depth analysis according to Fugard and Potts (2015).

**Table 1***Geographic Distribution of the Sample*

| <b>Country</b>      | <b>Participants (n)</b> | <b>Percentage %</b> |
|---------------------|-------------------------|---------------------|
| China               | 1                       | 7.69                |
| Egypt               | 1                       | 7.69                |
| Germany             | 2                       | 15.38               |
| Hong Kong           | 1                       | 7.69                |
| Malaysia            | 1                       | 7.69                |
| South Korea         | 2                       | 15.38               |
| Turkey              | 4                       | 30.77               |
| USA                 | 1                       | 7.69                |
| <b>Total</b>        | <b>13</b>               | <b>100</b>          |
| <b>Participants</b> |                         |                     |

**Table 2***Participants' Experience with Flipped Learning*

| <b>Experience in years</b> | <b>Participants (n)</b> | <b>Percentage %</b> |
|----------------------------|-------------------------|---------------------|
| 3 to 5 years               | 1                       | 7.69                |
| 6 to 8 years               | 8                       | 61.54%              |
| 9 to 11 years              | 4                       | 30.77               |

**Table 3***Participants' Disciplines*

| <b>Department</b>                      | <b>Participants</b> |
|----------------------------------------|---------------------|
| Education Sciences                     | 7                   |
| (English language teaching)            |                     |
| (Mathematics Education)                |                     |
| (Artificial intelligence in education) |                     |
| STEM                                   | 6                   |
| (Physics)                              |                     |
| (Mathematics and Informatics)          |                     |
| (Dental Education)                     |                     |
| (Statistical research)                 |                     |

***Compliance with Ethical Standards***

All participants completed and signed an informed consent document before the interviews. The study adhered to the ethical standards for human subjects' research established by the American Psychological Association (APA). The interview questions were designed following APA guidelines for content expert projects, focusing only on best practices and educators' experiences in typical educational settings. The participation was voluntary, and the

interview format was non-intrusive. That being said, the questions did not address personal, medical, gender-related topics or past traumas, ensuring the avoidance of sensitive issues.

All participants were adults and expert academicians in their fields of knowledge. Through a debriefing sheet, participants were provided with detailed information about the study's background and guidelines and a contact name, details for inquiries, a privacy notice explaining the anonymity (if chosen), protection of the transcribed data, and how the information would be used. The primary benefit emphasized for their participation was their contribution to the academic knowledge base. Then, they were given ample time to decide on their participation voluntarily. They were also informed clearly of the option to withdraw their data from the study at any time without facing any negative consequences.

The interviews were conducted online using the Zoom application. They were recorded with the participants' written consent and verbal confirmation of their acceptance of being recorded before the interviews took place. Participants who wished to remain anonymous were referred to by pseudonyms using their initials, while all participants agreed to disclose their affiliations and backgrounds. Only two participants chose to share all their information including their names. All signed consent forms are available upon request.

### ***Data Coding and Analysis***

Experts were interviewed and their insights were recorded for a qualitative thematic analysis. Approximately 450 minutes of recorded content were cleaned and focused on lessons from long-term FL implementation. The transcription process used manual and assisted methods, such as Otter.ai software. The author's journalism and social sciences expertise ensured reliable interviewing and transcribing.

The analysis involved searching data for common themes that describe the meaning of an experience from the participants' viewpoints. The study considered a range of emergent key themes during an initial open coding. Then, the full transcripts were coded according to preset themes and highly recurrent codes. The QDA Miner Lite Program was used to analyze qualitative data analysis.

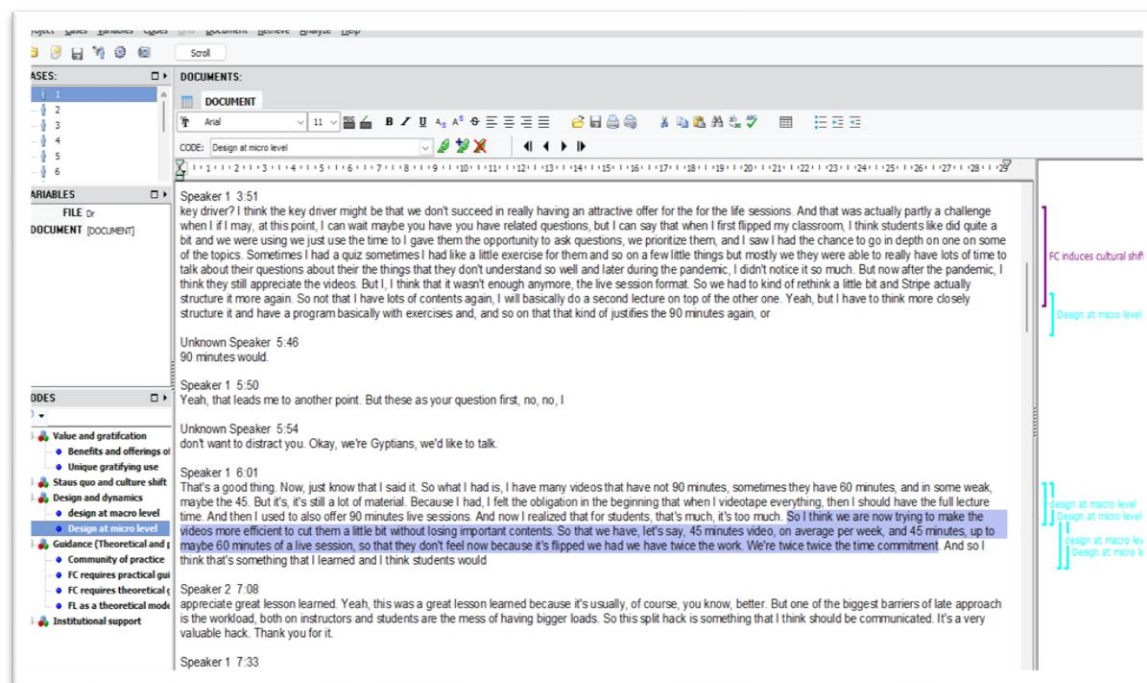
The study aimed to explore participants' experiences with the FC over several years. The collected data was analyzed at the sentence level and coded, with related codes assembled into themes. The analysis revealed five main themes, with several sub-codes within each theme. Interview quotes were presented to support the inferences and experiences identified. The following section provides a detailed presentation of the themes formed from the existing codes. The researcher looked for similarities and differences between the emergent themes from the data and themes identified through literature. One significant contribution of the study was finding convergences and divergences with previous literature results, which validated previous studies and informed the scope of the study, addressing specific literature gaps.

Finally, to establish the trustworthiness of the data, the author employed an audit trail. The audit trail provided step-by-step details about the process of data collection, coding, and analysis, allowing the chance for systematic replication. The following steps sum up the data coding and analysis:

1. The researcher read each transcript to familiarize herself with the data, then re-read using line-by-line analysis to extract and code the participants' experience meanings.
2. The researcher wrote notes in the margins of each transcript to emphasize understanding.
3. The researcher explored and separated meanings into categories and themes, aligning with the research's pursuit of responding to research questions.
4. The researcher presented findings along five cluster themes.

**Figure 1**

*A Snippet of the Coding Screen Extracted from QDA Miner*



## Results

### *Themes, Codes, and Description*

After conducting a qualitative thematic synthesis, the author identified 13 codes with 32 sub-codes. These codes were then organized into five themes—value and gratification, design and dynamics, status quo and culture shift, guidance (practical and theoretical), and institutional support. Figure 2, structured in the codebook, displays the five themes with their respective descriptive codes and various statistics, such as their frequency, the number of cases in which they appear, and the total number of associated words.

**Figure 2***Coding Frequency Tree*

|                                          | Count | % Codes | Cases | % Cases | Nb Words | % Words |
|------------------------------------------|-------|---------|-------|---------|----------|---------|
| Value and gratification                  |       |         |       |         |          |         |
| Benefits and offerings of the flipped    | 17    | 6.2%    | 10    | 76.9%   | 640      | 1.9%    |
| Unique gratifying use                    | 12    | 4.4%    | 9     | 69.2%   | 650      | 1.9%    |
| Staus quo and culture shift              |       |         |       |         |          |         |
| FC induces cultural shift(or partial)    | 28    | 10.2%   | 11    | 84.6%   | 2030     | 6.0%    |
| Flipped method and culture               | 23    | 8.4%    | 11    | 84.6%   | 1881     | 5.6%    |
| The norm                                 | 39    | 14.2%   | 13    | 100.0%  | 2160     | 6.4%    |
| Design and dynamics                      |       |         |       |         |          |         |
| design at macro level                    | 54    | 19.6%   | 12    | 92.3%   | 4824     | 14.3%   |
| Design at micro level                    | 49    | 17.8%   | 13    | 100.0%  | 3019     | 9.0%    |
| Guidance (Theoretical and practical)     |       |         |       |         |          |         |
| Community of practice                    | 4     | 1.5%    | 3     | 23.1%   | 77       | 0.2%    |
| FC requires practical guidance           | 12    | 4.4%    | 8     | 61.5%   | 644      | 1.9%    |
| FC requires theoretical guidance or not  | 10    | 3.6%    | 7     | 53.8%   | 415      | 1.2%    |
| FL as a theoretical model                | 6     | 2.2%    | 4     | 30.8%   | 283      | 0.8%    |
| Institutional support                    |       |         |       |         |          |         |
| Description of institutional support     | 13    | 4.7%    | 7     | 53.8%   | 1058     | 3.1%    |
| FL requires institutional support or not | 8     | 2.9%    | 5     | 38.5%   | 764      | 2.3%    |

*Note.* The coding frequency tree in QDA Miner shows code usage count, cases, and word count. “% Count,” “% Cases,” and “% Words” are the percentage of coding, cases, and words related to each code.

**Table 4***Codes, Description, and Sub-Codes*

| Category/Theme               | Code                                           | Description                                                                 | Sub-codes                                                                                                     |
|------------------------------|------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Value and gratification      | Benefits and offerings of the flipped approach | The benefits of the FC                                                      | - Student-centered learning<br>- Engagement<br>- Social interaction<br>- Team-based learning                  |
|                              | Unique gratifying use of FC                    | The use of the FC method provides unique benefits.                          | - Outsourcing direct teaching<br>- Extended teaching<br>- Advanced scholarly input<br>- Intellectual autonomy |
| Status quo and culture shift | FL and traditional learning culture.           | The culture of learning and teaching that either accepts or rejects the FC. | - Sage on stage<br>- Teachers assessed for teaching only                                                      |

|                                  |                                     |                                                                                     | - Active learning initiatives                                                             |
|----------------------------------|-------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
|                                  | De facto—the norm of FL in practice | Common understanding of the FC practice.                                            | - Modus operandi<br>- Video before class<br>- Repeating video lectures in class           |
|                                  | FL inducing a cultural shift        | Can FL bring about a culture change? Has FL already brought about a culture change? | - Self-regulated learning<br>- Teacher's role change                                      |
| Effective design and dynamics    | Design at a macro level             | The unique design formula for effective FC. Experienced design modifications.       | - Readiness assessment and orientation of students<br>- Partial flip                      |
|                                  | Design at a micro level             | Tips for FC design.                                                                 | - Backward design<br>- Shorten videos<br>- Structuring the live session<br>- Gamification |
| Category/Theme                   | Code                                | Description                                                                         | Sub-codes                                                                                 |
| Guidance (theoretical/practical) | Theoretical frameworks              | The theoretical foundation for designing learning experiences of FC.                | - Paucity in theory<br>- Suggested theories                                               |
|                                  | Practical guidance                  | The practical guidelines and training.                                              | - In-class session training<br>- Periodic plans' modification<br>- Community of practice  |
| Institutional support            | Institutional support provided      | What kind of support is required? What kind of support is provided?                 | - Technical support                                                                       |
|                                  | Institutional support required      | The role and need for institutional support                                         | - Incentive<br>- Commitment                                                               |

### *Interviews' Findings*

Below are the themes and results developed from analyzing the views and experiences of experts using the flipped learning approach. The experts responded to a set of research questions organized into subheadings.

### Unique Value and Gratification

**RQ1:** What is the unique value of FL implementation in higher education?

In a general sense, the flipped approach has various benefits and advantages. This code or sub-theme focuses on the significant advantages of the FC model in higher education. Expert interviews revealed that the FL approach basically aligns with the constructivist notion, and if implemented correctly, it promotes the student's role in the learning process. “Student-centered learning enhances inverted class offerings. If faculty members see its effectiveness, they may implement it long-term,” Prof. Jihun Lee, Professor of Dental Education, explained.

The benefits of active learning and the FC approach often overlap, with student engagement being a significant advantage of the latter. All experts interviewed agreed that increased engagement is one of the primary benefits of the FC approach. Prof. SS explained that FC (presumably a form of interactive learning) is more enjoyable and engaging for students. This is because attention spans are becoming shorter and shorter. The interviewed professor believes that expecting students to remain attentive and engaged during an hour and 15-minute classroom session is almost impossible. Other expert professors demonstrated situations when they employed the FC: most of the class was engaged compared to the traditional class. Dr. TL shared her experience in a class of pre-service teachers, as she noticed that before class, students actively shared their thoughts on the discussion board and were engaged in discussions, presentations, and peer comments during class.

Finally, in the FC, instruction is said to move from extrinsically motivating (teacher-centered) to intrinsically motivating (student-centered) with guidance from the teacher. As such, the learning experience with engagement and self-motivation in the center could also promote collaborative learning and “.....enriches team-based learning (TBL), which is crucial to some disciplines such as STEM,” Prof. Lee said and (n = 7) of the interviewed experts agreed.

*When asked to express their views regarding the distinct gratification (satisfaction and fulfillment) of employing the FC method, experts took some time to gather their thoughts. This pause for reflection was due to the difficulty of articulating a single gratification that only the FC method offers, given the similarity between the impacts of the FL approach and other blended and active learning approaches. Nevertheless, experts agree that one of the most satisfying aspects of the FC method is the ability to outsource direct teaching, which aligns with the philosophy behind the approach. Professor Dr. Christian Spannagel, a renowned expert in Mathematics and Computer Science Education, humorously sparked a debate by stating that lectures are nowadays “a waste of time.” He believes promoting more student-student and teacher-student interaction and outsourcing direct teaching are the primary uses of the FC.*

*Additionally, 11 experts believed feedback is a vital benefit of the FC. Constructive feedback can take time to impact, and the in-class time provided by the FC approach gives teachers the perfect opportunity to provide feedback to students on their work and learning processes. This incremental process allows students to master concepts, self-audit, modify, and enhance their learning experience. Prof. Spannagel observed how the FC approach provides more high-quality feedback during class or teacher-student interaction. A display of a list of sub-codes and quotes reflecting on experts’ views and interpretations of the “unique gratifying use of flipped approach” sub-theme is shown in Table 5.*

**Table 5***Unique Gratifying Uses of the Flipped Approach*

| Perceived gratification   | Count | Representative quotes                                                                                                                                                                               |
|---------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Extended teaching         | 12    | <i>"Class time will extend a double dose of teaching leading to deeper learning." Prof. Spannagel</i>                                                                                               |
| Constructive feedback     | 11    | <i>"Help students in smaller steps so they understand the material and stay oriented." Dr. ZZ</i>                                                                                                   |
| Focused Learning          | 10    | <i>"Teaching alone is not enough; FL emphasizes understanding rather than memorization. By prioritizing the learning experience, students can truly comprehend mathematical concepts." Prof. ON</i> |
| Self-paced learning       | 9     | <i>"Videos allow students to pause and rewind, ensuring comprehension and preventing missed information compared to traditional lectures." Dr. EA</i>                                               |
| Advancing scholarly input | 8     | <i>"In my view, the teacher has to keep gifted inputs for the students during class time, an input that adds to the basic concept teaching." Dr. L. CK</i>                                          |

Status Quo and Culture Shift

**RQ2:** How does the flipped classroom operate within the higher education system? How can it induce change in the higher education culture?

When promoting an active learning-intense method such as the FC method, it is crucial to consider the current state of higher education systems and the learning environment.

**Traditional Learning Culture and Flipped Learning.** Experts described the traditional learning culture in HE using specific keywords and indicative descriptors such as sage on the stage, spoon-feeding concepts, non-stop lecturing, etc. Prof. ON described learning and teaching habits in her culture: *"...in Asian culture, we are very accustomed to teaching passively, teaching one way and learning passively as such, i.e., heavy learning and teaching habit that we are very comfortable with it."* Many other expert professors (n = 8) representing different parts of the world and diverse teaching and learning cultures agreed with her comment. Interestingly, ten experts revealed that FC's incompatibility with traditional culture is also rooted in how most faculty define and perceive the FC method (see Table 6).



When asked about the level of acceptance of the FC method in higher education, most experts agreed that the FC method is essentially an extension of many other standard instructional methods based on constructivism. The method encourages engagement and enhances information retention in a more organized way. "...Some professors attempt active learning without a concrete strategy, making it difficult to replicate in other courses or programs. In this regard, FC is an asset to the teaching culture" Prof. SS.

Despite its positive impacts, mainstream HE environments would not invite innovative approaches like FL. The reason for this claim was suggested by (n = 5) experts, who specified that in the traditional learning culture in higher education, professors are primarily assessed for their teaching and research, but being assessed for trying distinguished teaching strategies remains individualistic.

**Table 6**

*Experts' Perception of the Flipped Classroom*

| FC method                         | Count (n) | Representative quotes                                                                                                                                                     |
|-----------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| An instructional strategy/ method | 8         | "Flipped learning is an instructional approach that can allow more time for you to conduct active learning activities inside the classroom. This is my opinion." Dr. L.CK |
| Blended learning approach         | 4         | "If you use the search term hybrid learning or blended learning with you, you will retrieve FL" Prof. MA                                                                  |
| Delivery method                   | 1         | "I would consider FC a delivery method, not an instructional approach." Prof. TA                                                                                          |

**De Facto of the Flipped Classroom Method.** Framing the FC method and its de facto is challenging due to inconsistent definitions in the literature (El Gamal, 2022). Focusing solely on the modus operandi or the FC's operational structure undermines its value. This approach allows for a more comprehensive and practical learning experience rather than simply focusing on operational planning; as Dr. EA implied: "...the learning environment is crucial for effective learning. Well-designed and varied content with different media and tools is essential for engagement. Collaboration and resources are vital for student success." Educators should not feel restricted by the three-phase structure of pre-class, during-class, and post-class, but instead should strive to plan the learning experience as a whole.

**Flipped Learning Induces a Culture Shift.** It took time to grasp whether the interviewed experts were optimists about FL's ability to induce a culture shift in the traditional HE status quo. Nevertheless, few professors shared exciting observations. For example, Dr. L.CK noted that one potential hurdle was educators' concern about students completing homework before class. This is just one of many challenges associated with the FC method, but he thought "...for FL, teachers should change their mindset. Traditional homework is not perfect, so use LMS analytics to help motivated and unmotivated students." To successfully adopt the FC method, educators must examine their mindset and determine what aspects of traditional teaching culture to keep and what to discard,, Dr. L.CK continued.

Another example shared by eight experts was one episode during the COVID-19 pandemic. These experts found it surprisingly more straightforward to implement the FC method in their departments without prior training than introducing it as a new norm after the lockdown ended. Some faculty members initially hesitated to create video lectures and instead recorded live lectures without students in front of a camera. Their previous teaching experience influenced this decision, as Prof. Lee suggested. However, upon returning to the physical classroom after uploading their video lectures to the learning management system (LMS), they concluded that the experience was not worth repeating, as she narrated.

In addition to its academic benefits, experts highlighted the critical role of the FC in enhancing social interaction between students, teachers, and their classmates, which can broaden and deepen students' knowledge. To demonstrate this benefit, Professor MA (who has been implementing FC for ten years) conducted a pilot study to assess the acceptance of the flipped method among graduate students and shared her findings. *She found “meaningful interaction between teacher and teacher, and teaching and student grew higher.”*

**Change of Teacher’s Role.** One of the recurrent sub-codes, as almost all experts agreed, is that HE culture is generally the same regarding the controlling role of professors in the knowledge transfer process. Experts viewed the acknowledgment of such change in the educator role as crucial to the diffusion of innovative methods such as FL. “... as an educator, it is my responsibility to direct and steer my students through their learning journey while ensuring that they receive constructive feedback to assist them in their growth and development,” Prof. Spannagel explained.

In the same context, some experts were also skeptical about the feasibility of an entirely flipped university model, with only one advocating for it and one believing that a competence-oriented approach is more critical. Prof. Spannagel argued “...the HE needs a competence-oriented university with diverse social, collaborative, and active learning methods. An inverted classroom approach with many micro-methods can provide this.” In addition, the cultural differences among the experts interviewed posed a challenge in assessing whether FC could successfully bring about a cultural shift towards a new norm. The extent to which people resist change differs across various regions, and students' attitudes can also influence this process. Dr. L.H. believes American professors, for instance, emphasize teamwork and innovation, while collectivist cultures tend to have a different approach.

**Self-Regulation.** This is among the highly recurrent sub-codes. Experts (n = 10) believe promoting FC will only be less challenging if students are trained or motivated towards self-regulation. “It is important to consider whether students have the self-regulated learning skills necessary to benefit from a flipped or blended learning approach fully,” Prof. TA. wondered. Strikingly, Dr. EA made an intriguing discovery in her research on using FC in English language teaching. She found that FC does not support self-regulated learning, which is crucial for effectiveness. Dr. EA concurred with the other experts' view that student-centered strategies assist students in customizing their learning preferences, leading to improved learning outcomes. She emphasized that FL allows students to learn without distractions and from diverse sources, fostering academic freedom.

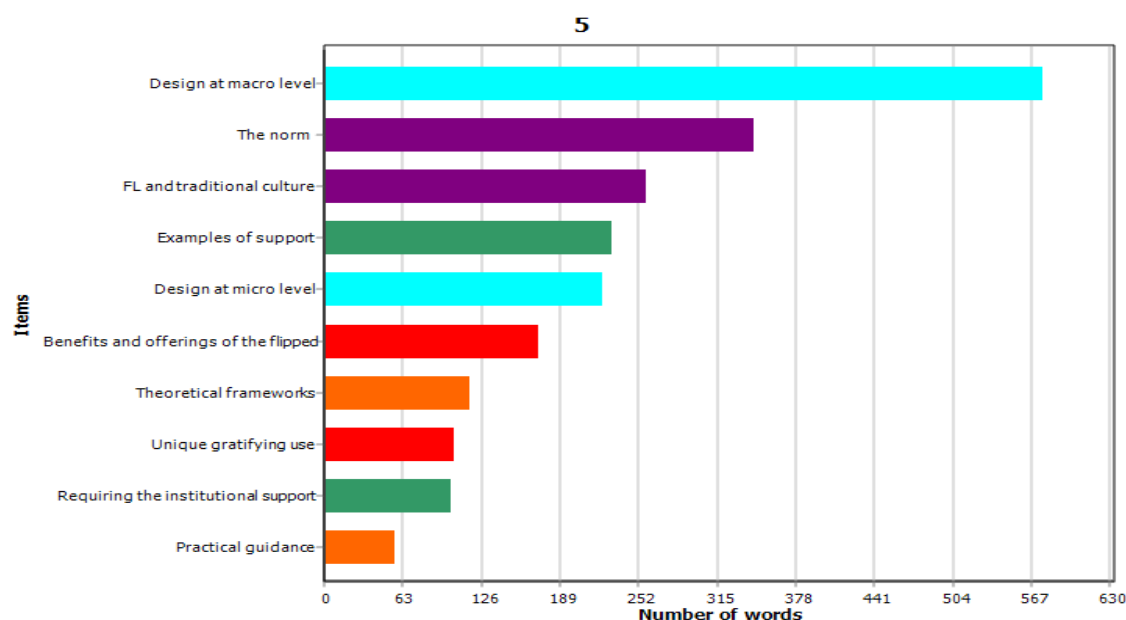
### Design and Dynamics

**RQ3:** What design decisions are needed for the effective implementation of the flipped classroom?

Design and dynamics generated the highest number of words during the interviews. Professors' multiyear implementation has led to a rich portfolio of tips and tricks about FC design. The large number of words (Figure 3) generated improved result comprehension. The design decisions were classified into two categories: macro and micro.

**Figure 3**

*An Example of Code Distribution in a Sample Interview*



**Design at the Macro Level.** This category involves analyzing the feasibility of incorporating FC into specific programs, determining which parts of the curriculum (macro-level) should be flipped and strategizing how to use specific tools to evaluate the effectiveness of the flipped approach. Based on the frequency of mentions in interviews, here are the experts' two most crucial recommendations for the macro-level design of the FC.

*Students' Needs Assessment and Orientation.* To design a successful FC, analyze contexts and objectives thoroughly. Engage in student dialogue for ongoing design. Dr. L. CK and Prof. MA emphasized this step as crucial in designing an effective flipped classroom. Experts recommend transparency and openness in flipped classrooms. Teachers should provide clear expectations, policies, guidelines, and grades to help students meet class standards.

*Partial Flip.* This term was the second most commonly mentioned term. It could refer to flipping a portion of the academic year, a specific course, or a program. "FL does not have to be used for the entire academic year or term. Instead, it can be used selectively for challenging topics. When designing a course, it is important to ask which parts to flip," Prof. EA elaborated.

**Design at the micro-level.** This category involved the design recommendations regarding the activities of the three phases of the flipped classroom (pre-class, in-class, and post-class) reflecting on the micro-level. A few quotes from the participants provide a range of their experiences and recommendations regarding the micro design of FCs.

*Structuring Live Sessions.* When designing a class, it is crucial to structure both the physical time and live sessions. This experience with FC is vital and cannot be overlooked. “. . . For successful live sessions, an attractive offer is important. If students do not have questions, prioritize discussing topics in detail, conducting quizzes, and encouraging them to bring up any uncertainties. This approach allows students to clarify doubts effectively,” Prof. SS said.

*Backward Design.* To successfully implement the inverted classroom method in a new class, it is imperative to prepare thoroughly and follow a backward design approach. “I invest ample time in understanding the subject matter and devising a comprehensive teaching plan. This involves organizing the class time and creating multiple tasks and media to facilitate effective student learning outcomes,” Dr. EA explained.

*Shortening of Videos.* Short videos are essential in motivating students to come prepared to class and create space for deeper learning by exploring the topics covered in the videos. “I learned that we should shorten our videos...to offer a more compact version of the inverted classroom,” said Prof. SS.

*Gamification.* Interestingly, five experts proposed employing gamification to foster student engagement, especially prior to and in class. For instance, Dr. ZZ suggested merging the FC with other pedagogical approaches to modify the conventional inverted classroom using what he called “gamified FC.” Experts also suggested active learning strategies such as Kahoot and debates were more effective in an FC.

#### Guidance: Theoretical and Practical

**RQ4:** Is the flipped learning guided theoretically and practically? In what manner?

**Theoretical guidance.** Experts (n = 10) agreed that the FC practice was under-theorized. Moreover, all participants agreed that to support teaching and learning effectively, it is crucial to recognize the diverse, flexible learning methods and customize the flipped approach to meet the specific needs of both learners and educators.

Professor Dr. TA emphasized that the flipped approach is “... just one of the many strategies that can be utilized to support learning.” This approach significantly improves the chances of achieving the desired learning outcomes and enhancing academic performance and engagement. By integrating learning theories such as scaffolding theory, Bloom's taxonomy, team-based learning (TBL), and the flipped classroom model, educators can implement the flexible classroom method more effectively, Prof. TA elaborated. In addition, employing the self-determination theory to motivate students, explained Professor Dr. Spannagel, can enhance students' autonomy, competence, and social relationships.

**Practical Guidance.** It is widely suggested that institutional-level training can be beneficial for teachers, particularly for those who are inexperienced. According to most experts, inexperienced teachers should learn from experienced colleagues. In addition, if usability tests are successful, novice teachers may consider following the FC model. Surprisingly, experts (n = 6) indicated that practical guidance is not essential for flipping the classroom. Dr. ZZ believes that there should be flexibility in implementing FC and that it should be tailored to each instructor. Therefore, it is recommended to establish a “Community of Practice” to facilitate knowledge sharing among peers. Prof. C. FK has shared her experience of developing “the new instructor journey,” which aims to familiarize new hires with the FC method from the student's perspective and to teach them how to design the face-to-face component of the course. She also mentioned that new hires receive mentoring from their peers and veteran professors.

*Training Inside the Face-to-Face Session.* According to Prof. Lee, pre-class activities are easier to design. However, she thinks that in-class sessions require on-site training for teachers to learn and practice hundreds of meaningful in-class activities.

*Periodic Modification of Teaching Plans.* According to ten experts, continuous assessment is crucial for identifying gaps and areas needing modification. This is because the flipped classroom approach depends on student acceptance and autonomy. Interview findings about the macro-level considerations of flipped classroom design support this idea.

### Institutional Support

**RQ5:** What institutional support is provided and required for the flipped classroom?

**The Provided Institutional Support.** Experts shared their views about the standard institutional support for implementing innovative teaching methods in general and FL in specific.

*Technical Support.* The most recurrent sub-code under this theme shows the institutional support for faculty wishing to flip their classes. “The university supports everything: a studio, a video camera, and people who can edit the video lecture. So, faculty members can lecture in front of the camera instead of in front of students and do not bother anything else” Prof. Lee described her experience. Institutions also offer assessments and analytics to monitor student performance outside of class. However, three experts said their universities did not provide the basic technical requirements needed. Professors can get frustrated with pre-class material, like time-consuming videos.

**The Required Institutional Support.** Institutions must facilitate the formula for the success of this impactful method and incubate the transformation towards effective implementation of FC over time.

*Incentives.* Unfortunately, most institutions do not offer incentives for innovative teaching methods, according to most respondents. Dr. LH. suggested that institutions encourage innovative teaching methods by incentivizing lecturers who introduce more than just the status quo to the university culture.

*Commitment.* This requirement refers to the degree to which HE institutions comply with the urge to change into a more student-centric learning environment and realize the value of the flipped approach in successfully achieving this change.

*To successfully implement a flipped delivery strategy, one must consider the unique variables of their education system and culture. Additionally, top management support plays a crucial role in determining the success of this approach. It is a top-down commitment to change management. (Prof. TA)*

**Practical Training.** The same opinion is extended among the sample experts of this study, who thought institutions should design cohesive training plans to enable faculty to implement the FC method.

## Discussion

The concept of flipped learning, as depicted in the literature, involves reversing the sequence of traditional classroom activities. However, researchers lack consensus regarding a universally recognized definition of the flipped approach (He et al., 2016). Some researchers, including Bishop and Verleger (2013), Lee et al. (2016), and Milman (2012), define FL by emphasizing pre-class activities, materials, and video-recorded lectures. Conversely, others, such as Lai and Hwang (2016), have a more comprehensive definition of FL, encompassing videos and reading assignments, homework problems, and PowerPoint presentations as pre-class learning materials. Therefore, it is crucial to standardize the terminology used to define the flipped approach. This standardization is not just a technicality but a critical step in advancing research in this area. Though the definition of FL is broad and may give the impression of an unstructured classroom, it allows teachers to implement various methods. This study seeks to identify practical concepts for implementing FL, which require tailored implementation and institutional support. The FL shares some important activities with traditional teaching. Experts propose that it is an innovative and efficient approach to higher education.

The research showed that considering extended exposure to the FC method could validate or alter the interpretation of evidence. This is important because the current excitement for FL surpasses the scientific evidence supporting it. The study addressed five main questions about FL's philosophy, application, and implementation factors. Using a qualitative approach, it emphasized recurring themes in existing literature and identified new areas of focus. Below is a summary of the five main thematic findings.

### ***The Value of Flipped Learning***

The interviews' findings may have suggested endless outcomes related to the FL method, yet this study primarily focused on the sub-codes or benefits consistently identified over several years of implementing the flipped approach in higher education. Meanwhile, the findings of a comprehensive systematic review by AlSamarraie et al. (2020) analyzed evidence from various disciplines to evaluate the positive effects of FCs in higher education. The review discovered that FL offers numerous benefits consistently reported in other systematic reviews (e.g., El Gamal, 2022; Birgili et al., 2021; Zou et al., 2020; Zainuddin et al., 2019; Kozikoglu, 2019; Lo & Hwang, 2018) over the last five years. These benefits include improved engagement, participation, attitudes, metacognition, performance, understanding, self-efficacy, satisfaction, problem-solving, motivation, involvement, time commitment, interaction, and self-directed learning. Experts who were interviewed repeatedly observed these benefits in various contexts

and settings, both online and physical, with students of varying abilities and in classes of all sizes.

Along the same line, *it is crucial to highlight the unique benefits observed over a multi-year FC media-enhanced teaching method implementation. The term “gratification” has been borrowed from the media theory of uses and gratifications (UGT), which suggests that people use certain types of media because they expect to obtain specific gratifications due to those choices (Blumler, 1979). It is assumed that educators may choose to use the FC method over other methods due to the particular gratifications this study aims to explore. In this study, the unique gratification of the FC method is meant to go beyond instant gratification, which means that the rewards of this approach are confirmed only over time. In other words, this gratification can only be realized through long-term implementation and a record of trial and error that ensures the effort exerted in effectively applying the FC method is worth it compared to this approach's unique reward. Despite challenges such as excessive workload and time consumption, experts continue to use the FC method.* The participants highlighted the following as the most valuable aspects of this method: increasing the instructor's scholarly input, teaching complex topics, providing an opportunity for improvisation, and fostering a thirst for learning. This suggests that the main advantage of FC is the extended exposure to the lecturer's interpretation of knowledge and understanding rather than just active student involvement. Nonetheless, the FC model is grounded in constructivism and active learning philosophies, enabling student development and intellectual growth. Additionally, the repetition effect provided through the FC leads to increased student learning, which is not possible with direct teaching.

### ***The Norm and Change***

The de facto of the FC method challenges the traditional teaching approach and requires a culture that supports in-class learning. Some recent studies have reported contrasting findings about the positive impacts of the FC method, possibly due to the incompatibility of the FC pedagogy with the traditional learning culture (e.g., Youhasan et al., 2021). Transitioning from a teacher-centered to a student-centered learning approach may take some time, but it is essential for acquiring conceptual knowledge. Shifting the focus of class time from the teacher to the students redirects attention toward their learning (Arslan, 2020). On the other hand, the FL approach adopts a constructivist understanding, so it can be said that the FL approach promotes the quality of students' constructive learning (Danisman et al., 2017). Nevertheless, the FC method's effectiveness depends on its implementation's cultural context. Studies have acknowledged differences in cultural dimensions at the country level, such as uncertainty avoidance and individualism versus collectivism. However, there has been little examination of how students' cultural orientations may impact the implementation of FL (Arslan, 2020). Experts have discussed dimensions like uncertainty avoidance and individualism versus collectivism, highlighting their potential influence on the success of flipped pedagogies. The FC teaching method, originating in the West, may enhance learning outcomes in countries with cultural similarities that value self-directed learning and align with FC educational ideologies. For instance, a study by Karagöl & Esen (2019) found that the FC method exhibited more significant benefits in Turkey than in other countries. This discrepancy could stem from the lesser prevalence of active learning in collectivist cultures in the Middle East and Asia. The success and sustainability of the method hinge on its compatibility with the cultural context. Therefore, it

is imperative to develop flipped pedagogy through an instructional system design at the macro level.

### ***The Macro and Micro Design of the FC***

To implement FL in a class, the workload must be balanced at both the macro and micro levels. Early assessments are crucial to identify students' difficulties (Hsieh et al., 2021). For success, a consistent and well-informed plan is necessary. Studies indicate that students are more likely to comply with FL as they gain more experience with the approach (McLaughlin et al., 2014). The FL approach is dynamic and can be applied to different stages of the learning process. Experts suggest dedicating sufficient workloads during class time and using design tips like backward design, shortening videos, and gamification.

### ***Theoretical and Practical Guidance***

Understanding the theory behind the flipped classroom is crucial for its successful implementation. However, Abeysekera and Dawson (2015) noted that the practice of flipped classrooms is “under-theorized” (p. 2). A recent systematic review in mathematics education found that most studies should have reported on the theoretical frameworks for implementing the FC intervention (Cevikbas & Kaiser, 2022). This finding aligns with another systematic review by El Gamal (2022), emphasizing the need for more reporting on theoretical frameworks in included studies, irrespective of the field of study. Arslan (2020) also argued that FL promotes active learning and student-centrism, emphasizing the need to define FL based on theoretical frameworks. As a result, there is consensus among study participants about the ongoing debate regarding how to theorize the components of this method. Per Eppard and Rouchdi (2017), understanding the effectiveness of the FC method requires considering its dynamic interaction with the traditional teaching approach. It is important to note that not all implementations of the FC method are the same. For instance, Kapur et al. (2022) challenged advocates of the FC method who stressed the importance of active learning, which is supposed to be the core of this method. They examined whether the FC method is being implemented as intended—passive learning before class followed by active learning in class, where active learning should complement the passive pre-class instruction. According to Kapur et al. (2022), the most significant impact of active learning occurs when it is done before in-class instruction or as part of traditional instruction, contrary to the fundamental claim of flipped instruction that active learning occurs during class time.

The practical guidance, however, was found to be problematic. While the majority of experts supported the idea that activating a community of practice among educators is vital for ensuring the success of this approach, they also thought it is essential to view the FC as a flexible concept that allows for the fluid application of different theories. Additionally, professional training, in-session coaching, and mentoring are all essential factors contributing to the effectiveness of the strategies.

### ***Institutional Support***

Implementing a new model involves assessing institutional readiness and building the necessary capacity for dissemination at all levels. Implementing “cohesive plans” is strongly recommended for a successful FC implementation (Evans, 2019, p. 76). Experts recommend initiating change from within by creating meso- and macro-level frameworks while considering





research will concentrate on large-scale studies aimed at exploring opportunities for promoting FL practices among different cultures, educational settings, and types of learners. Additionally, clear definitions are needed for effective implementation of FL, and design considerations are crucial for success. Further research is needed to comprehend the relationship between differentiated learning (DL) and FL. Delivering instructional videos and lectures in an FC format to students with lower abilities outside of class can help promote the effectiveness of FCs in diverse settings. Furthermore, it is vital to study the potential impact of combining FL with gamified tutoring and generative AI tools. Lastly, more research is needed on challenges and solutions related to FC practices.

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The author has disclosed no potential conflicts of interest in relation to the research, authorship, and publication of this article.

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# The Greek Version of the Blended Teaching Readiness Instrument (BTRI): Results of the Pretest Study and the Content Validation

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## **Abstract**

During the COVID-19 pandemic, education systems policymakers realized the importance of being able to communicate using technology and to fulfill their academic obligations. As a consequence, a different approach to education followed: blended learning. A literature review revealed a lack of psychometric tools related to blended teaching readiness in Greece. Hence, the purpose of this study was the translation from English to Greek and the adaptation of the “Blended Teaching Readiness Instrument” (BTRI). The research instrument assesses five instructional modules: teacher attitudes, learning activities, use of digital data, learning environments, and online interaction. The present study showed that the two versions of the BTRI, the original and the targeted, are fully equitable in terms of conceptual and adaptation meaning, with concepts of the same meaning in the Greek language. The final translated version corresponds to the original English version.

**Keywords:** Questionnaire adaptation, translation, validation, blended learning, teacher readiness

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Humanity has experienced an unprecedented crisis due to the spread of the COVID-19 virus, characterized by uncertainty about the future. Without previous experience, all sectors of society were summoned to face periods of confinement, but in a way that bridges the new conditions with human processes (Giannoulas et al., 2021). Without exception, the education systems tried to adapt to this new situation in order to tackle difficulties in teaching and learning (Schleicher, 2020; Weeden, & Cornwell, 2020). The new adaptation brought to surface negative aspects of education, which were neither clearly visible in the past nor given the necessary importance, such as lack of technical know-how, difficulties in communication, social inequalities, lack of network access, workload, feelings of pressure and stress, etc. (Ceglie et al., 2022; Giannoulas, 2023, pp. 10–11; Deng et al., 2022; Fray et al., 2022; Leask & Younie, 2022, pp. xxvi, 10, 59, 227–228; Robinson et al., 2022; UNESCO 2023a; UNESCO, 2023b; VanLone, 2022).

At every level of education, students and teachers, while remaining away from physical classrooms, carried on with educational processes through online education modalities (Deng et al., 2022; Giannoulas et al., 2021; Leask & Younie, 2022, pp. 3, 10, 47, 118; Weeden & Cornwell, 2020). With regard to the gradual transition to this different educational method, teachers had to ensure teaching and learning activities, while correspondingly students had to adapt to new ways of content delivery and communication.

Despite the positive or negative aspects of the unexpected and mandatory adoption of this particular approach to education, it undeniably contributed to the educational community's better knowing and understanding many of the characteristics of distance communication and distance education (Leask & Younie, 2022, p. 50). One of its fundamentals is the independence it offers to the apprentice in terms of the “space” of choice of study, but also in terms of the “time.” The concept of this kind of independence is understood for the younger students as freedom, a very well-known rule of their daily communication with each other through the use of technology like mobile phones (Zumbach, 2021, p. 14). It is precisely this different way of communication that transformed the world of education since the pandemic. It seems that the advent of the pandemic gave answers to the question about the necessity of educational reform. The ability to connect the physical presence in the classroom and the in-person communication with forms of distance communication is necessary.

Global education stakeholders realized the special importance of being able to communicate through technology in order to pursue the various educational activities. Students were able to access course materials before and after class; subsequently, teachers searched, discovered, and shared ideas for online resources that can support their distance teaching techniques (Leask & Younie, 2022, pp. 50–51). In other words, we met a different model of education, a totally flexible teaching and learning class, which can exist both in-person (learning inside a building) as in online forms. The reality is that this form of education as a concept has existed for decades— especially from the moment e-learning as a form of distance education was founded (Fedorova, 2021; Giannoulas, 2023, pp. 111–115). In this case, the building form of the conventional classroom, being the one part of the form, and the digital one, being the other part, artfully combined to create a new integrated educational field (Graham et al., 2019, p. 12). This is the “mixed educative form” or, as it is otherwise called, “blended learning.”



Blended learning is a form of education that combines independence in time and space, with respect to the pedagogical dimension of conventional teaching in-person inside a building class, with the aim of encouraging all students to actively participate in the learning process (active learning) (Joosten et al., 2021, pp. 9, 14). Its fundamental principle is the optimal combination of educational activities in-person with digital ones. It is a radical redesign that restructures the transactions of teaching and learning. It does not constitute a unilateral acceptance of distance education, but a reformation and an improvement of the traditional classroom (Garrison & Vaughan, 2007, pp. 5–7). However, it is very important to notice that this education approach with the combined in-person teaching and learning on the one hand and the distance learning on the other, give us the opportunity to have unlimited methods and practices available, due to this temporal and spatial independence (Conrad & Openo, 2018, p. 132).

Blended learning offers the possibility of maintaining education in any situation, even in the event of a crisis. The Ministry of Education in Greece must take advantage of this opportunity, strengthening the knowledge that it has acquired since the time of the pandemic and therefore consolidate this different approach to teaching and learning. On the other hand, the Greek educational community should understand that it is necessary to know “how” to smoothly combine the transition from pedagogical activities in the physical classroom, to digital formats and vice versa, in other words to be ready to use it in daily practice.

The purpose of this study is the translation from the English language and the semantic adaptation into Greek of the “Blended Teaching Readiness Instrument” with the aim of correspondingly measuring the degree of preparedness of Greek teachers.

## **Review of Literature**

Social needs, like those that emerged at the time of COVID-19 and the current ones, have led to significant changes in the educational process. This means that the transition from a traditional teaching model to a blended learning model—combining characteristics from the distance learning and the face-to-face traditional model—cannot be possible without meeting these needs. For the educational community, such a transition is quite challenging meaning that modern pedagogical approaches should be combined with the use of technology in order to get the best of results.

Therefore, educators need to leverage the experience and knowledge gained during the pandemic and post-pandemic time to promote their teaching practices using both distance learning and conventional teaching principles—in other words, blended learning (Eteokleous, 2021). Blended learning constitutes a combination of conventional teaching with forms of distance education. This means that learning should not be optimized by simply adding some digital materials or by delivering nonstop information, but to an integrated pedagogical framework where the teachers collaborate with technology and students are introduced to the teaching format (Pizzi, 2014) that uses the best of in-person teaching combined with distance learning (Cleveland-Innes & Wilton, 2018, pp. 5–6). Within the pedagogical framework, student-centered learning environments must be designed to provide optimal learning experiences that allow students to experience guided independent learning and sustained learning activity through

constant interaction between student-to-student, student-to-instructor, and student-to-learning resource (Eteokleous, 2021; Singh et al., 2021).

A well-integrated pedagogical environment in blended learning will encompass processes where students, in addition to being able to self-manage their learning time (Pizzi, 2014), will constantly have opportunities to develop learning communities (Skill & Young, 2002), which is a key element to student engagement (Eteokleous, 2021; McGee & Reis, 2012). For teaching in a blended learning environment to be successful, it is extremely important to focus on the capacity building of the teaching staff, not just to enable the sustainability of this teaching model at the educational and organizational level, but to develop measures and policies that will favor its better operation in the future (Batista-Toledo & Gavilán, 2022; Singh et al., 2021). This means that educators must be prepared to be aware of the potential benefits and potential challenges of blended learning and implement strategies to effectively address these challenges (Zhang, 2023).

A literature review revealed a few studies in Greece for adults about blended learning environments, many years before COVID-19, highlighting that the entire educational approach has to be implemented under pedagogical conditions (Anastasiades, 2012; Mouzakis, 2008). In terms of the educational part of this model of education, the blended learning model in Greece before COVID-19 seems to be limited to the voluntary use of digital files (Kouvara et al., 2022; Mavroudi, 2021), implying that teachers were not being sufficiently trained for implementing blended learning methods (Kouvara et al., 2022), preferring to stick to the traditional teaching style (Mavroudi, 2021). Despite an increased interest of teachers in the use of technology during the educational process, Mavroudi's research (2021) showed that they ultimately tend to prefer conventional teaching.

The prevailing law of the Greek Ministry of Education states that every educational process has to be conducted exclusively in its conventional format at the Primary and Secondary levels of education (Greek Republic, 2022), but also in every form of Tertiary education—except for postgraduate studies and courses of the Open University (Greek Republic, 2021). There are studies pointing out the benefits of BL as an educational model compared to the traditional one, for the Greek educational community (Lymperis, 2021; Mavroudi, 2021; Zagouras et al., 2022). Moreover, surveys related to the readiness of teachers in distance education were conducted during the lockdown period or immediately after. Some of them measured the teacher's level of readiness for teaching online (Giannouli et al., 2021; Tympa et al., 2023), while others assessed the readiness to teach in times of crisis (Perifanou et al., 2022). However, there is lack of research on the readiness of Greek teachers in blended learning.

The Blended Teaching Readiness Instrument (BTRI) was constructed by Archibald, Graham and Larsen (2020) and consists of five sections of pedagogical content, namely the “Disposition” section that concerns teachers' attitudes and four additional sections related to teachers' teaching ability in a blended system, with a total of 43 items or questions that can be answered on a six-point Likert scale. BTRI has been used in several research studies (Borup et al., 2022, pp. 17–37; Graham et al., 2019a, pp. 33–158; Short et al., 2021). Specifically, it concerns the following sections (Archibald, et al., 2020):

- (1) Disposition (for a blended design in practice): It assesses attitudes and beliefs of the

- teacher towards blended teaching and learning (eight questions).
- (2) Online Integration & Management: It evaluates the teacher's ability to function effectively by combining in-person activities in-person classroom learning with online classes and their ability to make and implement decisions (eleven questions—five for the online integration and six for the management).
  - (3) Data practices: It assesses the teacher's ability to use digital data to monitor each student's performance and intervene to achieve the pedagogical goals (eight questions).
  - (4) Personalizing instruction: It evaluates the teacher's ability to implement learning environments that allow the student to regulate pedagogical goals, one's pace of studying and learning, and make the best choice of the course content (eight questions).
  - (5) Online interaction: It assesses the teacher's ability to facilitate online interactions between all participants of the course (eight questions).

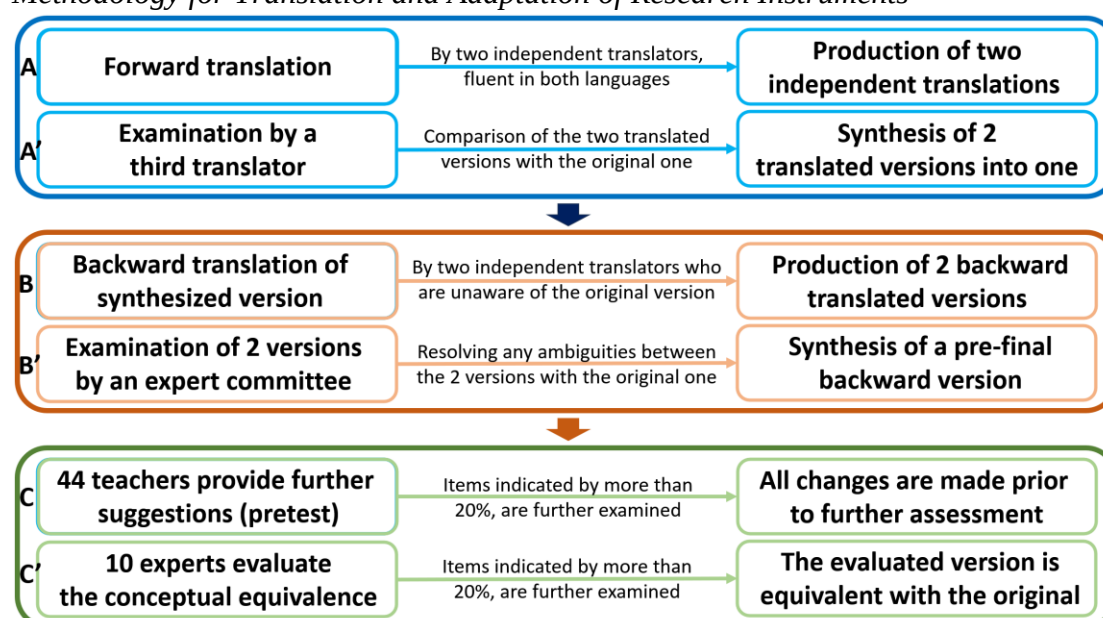
The BTRI was created as a measurement instrument in a blended program in primary and secondary classes in the U.S., with the aim of helping teachers tailor their training in distinct areas of their teaching ability in blended education, according to their needs. The responses from the survey, in each area of teaching domain of the proposed training model, converged and were valid (Archibald et al., 2020). In particular, BTRI meets, according to the confirmatory factor analysis in the above five pedagogical modules, the statistical limits defined by relative literature (before training: RMSEA = 0.045, CFI = 0.933, TLI = 0.929, SRMR = 0.043, and after training: RMSEA = 0.044, CFI = 0.911, TLI = 0.905, SRMR = 0.051), without any of the correlations exceeding the limit of 0.85 (Farrell & Rudd, 2009). Accordingly, Archibald, Graham, and Larsen's (2021) validation study of the BTRI showed that the model is acceptable as it fits the data adequately.

The BTRI has been used into other countries as well, such as in Turkey (Ayaydin & Kucuk, 2022) with a reliability score of 0.97, and in China (Deng et al., 2022), with a degree of reliability of 0.94, values that make it highly reliable (Johnson et al., 2022). The BTRI is based on the work of Graham, Borup, Pulham, et al. (2019), which concerns, apart from teachers' attitudes, a framework of abilities and measurement of readiness in blended learning. The instrument is simultaneously simple and pedagogically oriented. Hence, it has a strong impact and is accepted and adopted by the educational community.

## Method

Initially, after a written request, the research team received through email the consent of the creators of the BTRI for the translation from English to Greek and its use for the Greek educational community. Then, we additionally received the approval of the research ethics committee of the Higher School of Pedagogical and Technological Education (ASPETE)—protocol number 01/2022—to carry out the corresponding research project.

The methodology of translation, adaptation, and content validation of psychometric instruments that has been used in various studies was followed (Efsthathiou, 2019; Kalamatianos & Canellopoulos, 2022; Lyrakos et al., 2010), including specific steps and defining procedures to achieve linguistic equivalence and validity content (see Figure 1).

**Figure 1***Methodology for Translation and Adaptation of Research Instruments****Forward Translation and Synthesis of Translated Versions***

Step A: Two independent bilingual translators were asked to translate the BTRI assessment tool from English (source language) to Greek (target language), both in terms of its concepts and of its terminology. The result was the production of two independent translations of the instrument into Greek.

Step A': The two independent translations were compared by a third bilingual translator to the original language of the research instrument (English) for any differences. After communicating and discussing with the first two translators about any discrepancy between them, the third translator composed and structured the first version of the translated form of the instrument into Greek (see attached file 1).

***Backward Translation and Synthesis of the Translated Versions***

Step B: Similarly to step A, two independent bilingual translators without knowledge of the original English research instrument, were asked to convert the translated instrument in Greek back into English. The purpose of this reverse translation is to check the conceptual

equivalence of the translated version with the original one. The result was the production of two independent backward translations of the research instrument into English.

Step B': The research team then discussed the two independent back-translations. They checked their equivalence with the original English version and combined them into a single one. When there were conceptual differences, the additional opinion of teachers of tertiary education with experience in technology-assisted education, as well as in research methodology, was requested in order to correct the Greek version in every aspect that possibly altered the original English meaning. The process continued until all members of the research team and the teachers, as expert review committee for the research methodology and the topic under study, jointly agreed on the backward pre-final version (second version) of the research instrument into the Greek language (see attached file 2).

### ***Pretest of Synthesized Translated Backward Pre-Final Version and Cultural Equivalence***

Step C: We also evaluated the research instrument in terms of clarity of instructions, questions, and content in the Greek language and a sample of 44 teachers of all stages of education (7 primary school and kindergarten teachers, 14 teachers of secondary education, and 23 teachers of higher education) was invited to participate and to further examine the pre-final version of the translated instrument. Four teachers from the primary and the secondary stage of education, two from each stage of education, had never taught in a distance learning course. The characteristics of the teacher's population who took part in the study are listed in Table 1.

**Table 1**

#### *General Characteristics of Teachers Who Participated in the Pre-test*

| Sex                       | N         | N %         |
|---------------------------|-----------|-------------|
| Men                       | 23        | 52.3        |
| Women                     | 21        | 47.7        |
| Age                       |           |             |
| 25–35                     | 4         | 9.1         |
| 36–45                     | 11        | 25.0        |
| 46–55                     | 15        | 34.1        |
| 56+                       | 14        | 31.8        |
| Educational level         |           |             |
| Primary                   | 7         | 15.9        |
| Secondary (& Post)        | 14        | 31.8        |
| Tertiary                  | 23        | 52.3        |
| Professor                 | 3         |             |
| Associate professor       | 4         |             |
| Assistant professor       | 3         |             |
| Lecturer                  | 3         |             |
| Laboratory teaching staff | 7         |             |
| Research fellow           | 2         |             |
| Higher School Teachers    | 1         |             |
| <b>Total</b>              | <b>44</b> | <b>100%</b> |

The backward pre-final version of the BTRI was converted into an online questionnaire form (Google Forms) and posted it at an open and shared link address. All members of the sample completed the online questionnaire between November 2022 and March 2023. When a

sample member clicked on the questionnaire link, before the appearance of the online questionnaire webpage, another webpage appeared with information on the reasons for conducting this research. In this first informative webpage, each participant was kindly asked for his or her assistance and the possibility to contact the members of the research team by an electronic message or telephone call, if there was any unclear or controversial concept, as well as his or her suggestions to change and/or correct the content, in order to achieve and enhance the conceptual understanding of the texts. The indication of each controversial or unclear element and the related highlights and suggestions, by at least 20% of the participants, meant its further processing by the research team. After completing all the changes, the pre-final version of the research instrument (third version) was generated (see attached file 3).

Step C': At a later stage the final form of the research instrument was distributed to a committee of ten experts in the field (Lynn, 1986) in order to achieve cultural equivalence and content validity (Davis, 1992; Efstathiou, 2019; Polit & Beck, 2006; Thinakaran et al., 2018). It is the last step of assessing the appropriateness and representativeness of the content and concerns the degree of relevance of each question, in terms of the measurement tool itself and of the section to which it belongs. All the experts in the field had many years of experience in research and teaching in education, both in a conventional and online classroom, in school, academic, or other educational programs (Davis, 1992).

To achieve content validity by the panel of experts, an electronic validation form was created (docx format), just for the content of the BTRI in the previous step (the pre-final version). In each panel member the validation form was sent via email, providing instructions for critically evaluating all items in the research instrument. Each member of the committee had to evaluate separately the conceptual agreement of the pre-final translated form in Greek and made all the necessary changes to adapt it to the educational reality in Greece. After the content evaluation every expert had to send his or her answers by email to the research team. The assessment of the relevance of each item (question) in terms of the measurement tool and the section where it belongs, involved the critical selection of a grade on a 4-point scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant) (Efstathiou, 2019; Lynn, 1986; Polit & Beck, 2006). As in the case in the pretest assessment for issues of ambiguity or inconsistency, any indication of inconsistency by at least 20% of the expert panel members, in our assessment for the selection of scales 1 or 2 (Lynn, 1986), meant, regarding the research team, the further conceptual elaboration of the item and its re-evaluation (Efstathiou, 2019; Marzuki et al., 2018; Sousa & Rojjanasrirat, 2010).

The overall scoring of the research instrument by the panel of experts produced the content validity index, both at item level content validity index (I-CVI) and at the instrument level, or scale level content validity index (S-CVI) that summarize item relevancy score (Roebianto et al., 2023). According to the international literature (Efstathiou, 2019; Marzuki et al., 2018; Sousa & Rojjanasrirat, 2010), in order to accept the aforementioned scoring procedure, the result must score content validity values equal to or greater than 0.8 per question section (see attached file 4).

It is noted that, upon receiving the evaluation by each member of the expert committee and the calculation of the score, there was a verbal or written communication with the research

team, encouraging each evaluator expert to indicate the reasons for his evaluation grade on each individual element of the research instrument (Yusoff, 2019).

## Results

In the step C', a committee consisting of ten experts in the field evaluated the research instrument for content validity. Out of 43 questions in total, two (4.65%) in the first section were marked in a percentage greater than or equal to 20%, as “not relevant” or “somewhat relevant” (see red boxes in Table 2). The specific questions were modified according to the suggestions and re-evaluated. Subsequently, no items needed to be revised, as all questions have a degree of relevance of “quite relevant” or “highly relevant” (see Table 2).

**Table 2**

*Relevance Rating of the Instrument Questions After the Pretest*

| Initial assessment (N = 43 questions) |   |   |   |   |   |   |   |   |   |    |                |
|---------------------------------------|---|---|---|---|---|---|---|---|---|----|----------------|
| Unit 1                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |   |    |                |
| Unit 2                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11             |
| Unit 3                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |   |    |                |
| Unit 4                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |   |    |                |
| Unit 5                                | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |   |    |                |
| Final assessment (N = 2 questions)    |   |   |   |   |   |   |   |   |   |    |                |
| Unit 1                                |   |   | 3 |   | 5 |   |   |   |   |    |                |
|                                       |   |   |   |   |   |   |   |   |   |    | Accepted<br>41 |
|                                       |   |   |   |   |   |   |   |   |   |    | 2              |
|                                       |   |   |   |   |   |   |   |   |   |    | Total<br>43    |

Note. Green = approval, yellow = partial approval, and red = rejection.

Moreover, we calculated the content validity index (CVI). Specifically, the index for each item level question (I-CVI) was found to be greater than 0.90, and similarly the instrument (the scale) content validity index (S-CVI) was found to be greater than 0.95, which are completely acceptable indices (Efstathiou, 2019; Johnson et al., 2022; Sousa & Rojjanasrirat, 2010). More detailed results are presented in Table 3 (see also attached file 4).

In terms of the methodology followed for the specific study, there was immediate communication by the members of the research team with each member of the expert committee after the electronic receipt of each expert member evaluation. During communication (by e-mail or by telephone), all suggestions were discussed and taken into account, even those that were not changed (questions with a marking rate of less than 20% are indicated in orange in Table 2). In addition to the comments related to the relevance of the content, the elements of the research instrument in terms of clarity and understanding were also discussed and considered (see the final version of the translated BTRI in the Greek language—attached file 5).

**Table 3**

*Content Validity by Module, Item-Level, and Instrument-Level*

| Questions     | I-CVI |   |     |   |     |     |     |     |   |    |    | S-CVI/Ave |
|---------------|-------|---|-----|---|-----|-----|-----|-----|---|----|----|-----------|
|               | 1     | 2 | 3   | 4 | 5   | 6   | 7   | 8   | 9 | 10 | 11 |           |
| <b>Unit 1</b> | 1     | 1 | 0.9 | 1 | 0.9 | 0.9 | 1   | 0.9 | - | -  | -  | 0.95      |
| <b>Unit 2</b> | 1     | 1 | 1   | 1 | 1   | 1   | 1   | 1   | 1 | 1  | 1  | 1.00      |
| <b>Unit 3</b> | 1     | 1 | 1   | 1 | 0.9 | 1   | 0.9 | 1   | - | -  | -  | 0.98      |
| <b>Unit 4</b> | 1     | 1 | 1   | 1 | 1   | 1   | 1   | 1   | - | -  | -  | 1.00      |
| <b>Unit 5</b> | 1     | 1 | 1   | 1 | 0.9 | 1   | 1   | 1   | - | -  | -  | 0.99      |

Note. Number of experts in the field = 10.

## Discussion

The purpose of this study is to offer researchers, academics, and teachers the opportunity to calculate and to point out the level of preparedness of Greek teachers in mixed education. For this reason, the BTRI by Archibald, Graham, and Larsen (2021) was chosen.

BTRI has already been used in studies to calculate and to point out the level of preparedness of teachers in other countries as well. For example, in China, Deng, Tse, and Lok (2022) studied the attitude of 35 primary school teachers towards blended teaching. In particular, the researchers used the BTRI to find the factors that facilitate teachers to use a blended learning process and simultaneously identify the obstacles that inhibit it. Their study highlights the positive attitude of teachers towards the five BTRI factors that promote this educational model, but also the need to take part in professional training programs to maintain and strengthen these factors.

The BTRI was also adapted into Turkish language in order to measure the readiness of pre-service teachers and teachers from different branches, for blended teaching, by Ayaydin and Kucuk (2022). The researchers who carried out a survey of 446 teachers in Konstantinoupolis confirmed the five factors of the original instrument in the English language. As a result of the analysis, it was concluded that the BTRI, which was adapted into Turkish language, has the same structure as the original and it is a valid and reliable instrument that can measure the level of teachers' readiness for blended teaching in Turkey.

The adaptation of a research instrument includes its conversion into Greek and the Greek educational environment and a readability test. Thus, apart from the translation and linguistic equivalence, all elements, both conceptual and cultural, were checked and corrected, with the aim of the full equivalence of the research instrument in both languages, English and Greek, and in particular:

1. Conceptual meaning: appropriate words and/or phrases were chosen that give the same meaning in Greek as in the English version (e.g., “in-person” in English into “person to person” in Greek (see the “Vocabulary” section in attached file 1).
2. Cultural adaptation: the English concepts of technology and/or culture were replaced with concepts of the same meaning in the Greek language (e.g., “interact well” in English into “two-way interaction” in Greek).



The degree of content validity of the BTRI translated into Greek appeared to be acceptable. In this way, the process of its conceptual weighting is completed for possible use in future research studies and for the investigation of the degree of preparedness of Greek candidates or practicing teachers in mixed education and, in particular, the area or areas that need more attention. The BTRI may be used as an examination tool, not only in terms of the existing knowledge, but also as an investigation of the success of their efforts in professional development (Anoba & Cahapay, 2020; Archibald et al., 2020; Graham et al., 2019).

Overall, the final translated version of the BTRI in the Greek language, as completed through the aforementioned procedures of the evaluation steps of the methodology, is equivalent to the original version in the English language. Its items are relevant to the blended teaching readiness and representative to measure this behavior. In future studies, we intend to apply BTRI to teachers and verify that the Greek version has the same structure, with the original form, and that it is a reliable and valid tool to evaluate teachers' readiness for blended teaching.

### **Affiliate Contribution**

We would like to express our sincere gratitude to all those who participated in the creation of the Greek version of the BTRI, at whatever step their contribution was made, without whom the study would not have been possible. Among the contracting parties are (only colleagues who agreed to have their names displayed are listed): Irini Tsapeloglou, Faculty of Education, Cambridge University, England, Alexandra Mella, École de Traduction et Interprétation ISTI-Cooremans, Free University of Brussels, Belgium, Paraskevi Lygkonis, Pedagogical Department of Primary Education, National and Kapodistrian University of Athens, Greece, Paraskevi Karavida, Faculty of Management and Administration, University of National and World Economy, Bulgaria, Sotirios Karatzimas, Department of Accounting and Finance, Athens University of Economics, Greece, Aikaterini Kasimati, Department of Education, School of Pedagogical and Technological Education, Greece, Dimitra Kavka, Department of Education, School of Pedagogical and Technological Education, Greece, Aglaia-Lia Stamboltzi, Department of Economics and Sustainable Development, Harokopion University, Greece, Nadia Kourmousis, Department of Education, School of Pedagogical and Technological Education, Greece, Vasilios Naoum, Department of Maritime Studies, University of Piraeus, Greece, Sandra Cohen, Department of Organization and Business Administration, Athens University of Economics and Business, Greece, Ria Klada, Department of Education, School of Pedagogical and Technological Education, Greece, Athanasios Sakkas, Department of Accounting and Finance, Athens University of Economics and Business Greece, and Stefania Fouska, Department of Education, University of Nicosia, Cyprus.

### **Contribution of Authors**

All authors in this project are at the same time researchers who participated in the completion of the design of this study. All of them studied, gave and received comments and ultimately jointly approved the final version of the translated measurement instrument and the writing and publication of this study. This research received no specific grant from any funding

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## Appendix

Attached to this study are the five successive versions of the translated research instrument, as they were formed according to the methodology followed. Each of the following editions concerns the conceptual adaptation in Greek of the previous one.

1. **Attachment 1:** The first synthesized version of two original translations (forward translations) from English to Greek.
2. **Attachment 2:** The second compiled version in Greek after the two backward translations and their synthesis into one.
3. **Attachment 3:** The third version like the research instrument was formed after conducting the pretest on a sample of 44 teachers of all educational stages.
4. **Attachment 4:** Content validity, item-level and scale-level by panel of experts.
5. **Attachment 5:** The final version of the BTRI in the Greek language.

Access these attachments at

[https://drive.google.com/drive/folders/1Nj1kYAkrrsY0Zkho9lc5T6csL1y\\_Cznz?usp=sharing](https://drive.google.com/drive/folders/1Nj1kYAkrrsY0Zkho9lc5T6csL1y_Cznz?usp=sharing)

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# Written Assignments in Technology-Enhanced Postgraduate Courses in TESOL

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## Abstract

The research paper explores the impact of assignments on enhancing educational technology awareness among postgraduate trainee English language teachers at the Hellenic Open University. The study focused on participants in the teaching of English as a foreign language (EFL) program, specifically those engaging in the 13-week training module (Agg31) on the use of modern technologies in English teaching. The training involved distance learning materials, three four-hour sessions, forum discussions, and the completion of two substantial written assignments presented in a plenary format known as VIVA. During the academic year 2022–2023, 50 trainee teachers, split between winter and spring semesters, participated in the study. The research used closed- and open-ended questions, with 10 trainees engaging in focus group discussions to elaborate on questionnaire responses. Descriptive statistics and content analysis were employed for data examination. Results indicated that the assignments, often implemented in classrooms, expanded trainees' understanding of new media methods. The VIVA sessions provided opportunities for reflection and expressing a commitment to continuous learning. Trainees felt supported and inspired, fostering a desire to explore and exchange ideas for innovative techniques and resources.

**Keywords:** Teacher development, foreign language pedagogy, educational technology, intercultural awareness, differentiated instruction, written assignments, educational scenarios

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Open and distance learning is a popular option chosen by millions of people around the world to widen their knowledge and build skills in various professional fields (Afolayan, 2015; Evans & Nation, 2013). There are many varied motivations that drive people to decide on a distance learning program. In Europe, and in Greece in particular, such programs are run by universities, colleges, and various public and educational institutions. These courses may have a shorter or longer duration depending on the qualifications they award. Their content is determined by the goals they set, the groups of trainees they address, and the needs of the society in which they are embedded. In Greece, learning foreign languages, especially English, is a prerequisite for employment. Children start in kindergarten and continue to learn English until they receive their high school diploma. At the same time, it is almost common practice for learners to attend English courses in language centers or to take private lessons at home. As a result, foreign language education is systematically evolving and curricula are being developed and enriched, following new trends and modern methodologies in applied linguistics.

EFL teachers usually decide to join training programs because of the need to update their knowledge and skills. Modern language learning pedagogies include differentiated teaching, the use of new technologies, experiential teaching and projects, the promotion of intercultural and multilingual awareness among learners, alternative assessment combined with traditional assessment methods, etc. At the same time, teachers need to be able to analyze pupils' needs in order to design appropriate educational scenarios, collect data that contribute to formative assessment, plan and participate in innovative activities, cooperate with other teachers and parents for the benefit of their pupils and the wider school community, etc. Open and distance learning seems to be the most appropriate form of education and training for EFL teachers who wish to develop skills such as those mentioned above in order to improve their teaching and be competitive in the labor market. Distance learning programs offered to EFL teachers employ different modes of delivery but primarily embrace blended and flipped learning and involve trainees studying remotely and developing assignments (Stavroulia, 2011).

The master's program (MSc) offered by the Hellenic Open University (HOU) focuses on specialized postgraduate training for individuals involved in or aspiring to teach English as a foreign or international language. This comprehensive program encompasses various aspects of teaching English as a foreign language and is uniquely designed to accommodate distance learning, allowing trainee teachers to participate in the program without the need to leave their current teaching environments. The program places a strong emphasis on practical learning through creative assignments, encouraging trainee teachers to apply their acquired knowledge by designing, delivering, and assessing lessons. These assignments serve as opportunities for experimentation and the exploration of the multifaceted field of education.

This paper delves specifically into the realm of assignments, examining the factors that contribute to the professional growth of trainee teachers within the program. The research project discussed was conducted as part of the MSc program at HOU. Extensive research was conducted in 2019 within the MSc program, focusing on the assignments submitted by trainee teachers. This research centered on the feedback provided by course instructors, the reflection processes engaged in by trainees following assignment completion, as well as their academic writing and research skills (Georgountzou & Calfoglou, 2019; Karagianni, 2019; Kofou, 2019; Maliotaki, 2019; Trigonaki, 2019). Specifically, the 2019 research aimed to improve written feedback,

suggestions for assignment enhancement, and the design and submission of well-crafted dissertations. However, there has been a gap in researching the impact of these assignments on trainees' professional development, particularly in their classroom practice.

The purpose of the research project presented here is to explore the extent to which two written assignments and an oral presentation (VIVA) at the end of the educational technology in TESOL course (Agg31) aid trainees in developing an awareness of how Information Communication Technologies (ICTs) can be effectively integrated into everyday language lessons, and whether they contribute to the development of good pedagogical practices. This research project began with three main questions:

1. *What tools, applications, and technologies do trainees employ in the educational scenarios they design for their written assignments? What are the reasons behind these choices?*
2. Do trainees believe that the educational scenarios they design for their assignments are practically applicable in the lessons they teach? To what extent do these scenarios help them develop awareness of how educational technology can enhance foreign language learning?
3. Do trainees believe that the oral presentation of educational scenarios, along with subsequent discussions among participants, contributes to a deeper understanding of the innovative methodologies studied during the course? If so, to what extent?

The paper is structured into six main sections. Following this introduction is a theoretical framework outlining fundamental principles of modern language learning pedagogy, including the use of new technologies, intercultural awareness, and differentiated instruction, which serve as reference points revisited throughout the text. The third section details the research methodology, the fourth presents findings and results, the fifth discusses limitations, and the sixth summarizes findings and concludes the work.

### ***Preparing EFL Teachers for Diverse Challenges: Specializations in Language Teaching Pedagogy***

Teaching English to Speakers of Other Languages (TESOL) encompasses a broad spectrum of teaching approaches and methodologies aimed at facilitating effective language learning. These include communicative language teaching, task-based and project-based learning, content and language integrated learning, and technology-enhanced learning, among others, which educators are expected to leverage. As it is put forward in the relevant literature, it is customary for teachers to integrate multiple approaches to achieve a balance between accuracy and fluency while fostering a diverse range of knowledge and skills in learners (Cook, 2016; Pfenninger et al, 2013; Smith & Candlin, 2014).

As part of their training, prospective teachers (trainee teachers) need to acquire expertise in language acquisition theories, linguistics, and language structure. They must also become proficient in effective language teaching techniques, encompassing methods for enhancing students' reading, writing, speaking, pronunciation, vocabulary, and grammar skills (Mitchell et al., 2019). Additionally, trainee teachers must be attentive to the cultural diversity present in their classrooms, acknowledging the varied backgrounds and identities of their learners (Alyan, 2011). This awareness is vital for cultivating an inclusive and respectful classroom environment.

Teacher training programs should extend their focus to various specialized areas, including the adept use of digital media, personalized teaching approaches, catering to diverse age groups, and employing a variety of techniques for assessing language skills. The ensuing paragraphs in this section concentrate on the specific fields that garnered heightened attention from trainee teachers participating in this research project: educational technology, intercultural awareness, and differentiated instruction.

The advent of new media, tools, resources, and teaching methods has brought about a substantial transformation in the realm of second or foreign language acquisition. The proliferation of online platforms and mobile apps offering interactive lessons, exams, and assignments has greatly enhanced the accessibility of language learning. Furthermore, advancements in video conferencing technology have enabled learners to engage in interactive practice, connect with peers and educators from around the globe, and receive personalized instruction.

Interactive resources, such as online courses, podcasts, streaming services, and language learning websites, have streamlined the learning process. Additionally, the English language is now readily available through authentic reading materials like e-books, CDs, and online articles. These opportunities enable learners to expand their vocabulary by exposing them to language usage in authentic contexts. Moreover, learners can immerse themselves in virtual environments and participate in simulated discussions, providing them with enriching language learning experiences through augmented and virtual reality (Freiermuth & Zarrinabadi, 2020; Ziegler & González-Lloret, 2022).

Gamification has emerged as a pivotal factor in motivating learners of all ages and promoting language development (Reinhardt, 2018; Soares & Weissheimer, 2016). Consequently, it is essential for EFL teachers to receive training in the integration of educational technology into their lessons. This training should encompass not only familiarity with the tools and media but also the ability to effectively employ language teaching methodologies that take advantage of the possibilities offered by these applications and online resources.

Intercultural awareness forms a vital component of EFL teacher development programs, not only enhancing their teaching practice but also equipping them with the necessary skills and mindset to navigate effectively in the diverse and globalized world of English language education. In the context of learning English as an international language, the cultivation of learners' intercultural awareness takes precedence. This term pertains to their sensitivity and comprehension of diverse cultures and their social realities, an understanding that holds great significance since every language is intricately linked with the cultures and societal norms of its speakers.

Within EFL classes, instructional activities should inspire learners to respect and embrace various cultures, gain insights into different traditions, values, and practices, and discern the distinctions between their own culture and those of others (Byram, 2020; Fitzpatrick, 2019; Holliday, 2010; Jackson, 2019). Consequently, intercultural awareness becomes an integral component of a comprehensive teacher training program for EFL educators. It empowers

learners to become more effective communicators in various cultural contexts and fosters their sensitivity to diverse needs.

Various digital tools—including virtual communication platforms facilitating collaboration with learners from different cultures, multimedia resources presenting cultural aspects from various regions worldwide, educational games, and interactive applications enabling exploration of foreign cultures and languages—contribute significantly to the development of intercultural awareness. In essence, technology serves as a valuable means of offering learners rich intercultural experiences and cultivating a more receptive, sensitive, and open attitude towards other cultures and ethnic communities.

Another crucial area in which EFL teachers require training is differentiated instruction. Typically, learners in a classroom exhibit varying levels of English language proficiency, with some facing difficulties in language acquisition or possessing specific educational needs. Differentiated instruction accommodates these individual differences by allowing teachers to tailor their lessons to suit each learner's requirements and academic level (Blaz, 2016; [Tomlinson & McTighe, 2006](#)). Moreover, in many educational settings, classrooms comprise students from diverse ethnicities and cultural backgrounds. Embracing differentiated instruction can promote an appreciation for and respect of various cultures among learners, fostering a sense of inclusivity.

Differentiated instruction is a dynamic process that necessitates continuous adjustments based on learners' demands and responses. Teachers must employ a range of strategies, such as lectures, debates, hands-on activities, group work, and technology, to cater to different learning styles. Understanding learners' varied learning styles, abilities, challenges, and interests is crucial (Duquette, 2022). Teachers should foster a welcoming and respectful learning environment where every student feels valued and free to express themselves. Using various modalities, including visual, auditory, kinesthetic, and interactive approaches, and offering a diverse array of materials to engage different learner types are essential components of differentiated instruction ([Pappa, 2016](#)).

Technology plays a pivotal role in supporting diversified foreign language education by aiding teachers in customizing lessons to meet the diverse needs and abilities of their students. EFL teachers can make use of educational software and applications that offer exercises and lessons at different language proficiency levels, incorporate online resources like videos, audio materials, and websites to provide supplementary content, and create personalized assessments that align with each learner's knowledge and skills.

Conducting research on how teacher education programs can prepare instructors for the multifaceted demands of language teaching is of paramount importance. As Xie (2013) explains, such research not only elevates the standard of language instruction but also promotes inclusivity and addresses the evolving requirements of today's educational landscape. It assists in identifying the elements contributing to teacher success and job satisfaction, empowers stakeholders to make informed decisions to enhance quality, encourages teachers to stay updated on best practices, and ensures that educators are well-equipped to deliver effective language

education to a diverse range of learners in various educational contexts. Subsequent sections will delve into the research methodology, findings, and implications.

### *The Context and the Research Methodology*

The HOU's course AGG31, titled "Educational Technology in TESOL, has the primary objective of providing a comprehensive understanding of how ICTs can effectively be used in the teaching and learning processes of English as a second, foreign, or international language. This course, which corresponds to 15 ECTS (European Credit Transfer and Accumulation System) credits, places significant emphasis on equipping participants with the necessary skills to proficiently employ modern ICT applications as essential tools for English language education. It also focuses on using contemporary instructional resources to support teachers in their practice and guiding them in integrating current pedagogical theories with modern ICT tools.

The course adopts a flexible approach to learning, employing a course management system and a flipped classroom model. This allows trainee teachers to engage with online resources and applications, alongside synchronous online sessions, all while having the flexibility to engage in self-study and self-access from the comfort of their homes. Various communication channels, including videoconferencing, the course management system's "Discussion forum," as well as platforms like Facebook Messenger," "Viber," or "WhatsApp" groups, facilitate interaction and collaboration between trainees and their instructor, as well as among trainees themselves.

The course spans a duration of thirteen weeks, during which trainee teachers are tasked with completing educational activities on the course's 'Discussion Forum' and submitting two comprehensive written assignments. These written assignments revolve around the creation of learning units that effectively incorporate ICTs. The focal point of these assignments is the development of elaborate educational scenarios, highlighting the benefits of the proposed tools or technologies. These scenarios encompass all required materials, offer a clear rationale and justification for their design, and elucidate the advantages they bring to the intended learners.

Towards the conclusion of the thirteen-week course, trainee teachers are required to orally present their assignments to both the instructor and their peers, a session known as the VIVA." This presentation format enables constructive feedback, focusing on the potential applications of different tools and technologies, as well as the pedagogical methodologies employed.

The research project discussed in this paper aims to assess the extent to which the course activities, including the two assignments involving educational scenarios and the VIVA presentations, helps trainees to develop expertise, and competencies related to the proficient and purposeful use of technology to enhance the teaching and learning processes within EFL classrooms. The research was carried out during the academic year 2022–2023, spanning September 2022 to June 2023. It involved the active participation of 25 trainee instructors who successfully completed the module (Agg31) during the winter semester, alongside an additional 25 trainees who had taken part in the module during the subsequent spring semester. The

research data collection process employed a combination of closed-ended and open-ended questions, administered through an anonymous questionnaire hosted on Google Forms.

The questionnaire was divided into three sections. The first part focused on demographic data, including the trainees' sector of education and the language levels they taught. In the second part, trainees were asked about the two written assignments. Firstly, they were prompted to select tools, applications, and technologies they used in the educational scenarios they designed. Secondly, they were required to explain which of these tools they found most effective for their learners. Additionally, they were asked whether they had implemented the educational scenarios they designed in their teaching and if the outcomes met their expectations. Within this section, trainees were also questioned about whether they believed their designed scenarios helped them gain awareness of how educational technology contributes to effective learning. They were provided with three response options (not at all, a little, a lot) and were required to justify their choice. Moreover, they were asked to explain if they considered their assignments to have practical application in their teaching and instructional design.

The third part of the questionnaire addressed the VIVA. In the first question, trainees indicated the extent to which they believed the VIVA aided in their understanding of how educational technology facilitates effective language learning. Following this, they were asked to justify their response and specify which tools, from those used by their peers, they intended to incorporate into future lessons. Finally, they were invited to provide overall feedback on the assignments and VIVA, along with suggestions for improving course components to enhance their professional development as educators.

Furthermore, ten trainee teachers, evenly distributed between the two groups, participated in focus groups aimed at elaborating on their questionnaire responses. These discussions were conducted in two separate focus groups, with the first group convening in January 2023 and the second in June of the same year. Each focus group discussion session lasted approximately one hour. Focus groups allow researchers to gain in-depth insights into attitudes, beliefs, and experiences with the aid of open-ended questions that uncover motivations and emotions (Acocella & Cataldi, 2020; Barbour, 2018). The trainee teachers built on each other's comments, challenged viewpoints, and explored complex topics such as the effectiveness of the VIVA, and made valuable and substantiated proposals. Data analysis techniques applied in this research encompassed content analysis and descriptive statistics. Content analysis is a versatile research method that can be tailored to address a wide range of research questions and objectives. Its systematic and structured approach to examining communication materials makes it a valuable tool for researchers ([Neuendorf, 2016](#); Swann, 2020).

The responses from trainee teachers to the open-ended questions in the questionnaire, alongside discussions held in focus groups, were analyzed thematically. Key concepts used for data categorization included:

- “Accomplishing learning objectives”: examining whether the learning objectives set in educational scenarios were achieved when taught.
- “Learner needs and centeredness”: investigating whether trainees designed lessons to accommodate differentiated instruction.

- “Intercultural awareness”: exploring whether intercultural encounters influenced tool selection and learning activity design.
- “Creativity”: assessing whether imaginative and creative thinking were considered in pedagogical decision-making.
- “Communities of practice”: gathering trainees’ suggestions, frequently mentioned in both questionnaire responses and focus group discussions.

It is worth noting that responses from focus group discussions were cross-referenced with questionnaire responses to ensure triangulation of data.

## Presentation And Discussion of the Findings

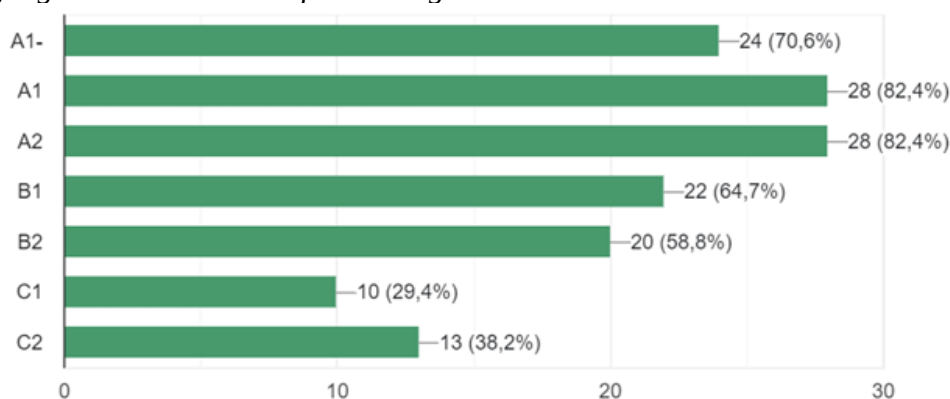
### *Demographic Information, Age Groups, Sectors in Education, Language Levels*

The study’s participants consisted entirely of females. Within this population, 38% fell within the age bracket of 41 to 50, while the remaining 62% were aged between 20 and 40. These participants were both residents and employees in various regions across the country. In terms of their professional roles, 50% served as educators in public schools, covering elementary, middle, and high school levels, 3% worked in private elementary schools, 6% were employed in public kindergartens, and 47% were associated with private language schools. Furthermore, 44% of the teachers offered private tutoring sessions to students in their homes. Some of the participants held positions in more than one educational sector.

Concerning their language proficiency instruction, the participants were involved in teaching across all levels, with the majority focusing on A1 and A2 CEFR levels (CEFR, 2020). A visual representation of the participants’ responses regarding the language levels they taught is provided in Table 1.

**Table 1**

### *Language Levels the Participants Taught*

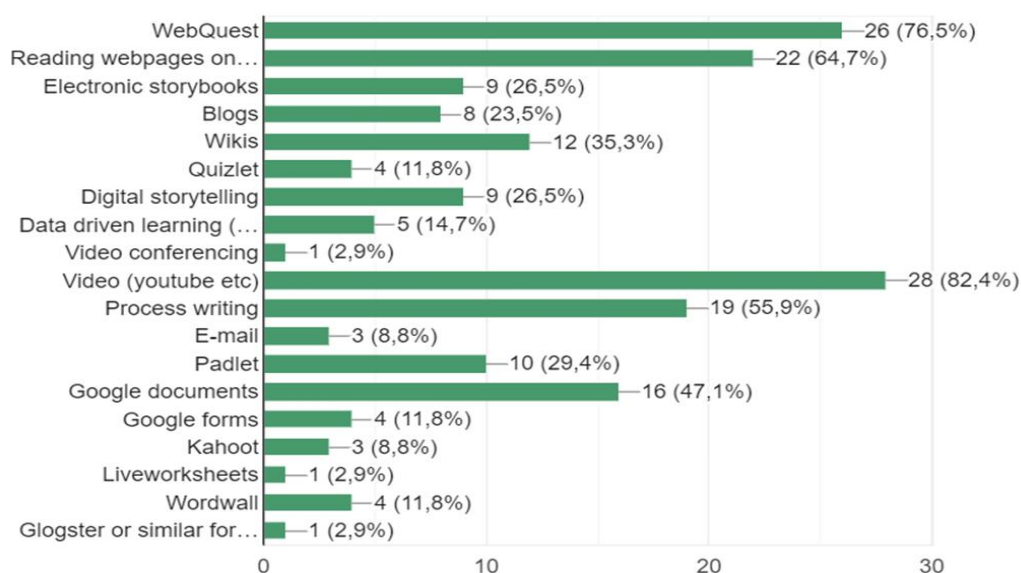


### *Choices in Integrating ICT Tools in Educational Scenarios*

In the second part of the questionnaire the trainee teachers were tasked with choosing the tools they employed in the educational scenarios they had devised for the two assignments. The reason behind including the first research question was to gather insights from trainee teachers regarding the tools they prefer to use for teaching the four language skills (listening, speaking, reading, writing), enhancing language awareness (grammar and vocabulary), promoting collaborative learning among learners, and ultimately, discerning which of these skills takes precedence in their teaching approach. Table 2 offers an overview of the choices made by trainee teachers in terms of tools and ICT learning models.

**Table 2**

*ICT Tools and Learning Models Trainee Teachers Used for the Design of their Educational Scenarios*



### ***Reading and Listening Skills***

As evident from the choices made by the trainee instructors, the language skills that took precedence in the development of the educational scenarios were “reading” and “listening.” More specifically, the trainees opted for the WebQuest learning model (76.5%), which is rooted in project-based learning pedagogy and provides opportunities for both receiving and producing written language, including reading webpages (64.7%). On the other hand, they favored video (82.4%), which encourages the reception of spoken language. As is reported in the relevant literature, both options are known to stimulate learner motivation, making the lessons engaging



and effective (Dodge, 2001; Goodman et al., 2017; Terantino, 2011; Tschirner, 2011; Vlachos, 2020)

### ***Writing Skills***

Concerning the production of written language, the majority of trainee teachers used Google Documents (47.1%) for constructing their scenarios. As it is endorsed in the literature (Abrahms, 2019; Suwantarathip & Wichadee, 2014; Zhou et al., 2012), Google Documents not only promote collaborative learning but also enhance creativity through the process of writing (55.9%). Interestingly, a smaller percentage of trainee teachers chose blogs and wikis (23.5% and 35.3%, respectively), which, according to the literature, facilitate student interaction (Kuimova & Zvekov, 2016; Li & Zhu, 2017). During the discussions in the two focus groups, when the researcher inquired about the choice between blogs, wikis, and Google Documents, the trainees explained that, in their view, all three tools are highly useful. However, Google Documents appeared to be more accessible to learners and were more easily integrated with other learning models, such as digital storytelling, where students are required to co-author the narrative script multiple times. As Table 2 indicates, fostering learner collaboration and interaction appears to be a significant criterion for trainee teachers when designing educational scenarios, as substantial percentages were attributed to tools that support student interaction, such as Padlet (29.4%), blogs, wikis, and Google Documents.

### ***Language Awareness***

Interestingly, less emphasis than expected was placed on teaching the structure of language, i.e., grammar and vocabulary, when designing the tasks. Only 14.7% of trainees used data-driven learning and online resources like the Corpus of Contemporary American English (COCA) to create activities aimed at developing language awareness. However, an overall percentage of 23.5% used tools like Quizlet, Kahoot, and Liveworksheets to help learners assimilate grammatical structures and vocabulary through engaging games that capture students' attention and interest.

### ***Intercultural Interactions and Collaboration***

Another notable observation is that only 2.9% of respondents chose to use videoconferencing applications, which have the potential to facilitate intercultural interactions among students from different countries. As discussed by Vlachos (2009a, b) and Vlachos & Papaefthymiou-Lytra (2008), cross-national educational projects involving students from diverse cultural backgrounds create an authentic learning environment where students can enhance their communication, collaboration, and intercultural skills. As emphasized in the second section of this paper, in the context of learning English as a second language, it is crucial to grasp cultural realities, show respect for other traditions, and nurture intercultural awareness. Engaging in cross-cultural, real-time interactions, typically facilitated by videoconferencing, aids in the process of learning about and embracing the distinctive characteristics of various cultures.

When this matter was discussed in the two focus groups, the participating trainee teachers unanimously concurred that videoconferencing and students collaborating with peers from different countries are among the most effective methods for fostering intercultural communicative competence. However, they clarified that they often choose less time-consuming and effort-intensive learning models and scenarios, such as WebQuests. In WebQuests, students

access authentic resources to acquire cultural information, which they can then analyze and compare with the cultures of their own societies. To accommodate the principle of collaboration, they prefer to assign WebQuest tasks in groups and pairs and encourage their learners to engage in collaborative problem solving.

### ***Comments on Tools and Applications***

Additional comments made by the trainee teachers concerning various applications, tools, and ICT pedagogical frameworks can be found in Table 3.

**Table 3**

#### *Trainee Teachers' Comments for Tools and ICT Pedagogical Frameworks*

|                                   |                                                                         |
|-----------------------------------|-------------------------------------------------------------------------|
| Live Worksheets and Wordwall      | Easier to use by trainee teachers                                       |
| Kahoot                            | Effective in pre-teaching vocabulary, and learners love it              |
| Wordwall & Padlet                 | More effective in facilitating learning                                 |
| Video                             | Videos, including authentic ones are seen as interesting and motivating |
| Google Docs                       | Highly effective for collaborative writing tasks                        |
| Email                             | More challenging for learners                                           |
| Video Ant                         | Useful for viewing videos in sections                                   |
| YouTube & Google Docs             | Highly effective and easy to access                                     |
| WebQuest                          | Interesting and inspiring for learners                                  |
| COCA                              | While considered demanding, some learners found it helpful              |
| Wikis                             | Effective educational tools                                             |
| Digital Storytelling              | Challenging but effective                                               |
| Blogs                             | Effective for improving writing skills                                  |
| Interactive Tools (e.g., Quizizz) | Effective for engaging learners                                         |
| Mindmap & Questionnaire           |                                                                         |
| Tools                             | Effective for specific tasks                                            |

### ***Perspectives on Integrating Technology In EFL: Effective Practices***

In the second section of the questionnaire, trainee instructors were surveyed regarding their experience teaching educational scenarios. Specifically, they were asked whether they had conducted the lessons and, if so, whether the outcomes aligned with their expectations. An overwhelming 90% confirmed that they had indeed taught the scenarios. Additionally, they were invited to provide feedback on how well the scenarios matched their anticipated outcomes.

Analysis of their responses revealed a notable trend: the instructors harbored positive expectations, which were largely fulfilled. They reported that their learners not only enjoyed the lessons but also that the instructors were successful in accomplishing their teaching objectives. Below are excerpts from their feedback:

- My students loved the lesson and my teaching aims and objectives were fully accomplished.
- The learners loved it. The objectives were achieved.

- I taught part of my scenario of the WebQuest with my proficiency class as a type of relief from their exams and they loved it!
- I taught the WebQuest I designed in the assignment and the feedback was positive. The teaching objectives were met and the students at the end of the lesson said it was the most interesting lesson.

Furthermore, several trainee teachers stressed the significance of tailoring tools and applications to accommodate the diverse needs of learners at varying proficiency levels. Some expressed an eagerness to incorporate more advanced tools into their lessons, demonstrating a willingness to adapt and innovate their teaching methods. In one instance, a trainee teacher noted the need to shorten tasks to match the attention span of younger learners. A few mentioned challenges related to technology availability or resource limitations in the classroom, which could potentially affect the implementation of specific teaching strategies. One trainee instructor expressed a desire for greater creativity, particularly in the evaluation phase of the lesson, indicating a continuous improvement mindset.

In line with relevant literature (Kourtis Kazoullis & Skourtou, 2007; Kourtis-Kazoullis, 2008; Kourtis Kazoullis & Vlachos, 2014), the trainees' primary focus was clearly on engaging learners and effectively using technology to enrich the learning experience. In their responses in this part of the questionnaire they acknowledged the significance of a variety of resources and programs in improving their English as a Foreign Language (EFL) classes. The effectiveness of these tools often depended on factors such as ease of use, level of interest, and alignment with the learners' needs. Even if some tools were considered more challenging, they were still valued for specific tasks. The ability to be flexible and adaptable in employing these tools played a crucial role in meeting the expectations of both teachers and students.

### ***Awareness of how Educational Technology Contributes to Effective Learning***

When asked whether the educational scenarios they had devised contributed to their understanding of the role of educational technology and new media in language learning, 100% of the trainee teachers indicated a heightened awareness. Consistent with existing literature (Borsheim et al., 2008; Cummins et al., 2007; Kalantzis & Cope, 2008), their responses to the open-ended question emphasized the pervasive presence of technology and media in learners' daily lives. They acknowledged the significance of integrating ICT tools into education, noting that such integration not only captures learners' attention but also enhances the effectiveness of EFL learning. One comment exemplifying this viewpoint states: The new media can play an important role in the EFL classroom. They give the teachers the potential to enrich their lessons in a way that can facilitate teaching and learning. Computer-mediated environments lay the foundations for a learner-centered classroom where the learner assumes a more active role and responsibility for his/her learning."

This newfound awareness led them to appreciate the potential of new media and educational technologies in enriching language lessons and creating learner-centered classrooms. By doing so, they believed that they could encourage learners to take a more active role in their own language acquisition, which aligned with the modern pedagogical principles discussed so far in this paper.

Furthermore, they acknowledged the versatility of technology in making lessons more engaging and appealing to learners of varying linguistic competencies. While they were not oblivious to the possible technical challenges associated with technology integration, they firmly believed that the benefits, such as heightened learner motivation through computer-based projects, outweighed these obstacles. Furthermore, they recognized that while there might be a time investment required to prepare digital materials, the resulting motivation and engagement facilitated by online tools are invaluable assets in a language classroom. Their comments exemplifying these two points states:

Even though there are some technical difficulties involved, mainly managing to get access to the school's computer lab, there is great potential for increasing the learners' motivation through computer-based projects.

There may be some time required in order to prepare the digital material for the lessons, but the motivation online tools bring to a lesson is worth it.

In light of this awareness, the trainee instructors expressed their determination to continue leveraging technology in their future lessons, as they now felt more confident in designing engaging, technology-enhanced learning experiences.

### ***Practical Implications of Assignments***

Regarding the practical implications of the two assignments they submitted for the course, the trainee teachers firmly believed that these assignments had a tangible impact on their future teaching endeavors. The comments in the open-ended questions suggest that they viewed the assignments as opportunities to experiment with a wide array of digital tools, enabling them to achieve specific teaching objectives and create lessons that were not only effective but also motivating for their learners. Below are some illustrative comments:

I think that the assignments give us the opportunity to generate ideas of how we can integrate the technological tools in our lessons and also see how these tools work in practice. I strongly believe that without the assignments we would just theoretically know the tools and we wouldn't know their actual use.

These assignments and the educational scenarios not only helped me to explore the new media and new technological tools, which I wasn't aware of beforehand, but also enabled me to open my horizons and realize how a simple lesson can turn into a fun, interesting and enjoyable process for everyone involved.

Additionally, they noted that the process of preparing these assignments had heightened their understanding of the importance of differentiated instruction and how technology could be harnessed to cater to the diverse needs of learners in their classes. This newfound knowledge was not just theoretical; it was practical and applicable, equipping them with valuable skills and insights they could immediately put into practice in their future language teaching endeavors.

The assignments are created in such a way that force you to create something practical and put the theory learnt into actual use. The knowledge obtained from the study material

and the contact sessions was put into use and made me experiment with tools I could use with classes of mixed abilities. The assignments created a need for me to be creative and design lesson that suit the different needs and language levels of my students.

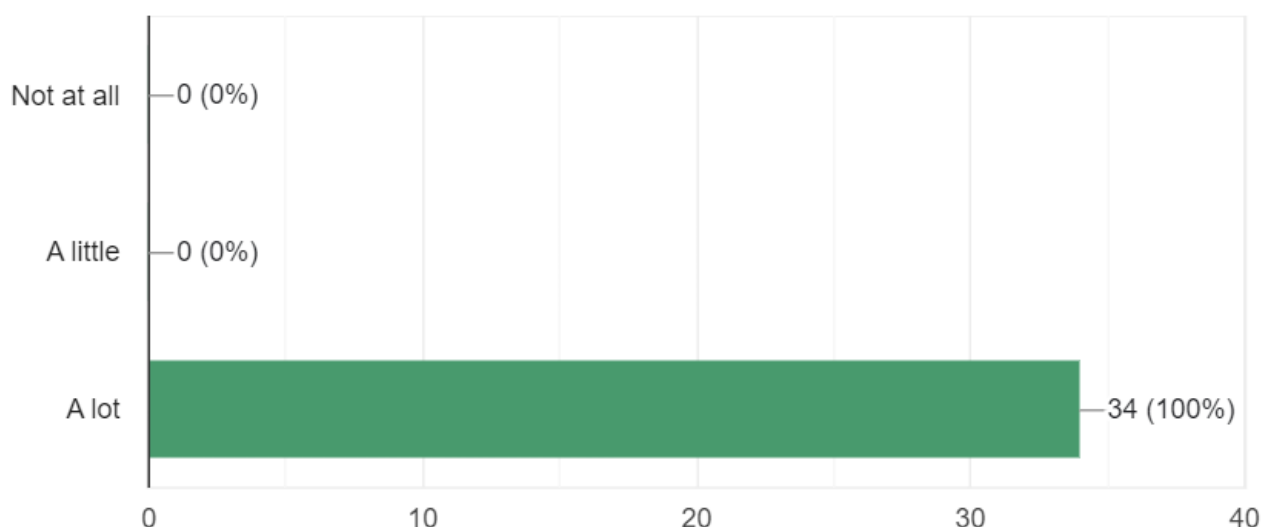
The trainee teachers believed that these assignments not only expanded their awareness of educational technology and new media but also equipped them with practical ideas and skills thus enabling them to design learner-centered, technology-enhanced lessons and ultimately improve their teaching methods. They viewed technology as an indispensable tool for creating engaging, inclusive, and effective language learning experiences and were committed to exploration of digital tools to enhance their teaching practices.

### ***Perspective on the Impact of VIVA Presentations***

All trainee teachers who answered question 10 of the questionnaire agreed (100%) that the VIVA at the end of the course significantly contributed to their awareness of how educational technology and new media can facilitate effective language learning. Table 4 illustrates their responses.

**Table 4**

*VIVA and Its Contribution to Awareness of How ICTs Facilitate Language Learning*



They found the scenarios presented during the VIVA sessions to be inspiring and engaging for learners with topics such as fashion, aliens, and others capturing their interest. They acknowledged that most of the projects presented could be easily implemented in their future classrooms, depending on the learners' language levels and interests. Many of their colleagues' projects featured creative ideas and practical applications of various digital tools, which left a lasting impression on them. Several specific tools and technologies were highlighted by the trainee teachers as particularly inspiring, including Wordwall, video lessons, digital storytelling, blogs, Google Docs, Wikis, StoryJumper, Edpuzzle, VideoAnt, Kahoot, Padlets, films with captions, Mentimeter, LiveWorksheets, Ted puzzle, and various web tools like WebQuests and Wikis.

It was established that the VIVA presentations provided a platform for trainee teachers to exchange ideas, learn from one another's projects, and explore innovative ways to incorporate technology into their future lessons. They recognized the value of these exchanges and expressed their intent to apply the insights and tools gained from their colleagues' projects in their own teaching practices. The VIVA sessions not only showcased the potential of educational technology but also fostered a sense of inspiration and collaboration among the trainee teachers, motivating them to enhance their future language lessons with the integration of digital tools. Here are some of their observations:

To see your colleagues being creative and apply the same theory and principles learnt in the course from their perspective is really inspiring! More or less the tools were the same, but it was the tasksheets that they came up with and the way they structured their lessons that was also motivational.

I was surprised with the creativity with which my colleagues approached the various scenarios and the multitude of ways in which each digital tool can be used. I would like to experiment with digital storytelling in the future.

I liked the idea of the webtool with subtitles which I intend to experiment with in my future lessons. I also liked the idea of having the learners simultaneously work on a mindmap instead of a PadletWall.

I loved the approach to travelling (a trivial issue) blended with the element of responsibility which gives the topic a different perspective.

The VIVA was very interesting and inspirational and I am sure that the scenarios presented will form the basis for my future lessons.

Furthermore, it is important to highlight that some aspiring trainee teachers expressed their intention to take their commitment to professional development to the next level. Specifically, they planned to actively engage in the exchange of educational scenarios and lessons, with the primary objective of witnessing how these instructional approaches manifest in real classroom settings. This collaborative endeavor was underpinned by a shared commitment to providing constructive feedback at a later stage. In essence, these trainee teachers were enthusiastically inclined towards establishing enduring communities of practice that will persist well beyond the completion of the Agg31 course.

The concept of communities of practice in education represents a dynamic and collaborative ecosystem that empowers educators to continually refine their craft, nurture professional growth, and actively contribute to the advancement of language teaching and learning. These communities extend the boundaries of traditional learning environments, enabling educators to thrive through collective expertise, shared experiences, and the continuous exchange of pedagogical innovation.

As substantiated by the relevant literature (Haligamo, 2021; Reardon & Leonard, 2013; Tummons, 2022), communities of practice within the realm of education serve as indispensable catalysts for nurturing collaboration, fostering professional development, and facilitating the dissemination of knowledge among educators and various stakeholders. For EFL educators seeking to collaborate, enhance their professional competencies, and share their wealth of knowledge, the concept of communities of practice emerges as an exceptionally fruitful proposition. These dynamic collectives contribute meaningfully to the ongoing evolution of techniques and methodologies in second and foreign language teaching and learning.

#### *Limitations and Recommendations For Further Research*

Throughout an entire academic year, our research project diligently engaged two cohorts of participants. However, it is evident that the inclusion of additional cohorts and an extended duration would have enriched our dataset, enhancing the robustness of our findings. Particularly, augmenting the quantitative data to capture participants' tool and application preferences would have provided deeper insights into the methodologies envisaged by postgraduate trainee teachers for their future professional practice.

Moreover, a more comprehensive questionnaire, delving into preferences for integrating AI tools into teaching practices and the pedagogical strategies aimed at fostering critical thinking skills, would have furnished us with contemporary insights. Such data would be invaluable in shaping the curriculum of future postgraduate courses in educational technology.

This realization propels us toward the next phase of research, namely, investigating the integration of AI into trainee teachers' assignments within postgraduate courses. Understanding

their attitudes and practices regarding the implementation of educational scenarios in their classrooms is imperative for informed curriculum development.

Furthermore, there exists a pressing need to delve into the potential formation of communities of practice among trainee teachers upon completing the course. This entails examining the goals they set, the modes of interaction they adopt, the collaborative content, as well as the reactions, benefits, challenges, and difficulties encountered by their learners.

In summary, extending the research to encompass additional cohorts, incorporating diverse data collection methods, and exploring the dynamics of communities of practice are vital steps towards advancing our understanding of the intersection between educational technology and teacher training. These efforts are crucial for informing the design of future postgraduate courses and enhancing the effectiveness of teacher education programs.

## **Summarizing Findings and Conclusion**

The emergence of new media, digital tools, and instructional strategies has revolutionized second/foreign language acquisition, rendering it more accessible and engaging. It's imperative for trainee teachers to have a heightened awareness of educational technology's role in language learning to ensure their effectiveness as educators. This paper presents findings from a research project aimed at shaping future training courses. It underscores the importance of integrating ICT tools into the educational process, as acknowledged by trainee teachers in Agg31. These tools not only capture learners' attention but also enhance the effectiveness of EFL learning. The practical assignments within the course, particularly the design of educational scenarios, encouraged experimentation with various digital tools, promoting learner engagement and motivation while emphasizing the principles of differentiated instruction and intercultural interactions. This equipped trainee teachers with valuable skills and insights for their future language teaching endeavors.

In addition, VIVA presentations at the end of the course played a crucial role in fostering awareness and collaboration among trainee instructors. The scenarios presented during these sessions served as inspiration, catalyzing additional ideas and discussions. Trainee teachers expressed a desire to continue their educational journey by establishing connections within a community of practice, facilitating the exchange of valuable insights and experiences and enhancing the collective toolbox of teaching methods. This research project underscores the critical role of educational technology in language education and teacher development, highlighting how well-designed courses, practical assignments, and collaborative experiences can empower language educators to effectively integrate technology into their teaching practices, benefiting both teachers and learners.

Teacher education programs must encompass a wide range of pedagogical methods and techniques to empower educators to be adaptable and responsive to their learners' needs. These programs play a vital role in raising the standard of language instruction, fostering inclusivity, and preparing teachers for the evolving demands of the educational landscape. By promoting ongoing research and teacher development, stakeholders can make informed decisions to



improve educational quality, encourage best practices, and ensure that educators are well-equipped to provide effective language education in diverse contexts.

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# Elementary STEM Teachers' Open Educational Resources and TPACK in a Professional Learning Network: A Case Study

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## Abstract

Research attention to investigating elementary STEM teachers' Professional Learning Networks (PLNs) has grown. However, what types of Open Educational Resources (OER) and Technological, Pedagogical, and Content Knowledge (TPACK) elementary STEM teachers share in their PLNs are still under-examined. This case study aims to explore elementary STEM teachers' use of OER, types of TPACK, and their relationships. Using qualitative content analysis, we analyzed qualitative messages extracted from a Facebook community for elementary STEM teachers. The results showed that tools and tips were the most commonly shared among the various OER types, and technology-related knowledge (i.e., TK and TPK) emerged dominant within the PLN. Also, we discuss the implications of elementary STEM teachers' discourses on OER and TPACK in a PLN.

*Keywords:* Elementary STEM teachers, open educational resources, TPACK, professional learning networks

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Professional Learning Networks (PLNs) offer teachers opportunities to interact with other educators beyond their local contexts, fostering accessibility and flexibility for engagement. Studies have reported that PLNs' connective, self-regulated, and collaborative natures can improve social and cognitive developmental capabilities (Trust et al., 2016). Furthermore, PLNs enable teachers to identify student characteristics and obtain effective digital tools with suitable teaching methods (Nochumson, 2019).

In STEM education, developing interdisciplinary and cross-curricular learning tasks is demanding, necessitating extra support and resources for elementary STEM teachers (Teo & Ke, 2014). In particular, integrating creative ideas and technology into teaching practices is essential in STEM education to provide authentic learning experiences for students. In this sense, Open Educational Resources (OER) shared in PLNs are advantageous for elementary STEM teachers due to their design flexibility, cost efficiency, and accessibility (Bencheva, 2020). Given that adopting OER for STEM courses requires teachers to use knowledge regarding technology, pedagogy, and content, the TPACK framework can help researchers understand what aspects of OER elementary STEM teachers would investigate or need for their practices.

Research has largely explored how the intersections of the TPACK framework (Mishra & Koehler, 2006) emerge from teachers' PLNs (van Bommel et al., 2020). A study examining math teachers' TPACK in PLNs reported that study participants mainly shared pedagogical content knowledge (PCK) involving “questions” and “offers” (Liljekvist et al., 2021). Furthermore, participating in PLNs has been associated with enhancing STEM-related content knowledge, pedagogical competence, digital literacy, and self-efficacy (Pelton, 2018).

Although the importance of STEM teachers' TPACK and PLNs is on the rise, few studies have provided an in-depth investigation of the specific OER that emerge in relation to TPACK among elementary STEM teachers in PLNs. Moreover, existing PLN studies have focused on K-12 teachers' general experiences in PLNs but appeared limited in illustrating how the dynamics of OER and PLN discourses emerge. Accordingly, this case study aims to investigate OER and TPACK in a PLN for elementary STEM teachers. The results of this study can provide a deeper understanding of elementary STEM teachers' OER use and knowledge related to educational practices and can also contribute to discussions about the future of OER by providing a broader picture of OER use in STEM education.

The research questions guiding this study are:

- RQ1. What are the dominant Open Educational Resources (OER) types in a Professional Learning Network (PLN) for elementary STEM teachers?
- RQ2. What types of TPACK do elementary STEM teachers mainly discuss in a PLN?
- RQ3. What are the relationships between the types of OER and TPACK in an elementary STEM teachers' PLN?



## Literature Review

### *Teacher Professional Learning Networks*

A PLN is a global group or network developed from self-selected connections and collaborators with shared interests (Davis, 2013). PLNs support teachers' ongoing learning in unique networks, and digital technologies (e.g., social media) can mediate their engagements with people, spaces, and tools regardless of time or location issues (Krutka et al., 2017).

PLNs are often compared with Community of Practices (CoP) because they share common characteristics, such as interactions with network components, sharing information, or receiving emotional support. These terms are often used interchangeably because members of both CoPs and PLNs routinely engage in discussions, interact with one another, and voluntarily exchange information. Whereas PLNs are informal networks that characterize individualized learning for personal and professional development (Krutka et al., 2017), CoPs are a foundational concept of a broader social learning system with group members who organize group norms, build relationships, decide the main focus and goals of the group, and share resources (Hass et al., 2020; Lave & Wenger, 1991).

PLNs are informal and collaborative networks that enable the exchange of resources, knowledge, and ideas via interpersonal connections. Empirical studies have investigated how teachers behave in their PLNs and why they engage in PLNs. Trust (2017) identified that in-service teachers actively evaluate, collect, and organize shared knowledge using digital tools, such as Pinterest, Symbaloo, Edmodo, or email. Moreover, Oddone's (2022) qualitative case study showed five selected teachers' use of PLNs in their professional learning. The participants' identities and the nature of their professional learning in PLNs were individual, social, and digitally connected.

These PLN environments offer unique opportunities for STEM teachers to enhance their instructional practices without the constraints of traditional on-site professional development programs (National Research Council, 2009; Peppler, 2017). However, as a subset of the broader field of STEM education, informal professional development for STEM teachers has received less attention, particularly regarding how teachers develop their professional competencies in these settings. Despite this limitation, studies indicate that informal professional learning in PLNs contributes to teacher professional growth by showing improvement in teachers' STEM literacy (Jackson & Mohr-Schroeder, 2018), encouraging experimentation with innovative pedagogical approaches, and fostering the development of crucial skills such as creativity, social interaction, and leadership, all of which are directly applicable to classroom teaching (Terrazas-Marín, 2018).

In particular, elementary STEM teachers need to develop a variety of knowledge and skills to plan and deliver STEM learning activities. Compared to other subject disciplines, STEM education is unique by its nature because the content in STEM is rapidly and consistently evolving, and STEM education generally focuses on student-centered scientific inquiry that encourages the use of new tools or equipment (Lesseig et al., 2016; Polgampala et al., 2017). In addition to developing STEM content knowledge, STEM teachers must understand pedagogical knowledge and skills for integrative and cross-disciplinary approaches emphasized in STEM

education (Margot et al., 2019). These professional learning needs of elementary STEM teachers, however, are less likely to be addressed by their teacher preparation programs because many elementary STEM teachers have been trained within a single subject discipline (e.g., mathematics or biology) during their teacher preparation program (Aslam et al., 2018; Geng et al., 2019).

For many elementary STEM teachers, PLNs provide opportunities to meet their diverse professional learning needs. Teachers can find needed content or pedagogical knowledge as well as teaching resources through their PLNs (Beach, 2018; Trust et al., 2016). In addition, they can also find helpful advice or managerial strategies to properly plan and coordinate STEM activities that are frequently involved with financial and organizational issues (Aslam et al., 2018). With the development of information technology (e.g., the internet), many elementary STEM teachers now use digital tools (e.g., Facebook and Twitter/X) to build their own PLNs and leverage the affordances beyond their local contexts (Carpenter & Krutka, 2016). Irrespective of the context of PLNs—face-to-face, online, or blended—PLNs can offer professional learning opportunities for elementary STEM teachers in myriad ways.

## Open Educational Resources (OER)

Open Educational Resources (OER) refer to works that are useful for educational purposes and are available to the public for free. These resources are not subject to copyright restrictions and rather allow users to manage the resources perpetually. OER include instructional materials, modules, text, videos, assessments, and any formats used to support educational activities (Hewlett Foundation, 2015).

OER provides a significant benefit to teachers and students by offering access to high-quality educational materials at no cost. The spectrum of OER encompasses a wide range of educational materials, including comprehensive courses, individual course components, specific modules, discrete learning objects, and open-access textbooks. Additionally, OER may take the form of openly licensed video content (often available via streaming), assessment tools, software applications, and various other resources or methodologies designed to facilitate students' knowledge acquisition. This diverse array of OER formats reflects the multifaceted nature of educational resources in the digital age and offers educators and learners a rich variety of tools and materials to support their teaching practices (Butcher & Moore, 2015) which allow students to visualize abstract science concepts and make complex STEM topics more accessible. As another example, Code.org provides users with free coding courses and projects that are essential for developing computational thinking skills integral to many STEM fields. These OER types expand users' opportunities to leverage their teaching and learning by providing access to up-to-date, interactive, and engaging materials that might otherwise be unavailable due to cost or resource constraints. Research reports that teachers have typically utilized OER to leverage the quality of their teaching, such as instructional strategy selection and application. Instructional strategies are one type of OER providing informal tips to guide specific and iterative instructional design (Jonassen, 1991). Aligned with a PLN, suggestions or sharing experiences of instructional strategy selection, application, and customization shared in the public domain meet the requirement of OER (Pawlowski & Bick, 2012).

OER have become increasingly significant for STEM teachers because its components provide accessible materials for classroom management and instructional lesson design. Online textbooks, instructional videos, websites, and quizzes were identified as OER materials used by STEM teachers for pedagogical purposes (Yassin & Jung, 2021). In particular, OER shared and reviewed by a PLN can fulfil STEM teachers' current needs in learning resources: (1) access to high-quality materials and (2) quality assurance of educational resources (Almendo & Silveira, 2018; Kimmons, 2015; Tang et al., 2020). Validation of educational resources is crucial because teachers need materials that can be easily applied in their classrooms. Additionally, a major challenge of using OER is to ensure the reliability and validity of public resources and their alignment with subject domain standards. Specifically, to promote the active use of OER, peer evaluation is critical. Informal learning that happens in a PLN is advantageous to facilitate the validation, distribution, and reproduction of OER aligned with their quality assurance.

PLN-supported informal learning among STEM teachers could synergistically contribute to the quality assurance of OER. Beaven (2018) reported on the lifecycle of OER used by teachers and showed that OER materials are typically evaluated by teachers and their colleagues and then adapted for delivery to students. Beaven (2018) also reinforced the idea that a PLN among teachers could play a role in mediating the uses of OER. In addition, Tang et al. (2020) demonstrated that teachers' perceived usefulness of OER significantly predicted their attitude toward OER. The study findings demonstrated the importance of promoting teachers' consolidation in selecting, using, and revising OER tailored to their instructional/learning contexts.

Despite the growing use of OER by STEM teachers, a significant gap exists in our understanding of how elementary STEM teachers specifically utilize OER within PLNs. While previous studies have examined OER use in general K-12 settings, there is limited research on the intersection of OER, TPACK, and PLNs in the context of elementary STEM education. A thorough analysis of how OER can promote certain areas of STEM teacher competency is thus essential. Therefore, in-depth research is indicated to better understand the role of PLNs in promoting the use, selection, and revision of OER tailored to the instructional/learning contexts of elementary STEM teachers and knowledge domains related to instructional practices.

## Technological Pedagogical and Content Knowledge (TPACK)

The concept of TPACK has been evolving since Shulman's (1986) clarification of pedagogical content knowledge, which defines what teachers should know and be able to do in their teaching professions (Mishra & Koehler, 2006). The TPACK framework that has emerged combines the knowledge relevant to instruction with digital technologies (Niess, 2005) with the pedagogical and content knowledge. TPACK is viewed as the synergy between technology, pedagogy, and content knowledge, and it can be useful for both educational practitioners and researchers since they can apply it to develop teacher education programs and professional learning or to investigate the current status of teachers' knowledge and support (Harris, 2008).

In teachers' PLNs, the components of TPACK are varied. van Bommel et al. (2020) found that discussions in Swedish teachers' Facebook groups focused primarily on pedagogical and content knowledge (PCK) and learner understanding. Meanwhile, math teachers in six PLNs

mainly shared pedagogical content knowledge (PCK) by questioning and offering resources (Liljekvist et al., 2021). On the other hand, Parsons et al. (2019) found that the US teachers' PLNs focused on Technological Content Knowledge (TCK). Learning digital tools and new teaching methods or ideas were also the main characteristics of teachers' PLNs (Nochumson, 2019).

Regarding STEM teachers' TPACK competencies in professional development situations, Chai (2019) reviewed 20 articles about STEM teachers' professional development studies by using the TPACK framework. The primary finding showed that pedagogical knowledge (PK) was mainly provided via workshops, and reviewed studies exploring STEM teachers' professional development emphasized the use of technology to deliver a subject matter. Similarly, a recent literature review study (Huang et al., 2022) about STEM teachers' TPD programs found that most teacher professional development programs were focused on pedagogical knowledge (PK) and pedagogical content knowledge (PCK), whereas a few numbers of programs addressed technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK) for elementary teachers.

Although the varied components of TPACK and types of OER for STEM teachers are demonstrated in PLNs, there is still a lack of exploration on how elementary STEM teachers enact shared resources and knowledge domains in these networks. Moreover, studies on teachers' TPACK mainly employed self-report, interviews, and performance assessments (Monjelat & Lantz-Andersson, 2020), while studies using data sources collected from real-life practice are needed to reflect the nature of TPACK (Rosenberg & Koehler, 2015). Therefore, analyzing the qualitative messages of a PLN could shed light on how teachers execute OER, TPACK, and their relationships in their practices.

## Method

This study employed a case study as a research method (Yin, 2018). A case study design allows an in-depth exploration of the phenomenon of the case and its findings. Further, it helps researchers focus on research questions and implications by applying a detailed analysis of the case. A case study design appeared suitable for this study because we sought to explore a specific phenomenon about elementary STEM teachers' professional learning network on social media (i.e., Facebook), which is an authentic informal learning space where teachers seek and share educational resources and ideas.

### *The Case*

For this case study, we chose a private Facebook group for elementary STEM teachers. This Facebook group was established in 2019 by a STEM teacher who is a K-5 STEM specialist in North Carolina (See Figure 1). As of March 2023, this Facebook group has approximately 50,000 members. Only members of this group can participate in the discussion and access the resources shared within the group. To become a member, individuals must provide detailed information (e.g., their school's location and years of experience in teaching elementary school-level STEM) and get approval from moderators of this group. Based on a brief informal survey that the group administrator posted, participants consisted of elementary STEM teachers from around the world. According to the results of the survey, 40% of the respondents were K-5

STEM or Makerspace teachers and 15% of the respondents were defined as K-5 classroom teachers. On average, over 15 new posts are uploaded daily in this group.

This group was chosen for several reasons. First, social media platforms, particularly Facebook groups, have emerged as significant spaces for teacher professional development and informal learning, offering unique insights into how educators share knowledge in the digital age (Carpenter & Krutka, 2015). Second, while research on online teacher communities is growing, there remains a notable gap in understanding how elementary STEM teachers specifically leverage these platforms for their professional growth and classroom practice (Trust et al., 2016). The group for elementary STEM teachers represented a rich case study opportunity due to its size, active engagement, and focused content area, allowing for an in-depth exploration of how STEM education resources and ideas are shared and implemented at the elementary level (Macià & García, 2016). Additionally, studying this group provided a window into the challenges and opportunities of STEM integration in elementary education.

The study was reviewed and approved by the Institutional Review Board (IRB) and deemed eligible for exemption of review after obtaining consent from the moderator of the group. Permission was achieved by guaranteeing the collection of only anonymized qualitative data. Additionally, as part of our agreement with the group moderator, researchers were required to share findings after publication with the community members. All data sources were stored only on the lead researcher's personal computer.

## Data Collection and Analysis

Data sources for this study consisted of messages extracted from the Facebook group for elementary STEM teachers, including texts, URLs for videos or web pages, and images that teachers shared for one month between October and November 2021. We employed a multiple-methods study using both qualitative and quantitative data analysis approaches.

We used qualitative content analysis (Assarroudi et al., 2018) to explore distributions of OER and TPACK and descriptive and network analysis for OER and TPACK patterns and their relationships. Content analysis was suitable for this study because it helps analyze recorded communication messages (Cole, 1988), such as discussions on social media. In particular, we conducted inductive content analysis because few studies have discussed elementary STEM teachers' OER in PLNs, leading to only limited knowledge (Vears & Gillam, 2022).

Following the data analysis steps suggested by Vears and Gillam (2022), we first piloted the coding process before we extracted the main data sources to become familiar with the data, simulate the coding process, and determine initial codes. We used 582 messages in the pilot phases using integrated OER types and definitions of TPACK and instructional strategies. All researchers are saturated with the meaning of the codes for cohesive results. In the relevance check phase, we focused on the message itself and whether messages contained real resources for STEM teaching or not. The researchers coded the same dataset, and the final codes were determined by discussing the differences in understanding the codes. Through the pilot data analysis, Five OER types—course materials, instructional strategies, lesson plans, professional

development, and tools and tips—were selected with operationalized definitions based on the extracted data sources to contextualize the results (Butcher & Moore, 2015; Hewlett Foundation, 2015; Pawlowski & Bick, 2012; Yassin & Jung, 2021) (See Table 1). Regarding the definitions of instructional strategies and TPACK, we followed the definitions suggested by Jonassen (1991) and Koehler and Mishra (2013). (See 2 and 3)

**Figure 1**

*The Facebook Group for Elementary STEM Teachers*



**Table 1**

*Definitions of OER Types*

| Types                | Definition                                                                                                                                      | Examples                                                                                                                                                                                                                                                                                                          |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Course Material (CM) | General materials to be applied to classroom instruction (e.g., videos, images, resources for hands-on activities, worksheets, templates, etc.) | Here are my top 3 favorites:<br><a href="https://edgeucating.com/.../global-futures-creating.../">https://edgeucating.com/.../global-futures-creating.../</a><br><a href="https://edgeucating.com/.../kais-clan-interactive.../">https://edgeucating.com/.../kais-clan-interactive.../</a> And of Dash is a must! |

|                               |                                                                                                                                                       |                                                                                                                                                                                                                                                                     |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Instructional Strategy (IS)   | Intellectual resources verbally described related to STEM instruction based on experiences (e.g., Sequence of lessons, manual for device uses, etc.)  | Students program the robots to create polygons using a rug as the four quadrants. They program the robot to drop chips at the coordinates and they program the robots to state the coordinates.                                                                     |
| Lesson Plan (LP)              | Lesson plans that can be used in the instruction                                                                                                      | The best way I've found to organise my kids/standards/ my planning is to divide our quarters into a school wide emphasis. Q1- scientific skills with EDP challenges, Q2 - coding and computer science...                                                            |
| Professional Development (PD) | Resources for teacher learning or activities                                                                                                          | STEM MINDS has launched Professional Development Micro-credentials, for teachers, backed by Digital Promise. STEM MINDS is on a mission to empower our teachers with tools and skill building opportunities so they can continue to thrive supporting our children. |
| Tools and Tips (T&T)          | Information about open source (e.g., code.org), topics for special events (Halloween, Christmas, vacation, etc.), or activity photos and descriptions | Well, aside from Bill Nye and Magic School Bus, I would agree with the Baking Impossible, Making Fun. I would love to show Apollo 13 if it were appropriate.                                                                                                        |

The main data analysis included the relevance check, coding, and analysis of the distributions of types of OER, instructional strategies, and TPACK, and relationships between OER and TPACK. A total of 1,770 messages were extracted as the initial raw data. After discussing the different decisions of coding for types of OER, instructional strategies, and TPACK, 1,346 messages were coded for types of OER, 212 messages for instructional strategies, and 1,596 messages were included in TPACK as the final data for coding processes. The 1,329 messages coded for both OER and TPACK were applied for the network analysis to identify the relationships between OER and TPACK. The messages were analyzed by applying multiple codes since some messages implied more than two types of OER and TPACK in one message. We used Microsoft Excel and Gephi (<https://gephi.org>) for data analysis and visualization. Gephi is an open-source software for network visualization and analysis, revealing patterns and trends from data (Bastian et al., 2009).

**Table 2**

*Examples of Instructional Strategies*

|                                  | Examples                                                                                                                                                                       |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Contextualizing instruction (CI) | I give a group discussion at the beginning asking them what they think our challenges may be with this STEM and what design solutions they could consider. It helps immensely. |

|                                                   |                                                                                                                                                                                                                                                |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Present and cue lesson content (PC)               | I like to give examples of assembly techniques but I never show a final project. If I do, they just duplicate it.                                                                                                                              |
| Activating learner processing of instruction (AP) | After the guessing contest we calculated out how many cases that would be in a year. (Oops, 93!) You could always make a large graph paper and have them fill in coordinates in a certain color Post It notes to make a pixelated picture too. |
| Assess learning (AL)                              | I use Quizizz and make quick exit tickets that are self grading. You can ask questions about vocabulary.                                                                                                                                       |
| Sequencing instructional events (SE)              | I have them for 45 minutes. First, I displayed two different pictures of the book covers... Ask for those that had never heard the story...                                                                                                    |

**Table 3***Definitions of TPACK*

|                                           | Definition                                                                                                                       | Examples                                                                                                                                                                                                        |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Content Knowledge (CK)                    | Knowledge of the subject matter to be taught (e.g., knowledge of facts and concepts of subjects)                                 | FREE Multiplying Decimals Using Models - Printable PDF file. Model the product of two decimals by finding the area of a rectangle. Free template to print, cut out and laminate.                                |
| Pedagogical Knowledge (PK)                | Knowledge of teaching and learning (e.g., learning activities, theories, processes, or practices)                                | You can do the activities without the reading but read through the units! You can pick and choose what you do. I have found the kids need multiple days for projects so get some good storage figured out.      |
| Technology Knowledge (TK)                 | Knowledge of the standard or emerging technologies, including online learning platforms, websites, or skills to manipulate tools | The time to create the design isn't the problem- it's the time it takes to print. I would imagine that cup (if it is life sized) would take at least 15 hours to print.                                         |
| Pedagogical Content Knowledge (PCK)       | Knowledge of both content and pedagogy, including applying appropriate pedagogical approaches for a specific content             | Space is a subject I've found kids will ask endless questions and will listen to answers for long periods of time. I once had to cut off a 20 min Q+A with first graders all listening intently the whole time. |
| Technological Content Knowledge (TCK)     | The knowledge that concerns representations using technology to deliver specific topics                                          | Science Max for both age groups. The concepts are hard enough for older kids, but the visuals are great for younger kids.                                                                                       |
| Technological Pedagogical Knowledge (TPK) | Knowledge of using emerging technologies to support general teaching and learning activities                                     | I came up with all kinds of 'holes' using poster board strips, tubes, etc. and I used foamcore to create the greens (a basic rectangle with 3/4' walls to create a low box). Made some examples then...         |



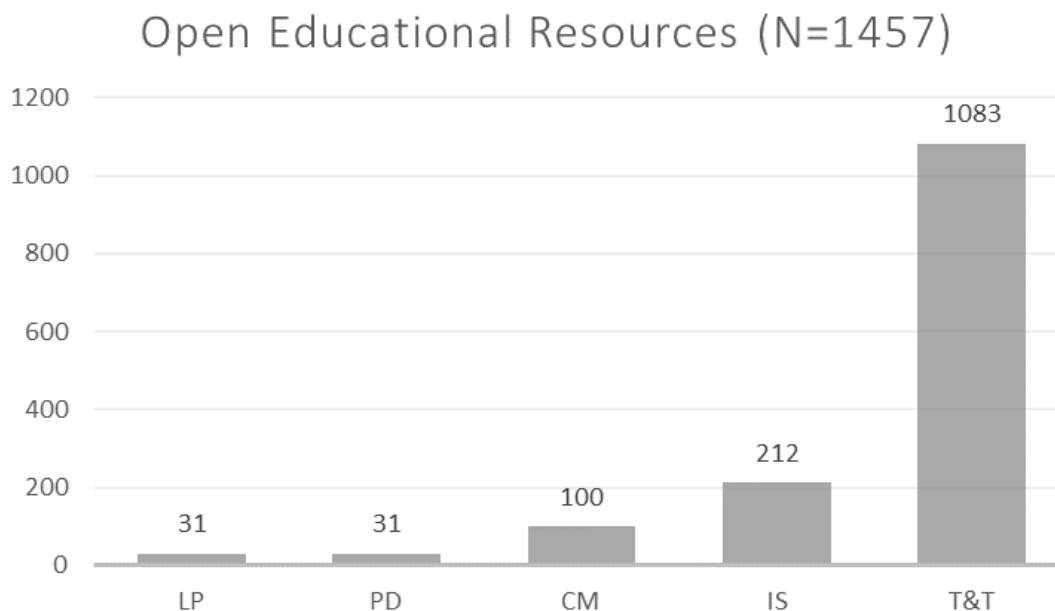
|                                                                 |                                                                                                        |                                                                                                                                                                        |
|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Technological<br>Pedagogical<br>Content<br>Knowledge<br>(TPACK) | Knowledge of using<br>emerging technologies to<br>represent the subject with<br>pedagogical activities | We were teaching how turtles return to the<br>same beach using magnetic input. We laser<br>cut beaches on card board and inserted an<br>unfolded paper clip into it... |
|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Findings

RQ1. What Are the Dominant Open Educational Resources (OER) Types in a Professional Learning Network (PLN) for Elementary STEM Teachers?

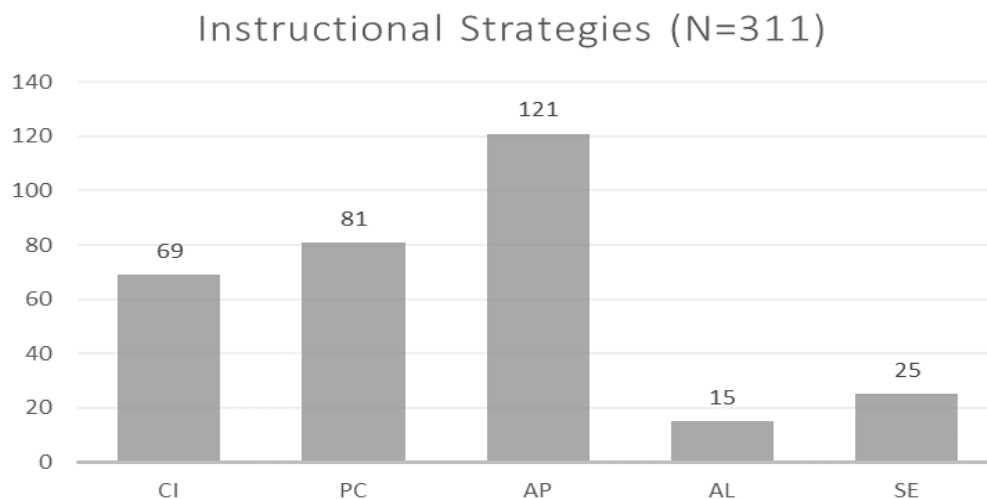
Across five OER types (i.e., lesson plans, professional development, course materials, instructional strategies, and tools and tips), the most prevalent OER type was tools and tips (N=1083, 74.3%), followed by instructional strategies (N=212, 14.6%). On the other hand, lesson plans and professional development for teachers (N= 31, 2.1%) were the least-shared type among elementary STEM teachers in the PLN. (See Figure 2)

**Figure 2**  
*Distribution of OER Types*



*Note:* N indicates the number of codes.

Regarding instructional strategies and types of OER shared in an elementary STEM teachers' PLN, teachers sought ideas about activating learner processing of instruction (N=121, 38.9%), such as effective learning activities for seasonal themes or topics for meaningful questions to facilitate students' cognitive processes (See Figure 3). For instance, a user shared a representative discourse of activating the process of learning by sharing, "I've been using it with 5th graders on the first day of our weekly rotation this month, then they choose a STEM challenge based upon what inspired them from the film." Strategies for presenting content (N=81, 26.0%) were followed by showing messages about how to provide examples or learning materials. However, discussing methods or experiences for assessing students' learning was rarely presented (N=15, 4.8%).

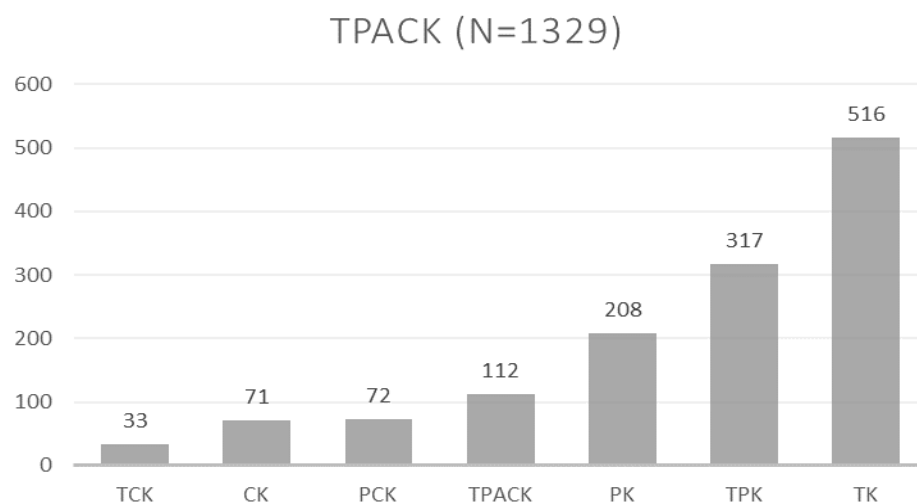
**Figure 3***Distribution of Instructional Strategies*

Note: N indicates the number of codes.

## RQ2. What Types of TPACK Do Elementary STEM Teachers Mainly Discuss in a PLN?

In terms of TPACK, Technological Knowledge (TK) was the most frequently discussed (N=516, 38.8%), followed by Technological and Pedagogical Knowledge (TPK) (N=317, 23.9%). On the other hand, Technological Content Knowledge (TCK) was the least shared type of TPACK (N=33, 2.5%). In other words, elementary STEM teachers in the PLN we examined sought ideas and shared knowledge or information on how to implement technologies for pedagogical usages, such as different learning activities based on age or tech savviness. (See Figure 4)

**Figure 4***Distribution of TPACK*



*Note:* N indicates the number of codes.

### RQ3. What Are the Relationships Between the Types of OER and TPACK in an Elementary STEM Teachers' PLN?

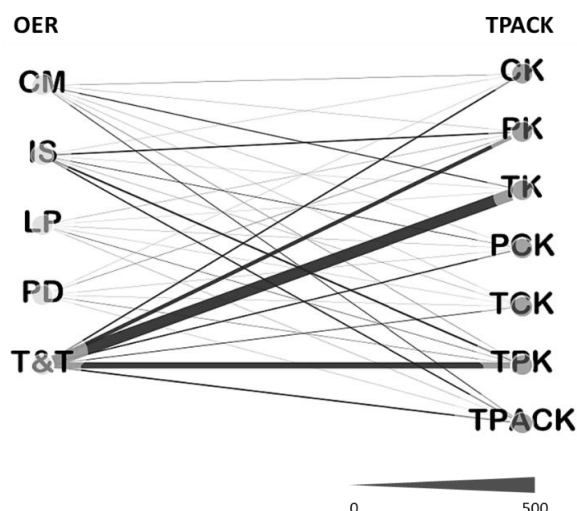
Figure 5 presents the associations between OER and TPACK in a network highlighting the weight of edges. The weight of edges is the summed frequency that edges traversed between a pair of nodes; thus, a thicker edge represents a stronger association of a type of OER and a component of TPACK. The relationship between tools and tips and Technological Knowledge (TK) showed the highest level of the weight of edges (N=477, 32.7%), indicating that teachers mainly discussed knowledge or skills of what technologies are available or how to use specific technologies in the classroom teaching.

One comment revealed the relationship between tools and tips and TK: “For some bottle caps, just pushing strongly, straight down, with a Phillips head screwdriver works. Then you can size the tool to match your skewers or axles. I always put cardboard underneath to protect the table or floor.”

Messages relating to tools and tips and TPK were as follows (N=252, 17.3%), which means teachers shared how to apply technologies in teaching and learning activities.

#### **Figure 5**

*Relationships Between OER Types and TPACK*



## Discussion and Implications

This study aimed to explore what types of OER and knowledge domains elementary STEM teachers shared in a space for informal professional learning and the relationships between OER and TPACK. By applying the qualitative content analysis method, we found that elementary STEM teachers shared techniques, such as tools and tips to apply to teaching the most, and technology-related knowledge and ideas to apply technology to their teaching were the major domains. Finally, elementary STEM teachers in a PLN shared resources on how to use technology more than any other knowledge domain for teaching.

### RQ1. What are the dominant Open Educational Resources (OER) types in a Professional Learning Network (PLN) for elementary STEM teachers?

Across five different types of OER, we observed that elementary STEM teachers' OER in a PLN mainly focused on two types of OER: tools and tips (74.3%) and instructional strategies (14.6%). The study's findings support teachers' interest in learning about different resources and advice. Considering the nature of STEM education that aims to integrate technologies (e.g., coding robots and 3D printers) into teaching practices, this dominance of tools and tips and associated instructional strategies makes sense because these include resources and advice that can be useful when elementary STEM teachers employ technologies in their classrooms. Additionally, tools and tips can assist STEM instructors in providing their students with more differentiated and individualized learning experiences (Chaipidech et al., 2022; Moon & Park, 2021). For instance, by providing resources on various instructional strategies, assessment techniques, and adaptive technologies, teachers can better meet the diverse needs of their students and ensure that each learner is appropriately challenged and supported. These results are consistent with existing research, emphasizing the significance of practical resource sharing and instructional strategy exchange among teacher groups to promote a collaborative learning environment. (Trust et al., 2016).

## RQ2. What types of TPACK do elementary STEM teachers mainly discuss in a PLN?

This study found that elementary STEM teachers in a PLN discussed TK and TPK the most, which is not in line with the previous studies showing that PK or PCK as dominant knowledge domains of STEM teachers in both formal and informal professional learning environments (Huang et al., 2022; Liljekvist et al., 2021; van Bommel et al., 2020). This result indicates that support for elementary STEM teachers' competencies can be different based on the nature of STEM education and teachers' contextual needs (Kast, 2020). Although developing interdisciplinary and cross-curricular learning tasks is demanding for elementary STEM teachers, they occasionally struggle with their interaction with technology, such as maintaining connections between smart devices and robots with too many students in a classroom (Burton, 2022). This finding shows the needs that existing studies addressed, such as more support in improving elementary STEM teachers' skills and knowledge of using appropriate technology along with their pedagogical and content knowledge (Hsu et al., 2011; Huang et al., 2022).

## RQ3. What are the relationships between the types of OER and TPACK in an elementary STEM teachers' PLN?

The purpose of exploring the relationships between OER types and TPACK was to investigate what knowledge domains are associated with specific OER types as an in-depth analysis. The results showed that tools and tips and TK and TPK were strongly associated, meaning that elementary STEM teachers informally seek and share ideas or knowledge about technologies to learn technology itself or how to use specific technologies in classroom teaching. Honey et al. (2014) specifically identified three perspectives on technology in STEM education; the product of engineering; educational/instructional technology (e.g., clickers or SMART boards); and the tools of practitioners of the STEM field. Out of the three roles of technology in STEM education, the authors (Honey et al., 2014) emphasized the technology for practitioners (i.e., teachers) and consider it as the greatest potential to impact students' learning. Moreover, Hofer and Harris (2016) developed an OER-based teacher education program to help teachers' TPACK by insisting on more support of OER to assist teacher educators' efforts in critical ways.

# Implications

## Research Implications

This study has research implications for investigating what specific educational resources elementary STEM teachers sought and exploring distributions of their knowledge in an informal professional development space, which is still under-examined. The results of tools and tips and knowledge related to technology imply that researchers need to focus more on elementary teachers' realistic teaching contexts and suggest systematic support for technology integration (Kast, 2020). Since elementary school teachers are specialized in teaching multiple subjects, they

have to demonstrate teaching with more subjects than single-subject teachers. In other words, it is challenging for them to dive as deep into all subjects regarding overall content and pedagogical mastery. The barriers to the implementation of STEM for K-12 teachers include limited interdisciplinary knowledge, challenging situations of adjusting to the pedagogical principles and classroom roles, a lack of time and expertise in curriculum integration, and difficulties with assessments (Chai, 2019; Margot & Kettler, 2019). Those consistent voices from elementary STEM teachers reflect that researchers and teacher educators should design teacher preparation systems for technology integration before and after they become in-service teachers, such as providing a knowledge repository for STEM teachers with specific examples or ideas to implement STEM in teaching practice.

In PLNs for elementary STEM teachers, suggestions of instructional design or sharing experiences of instructional design for teaching STEM can be useful resources (Arshavskaya, 2019). This type of OER can be connected to Open Educational Practices (OEP) on how to adopt intellectual resources (i.e., instructional strategies) into instructional practices. Wiley et al. (2017) insisted that the sustainability of OER in K-12 settings is promising through empowering both teachers and learners as content creators or curators. Tang et al. (2020) also demonstrated the need to promote teachers' consolidation of selecting, using, and revising OER tailored to their instructional/learning contexts in their investigation of teachers' attitudes towards OER and perceived usefulness. Further examinations are necessary to uncover how elementary STEM teachers transfer various OER materials they acquire from their PLNs into their practices.

## Design Implications

The current study's findings have important implications for PLN design. First, the results emphasize the significance of incorporating various types of OER, specifically tools and tips, into professional development programs for STEM teachers. The findings demonstrate a strong relationship between tools, tips, and technological knowledge. This highlights the necessity for STEM teachers to have access to resources that can assist them in effectively integrating technology into their teaching practices. In a PLN system, we could consider curating a diverse collection of OER that covers a wide range of tools and tips, addressing various aspects of technology integration in K-12 education (Tang, 2020). Additionally, it is valuable to encourage teachers' collaboration and knowledge-sharing through informal peer groups in PLNs by hosting regular virtual meetups or initiating collaborative projects. Furthermore, it is beneficial to provide microlearning resources (Word & Dennen, 2020) that offer bite-sized learning materials (e.g., videos and blog posts) to enable educators to quickly grasp insights on technology integration.

## Limitations and Conclusion

There are limitations of the present study. While our study provides valuable insights into elementary STEM teachers' OER and TPACK in a PLN as informal professional development, it's important to acknowledge certain methodological limitations. The use of one case may have introduced selection bias, potentially limiting the generalizability of our findings to broader populations (Stake, 2006). Future studies could address these limitations by employing diverse cases. Despite these constraints, our approach allowed us to present an overview of elementary

STEM teachers' informal professional development on teaching practices and TPACK through interactions with OER, providing a foundation for future research in this area. Second, the current study did not examine how teachers' use of OER and TPACK varies across different grade levels or particular subject areas. There is also little examination on how instructors' OER and TPACK manifest themselves at various stages of their careers. Understanding these elements could give insights to educational institutions and lawmakers in creating tailored support and intervention strategies to improve teachers' knowledge of OER and practices in technology integration.

The current study investigated how elementary STEM teachers explored OER that were aligned with different TPACKs inside a PLN. In particular, we discovered that elementary STEM teachers primarily share tools and tips, and instructional strategies as OER, whereas TK and TPK are the most often discussed TPACK domains. Additionally, the study identified a close connection between TK and TPK and tools and tips, revealing that these teachers actively seek out and exchange knowledge or concepts about using technology in their classroom during a PLN. We hope that the current study results are informative to various stakeholders to shed light on creating PLNs and teacher development programs that enhance teachers' TPACK.

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# Setting the Stage for Success: Readiness and Connectedness as Antecedents of Learning Continuance Intention in Online Learning

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## Abstract

Through a hierarchical multiple regression analysis, this study investigated how dimensions of online learning readiness and online connectedness influence students' intentions to continue to take online courses. Data from 369 students who took at least one online course at a four-year public university showed that online learning readiness had a stronger relationship with continuance intention than online student connectedness, while online learning readiness had a significant correlation with online student connectedness. Online learning readiness and connectedness were indicators of online learning persistence. Factors such as age, computer/internet self-efficacy, self-directed learning, learner control, and facilitation influence students' intention to continue with online learning. Moreover, among the five subscales of readiness, motivation had the strongest connection with continuance intention. In addition, course facilitation was positively and significantly related to the intention to continue participating in courses. The study's implications and directions for future research were also explored.

**Keywords:** Distance education and online learning, online learning readiness, connectedness, continuance intention, higher education

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Online course delivery became a primary medium of instruction during the COVID pandemic; therefore, while it is essential to comprehend factors that determine the success of online learning from the perspective of instructors, instructional designers, technical support staff, and institutional administrators, it is equally important for them to understand and assess how prepared students are for online learning. Since the early 21<sup>st</sup> Century, researchers started to explore the dynamic factors and constructs, learner characteristics and capabilities that would help to assess students' readiness or preparedness for smooth and successful online learning experience (Dray et al., 2011; Hung et al., 2010). Online learning readiness (OLR) refers to a person's preparedness and capacity to successfully participate in an online course or online learning activities (Chien et al., 2022). It consists of a set of skills, attitudes, and behaviors that enable students to participate in online learning activities and accomplish their learning objectives. Moreover, when students are well-prepared for online learning, they are more likely to be active agents in the learning community, to have positive experiences, and to have a higher intention to continue their online learning journey.

Prior studies have identified factors that affect students' online learning continuance intention (OLCI). The factors were concentrated in three perspectives: (a) students' characteristics and learning attitudes (Cochran et al., 2014; Zhu et al., 2020b), (b) e-learning systems or services (Dağhan & Akkoyunlu, 2016; Dai et al., 2020; Lin, 2011), and (c) senses of presence and connectedness (Dai et al., 2020; Zhao et al., 2021). Studies found that online learning readiness (OLR) can strongly predict the extent to which a student will experience and achieve online learning (Joosten & Cusatis, 2020; Kirmizi, 2015; Tang et al., 2021) and can influence their persistence in online courses and programs (Aragon & Johnson, 2008; Yu & Richardson, 2015).

Understanding students' readiness for online learning is critical because it gives teachers insights about their students and allows them to provide direction for a successful and productive online learning experience. In online learning environments, educators may find it necessary to assist students to cultivate self-directed learning abilities and foster a sense of control over their learning experiences, as emphasized by Hung et al. (2010). However, the literature review revealed little research attention to the associations among online learning readiness, online learning experiences, and online learning continuance intention (Ngah et al., 2022; Zhao et al., 2021). Thus, the purpose of the study was to examine the relationships among online learning readiness, online connectedness, and online learning continuance intention, and to investigate how dimensions of OLR and online connectedness influence students' intention to continue to take online courses.

## **Literature Review**

### ***Online Learning Readiness (OLR)***

To have positive and productive experiences in an online learning environment, learners must be prepared. The concept of online learning readiness has changed over time in response to changes in technology, pedagogical techniques, and educational environments. In the late 1990s, Warner et al. (1998) introduced the concept of online learning readiness in the Australian Technical Vocational Education and Training sector (TVET), describing it as the degree to which learners are prepared to participate in online learning, considering their technical skills,



learning attitudes, and motivation. With the increased prevalence of online learning and advancements in technology at the beginning of the 21<sup>st</sup> century, scholars began examining factors that determine online learning readiness. Evans (1999), Guglielmino and Guglielmino (2003), and Schreurs et al. (2008) emphasized the importance of computer and internet self-efficacy, as well as the learner's competency in using technological tools (Martin et al., 2020a), in determining the level of readiness of students for engaging in online learning. Furthermore, Smith (2005) examined student behaviors and attitudes, and identified factors such as self-directed learning, motivation, and learner control that contribute to effective online learning preparation. Smith et al. (2003) revealed the importance of possessing efficient communication abilities in the context of online education. Hung et al. (2010) presented an extensive framework of online learning readiness consisting of five dimensions: computer/internet self-efficacy, self-directed learning, learner control, motivation for learning, and online communication self-efficacy. These factors illustrate the complex nature of online learning readiness and the necessity of considering a wide range of elements when evaluating students' preparedness for online learning.

### ***Computer/Internet Self-Efficacy***

Compeau and Higgins (1995) defined computer internet self-efficacy as the perception of one's ability to use a computer and apply computer skills to a broader task. Given that an online course is facilitated through technology-mediated tools, it is imperative that students possess the necessary proficiency in utilizing computers and the internet. Research has shown that individuals who have higher levels of computer self-efficacy are more likely to participate in e-learning activities and have better performance in online courses (Aboobaker & Muneer, 2022; Wolverson et al., 2020). In addition, computer self-efficacy has a positive influence on learners' attitudes, motivation, and satisfaction in e-learning environments, which leads to improved learning outcomes (Chen, 2017; Chien, 2012; Doğru, 2020; Lu et al., 2016). Moreover, students' level of self-efficacy with computers is significantly inversely related to their level of anxiety over e-learning (Azizi et al., 2022; Saadé & Kira, 2009). Therefore, computer/internet self-efficacy evidently plays a crucial role in the effectiveness of e-learning experiences.

### ***Self-Directed Learning***

Knowles (1975) defined self-directed learning as “process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes” (p. 18). Important characteristics of self-directed learners include intrinsic motivation, the ability to choose personal objectives, self-discipline, the capacity for self-evaluation, and metacognitive skills (King, 2011). Self-directed learners in the context of online learning are prone to engaging actively in learning tasks, exhibiting effective time management skills, and seeking assistance when necessary (Botha et al., 2015; Garrison, 1997; Zhu et al., 2020a).

### ***Learner Control***

Learner control refers to instructional approaches that provide students with some control over educational events. It gives students autonomy and decision-making authority over their learning experiences, allowing them to accommodate and optimize their benefits (Hannafin, 1984; Scheiter, 2014). Due to the flexible nature of e-learning, students must assume

more accountability for their own learning progress. Online learning is more likely to be successful for students who can direct their own learning progress, manage their time efficiently, and maintain focus on learning duties. Learner control is identified as a key factor in determining both learning outcomes and satisfaction with e-learning courses (Clark & Mayer, 2011; Kraiger & Jerden, 2007; Piccoli et al., 2001).

### ***Motivation for Learning***

Learning motivation is what compels a person to seek out and engage in educational activities. It involves the desire to acquire new knowledge, skills, and experiences as well as a willingness to put in the necessary effort to do so. Learning motivation can be affected by a variety of factors, including personal interests, internal rewards, external pressures, and social support. The motivational orientation of students, whether intrinsic or extrinsic, has substantial effects on their academic performance. Motivated learners are more likely to take on an extensive approach to learning, engage in challenging activities, and demonstrate higher levels of achievement in online learning environments. (Amrai et al., 2011; Conley & French, 2013; Daumiller & Zarrinabadi, 2021; Trevino & DeFreitas, 2014).

### ***Online Communication Self-Efficacy***

Online communication self-efficacy refers to an individual's confidence in their ability to communicate effectively with others via online channels (e.g., email, social media, messaging applications, video conferencing, and discussion boards, etc.). Students possessing a greater degree of self-efficacy in online communication tend to exhibit motivation and perseverance in their endeavors to actively engage and excel in online learning environments. They are more open to participating in discussions, inquire about concepts, and express thoughts and emotions, thereby fostering increased involvement in online learning activities and enabling effective collaboration with both instructors and peers (Roper, 2007; Wang et al., 2022).

### ***Online Student Connectedness (OSC)***

According to Bolliger and Inan's (2012) definition, connectedness refers to an individual's perception of being recognized and sense of belonging. The term pertains to an individual's belief or perception about the existence of a relationship between themselves and one or more other individuals. Bolliger and Inan developed the Online Student Connectedness Survey (OSCS) as a tool for assessing the degree of connectedness among online students. The OSCS comprises four distinct subscales: comfort, community, facilitation, and interaction and collaboration. Zimmerman and Nimon (2017) investigated the validity and reliability of the OSCS and established connections with comparable instruments, such as the Classroom Connectedness Survey (CCS) and the Community of Inquiry Survey (CoI), confirming that it accurately measures feelings of connection among participants in online courses at higher education institutions. Hart (2012) argued that students are more likely to be actively engaged in the learning process if they feel a stronger connection to the classroom. The most engaged and devoted students in online courses are those who perceive a strong social presence and sense of closeness with peers. Learning community and social connectedness significantly predicted self-determined requirements, satisfaction, and the intention to continue online learning (Geary et al., 2023; Tseng et al., 2022; Zhu et al., 2020a). Moreover, research showed that connectedness

improves students' physical and emotional health, academic advancement, and likelihood of graduating (Arslan, 2021; Bridgstock et al., 2019; Wilson, 2018).

### ***Aspects Influencing Online Learning Continuance Intention (OLCI)***

The concept of online learning continuance intention refers to the inclination of individuals to sustain their involvement in online learning activities or courses over a period. It evaluates the level of determination demonstrated by individuals in their pursuit of online learning. The study of continuation intention is significant in the disciplines of educational research and practice because of its impact on learner retention, completion rates, and overall academic accomplishment. Intentions to continue online learning are complex, and the significance of contributing factors can vary depending on the learners and their respective circumstances. The factors that have been identified in the literature include computer anxiety, computer self-efficacy, and enjoyment (Alenezi et al., 2010), communication self-efficacy and learning motivation (Hung, 2016), learning satisfaction, perceived usefulness, perceived ease of use, perceived value, information quality, and connectedness (Al Amin et al., 2023; Lee, 2010; Li et al., 2021; Nugroho et al., 2019; Roca et al., 2006; Tseng et al., 2022; Wang et al., 2021; Wu & Zhang, 2014). Additionally, personal traits, attitude, and curiosity (Dai et al., 2020), compatibility of hardware/software (Indriana et al., 2022), and social interaction (Chung et al., 2020; Panigrahi et al., 2018; Li & Zhao, 2021) have also been found to be relevant factors.

Research has been undertaken to investigate students' continuous intention towards online learning, with sole focus either on their state of preparedness or connectedness (Farsawang & Songkram, 2022; Tseng et al., 2022). Therefore, this study was designed to examine students' willingness to continue with online learning by including both readiness and connectedness factors. The research questions leading the study were:

Q1: What is a student's level of online learning readiness, online student connectedness, and continuance intention for online learning?

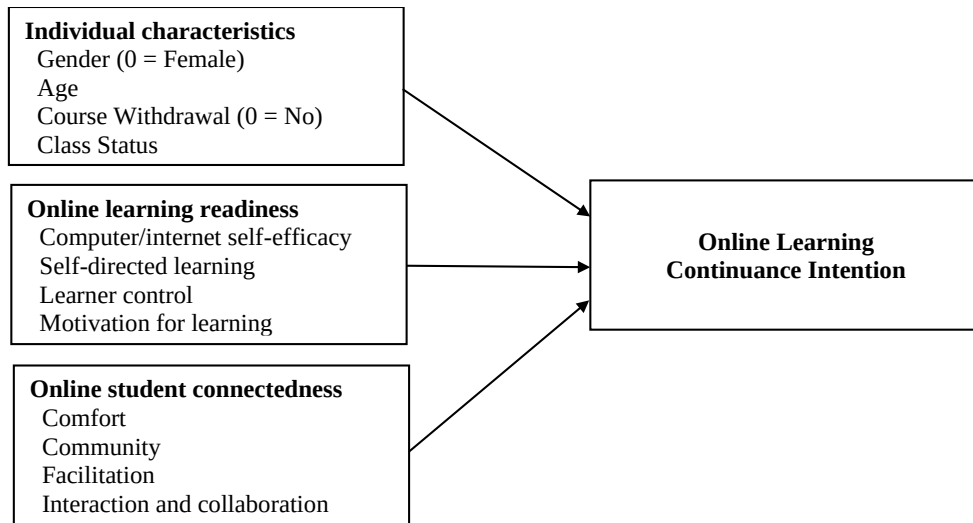
Q2: Does gender influence online learning readiness levels?

Q3: What is the correlation between online learning readiness, online student connectedness, and continuance intention?

Q4: After controlling for individual characteristics, do variables relating to students' readiness and connectedness for online learning have a positive effect on their intention to continue learning? (See Figure 1)

### **Figure 1**

*Hierarchical Multiple Regression Analysis Model*



## Methodology

### *Participants*

The survey was distributed to 1187 students who had taken at least one online course at a four-year public university/institution in the southern United States. A total of 369 students responded, for a response rate of 31%. There were 268 female participants, accounting for 72.6% of the total (See Table 1). Approximately 43.1% of the participants belonged to the age group of 20 to 29 years. Among the sample, 83.7% were undergraduate students, and 26.8% were in their junior year. Most of them ( $n = 128$ , 34.7%) enrolled in a single online course, while five participants (1.4%), enrolled in more than five courses. Approximately 10% of the students withdrew from classes. Among those students, 9.7% dropped one course and 0.8% dropped two.

### *Data Collection and Analysis*

Prior to data collection, this study received Institutional Review Board (IRB) approval from the university. Data collection was carried out using EvaluationKit, an online tool that has been integrated into the university's system. The survey was distributed three weeks prior to the finals week. The respondents were invited to participate in the survey. The statistical analysis was conducted using IBM SPSS. Independent samples *t*-Test, correlation analysis, and hierarchical multiple regression analysis were performed. To compare the effects of variables on a similar scale, improve interpretability, and quantify the relative relevance of predictors in regression models, standardized beta coefficients were employed in regression analysis.

**Table 1**

*Demographic Profile of the Respondents ( $n = 369$ )*

| Demographic | Item   | Number (Percentage) |
|-------------|--------|---------------------|
| Gender      | Female | 268 (72.6%)         |
|             | Male   | 101 (27.4%)         |

|                   |                |             |
|-------------------|----------------|-------------|
| Age               | Under 20       | 96 (26.0%)  |
|                   | 20-29          | 159 (43.1%) |
|                   | 30-39          | 55 (14.9%)  |
|                   | 40-49          | 45 (12.2%)  |
|                   | Over 50        | 14 (3.8%)   |
| Course Enrolled   | One            | 128 (34.7%) |
|                   | Two            | 102 (27.6%) |
|                   | Three          | 51 (13.8%)  |
|                   | Four           | 48 (13.0%)  |
|                   | Five           | 23 (6.2%)   |
|                   | More than five | 5 (1.4%)    |
|                   | Missing        | 12 (3.3%)   |
| Course Withdrawal | One            | 36 (9.7%)   |
|                   | Two            | 3 (0.8%)    |

### ***Instruments***

*The Online Learning Readiness Scale (OLRS).* The OLRS, which was adopted from Hung et al.'s (2010) multidimensional instrument for college students' readiness for online learning, consists of 18 items distributed across five subscales: computer/internet self-efficacy, self-directed learning, learner control, motivation for learning, and online communication self-efficacy.

*The Online Student Connectedness Survey (OSCS).* The OSCS, adopted from Bolliger and Inan (2012) to measure students' perceptions of connectedness in online programs, consists of 25 items distributed across four subscales: comfort, communication, facilitation, and interaction and collaboration.

*The Online Learning Continuance Intention (OLCI).* The OLCI consists of 4 items modified from Alraimi et al. (2015) to measure students' intention to continue using online learning platforms.

All items were measured using a five-point Likert scale ranging from "strongly agree" to "strongly disagree." Cronbach's alpha ( $\alpha$ ) was used to assess the internal consistency of each subscale. In this study, all subscales' Cronbach's alpha were above .7, indicating an acceptable internal consistency (Nunnally & Bernstein, 1994). The example questionnaire and Cronbach's alpha for each subscale are presented in Table 2.

**Table 2**

#### *Descriptive Statistics, Reliability Information of Each Scale*

| Scales | # of Items | Sample Item | Cronbach's alpha | Mean | SD |
|--------|------------|-------------|------------------|------|----|
|--------|------------|-------------|------------------|------|----|

|                                    |    |                                                                                                    |     |      |      |
|------------------------------------|----|----------------------------------------------------------------------------------------------------|-----|------|------|
| <b>OLRS</b>                        | 18 |                                                                                                    | .94 | 4.19 | .58  |
| Computer/internet self-efficacy    | 3  | I feel confident in my knowledge and skills of how to manage software for online learning.         | .91 | 4.36 | .71  |
| Self-directed learning             | 5  | I carry out my own study plan.                                                                     | .87 | 4.13 | .70  |
| Learner control                    | 3  | I can direct my own learning progress.                                                             | .75 | 3.98 | .75  |
| Motivation for learning            | 4  | I am motivated to learn.                                                                           | .86 | 4.29 | .59  |
| Online communication self-efficacy | 3  | I feel confident in using online tools (email, discussion) to effectively communicate with others. | .83 | 4.21 | .61  |
| <b>OSCS</b>                        | 25 |                                                                                                    | .96 | 3.48 | .78  |
| Comfort                            | 8  | I have no difficulties with expressing my thoughts in my online courses.                           | .94 | 4.06 | .69  |
| Community                          | 6  | My peers have gotten to know me quite well in my online courses.                                   | .96 | 2.80 | 1.16 |
| Facilitation                       | 6  | I receive frequent feedback from my online instructors.                                            | .90 | 3.74 | .86  |
| Interaction and collaboration      | 5  | I work with others in my online courses.                                                           | .95 | 3.09 | 1.16 |
| <b>OLCI</b>                        | 4  | I intend to continue taking online learning courses in the future.                                 | .96 | 4.06 | .97  |

## Results

### *Level of Online Learning Readiness, Online Student Connectedness, and Continuance Intention*

The study employed descriptive statistics to analyze the online students' readiness, connectedness for online learning and level of continuance intention. The mean for online learning readiness was 4.19 ( $SD = .58$ ). Furthermore, the mean scores for the five dimensions of readiness were arranged in descending order as follows: computer/internet self-efficacy ( $M = 4.36$ ,  $SD = .71$ ), motivation for learning ( $M = 4.29$ ,  $SD = .59$ ), online communication self-efficacy ( $M = 4.21$ ,  $SD = .61$ ), self-directed learning ( $M = 4.13$ ,  $SD = .70$ ), and learner control ( $M = 3.98$ ,  $SD = .75$ ). Second, the mean score for the connectedness was 3.48 ( $SD = .78$ ). Moreover, the mean scores for the four sub-scales of connectedness were arranged in descending order as follows: comfort ( $M = 4.06$ ,  $SD = .69$ ), facilitation ( $M = 3.74$ ,  $SD = .86$ ), interaction and collaboration ( $M = 3.09$ ,  $SD = 1.16$ ), and community ( $M = 2.80$ ,  $SD = 1.16$ ). Finally, the mean score for the online learning continuance intention was 4.06 ( $SD = .97$ ), implying that students are more inclined to continue taking online classes (see Table 2).

### *Online Learning Readiness by Gender*

An Independent Samples *t*-Test was utilized to assess the gender-based differences in the five dimensions of online readiness. The population variances of the compared female and male groups were equal (equal variances assumed) except for the motivation for learning variable.

There were statistically significant differences ( $t(367) = 2.99, p < .01$ ) in the overall online readiness scores, with the mean score for female ( $M = 4.25, SD = .52$ ) being higher than that for male ( $M = 4.05, SD = .70$ ). In addition, there were significant gender differences for computer/internet self-efficacy ( $t(367) = 2.09, p < .01$ ), self-directed learning ( $t(367) = 3.20, p < .05$ ), motivation for learning ( $t(367) = 2.40, p < .05$ ), and online communication self-efficacy ( $t(367) = 2.50, p < .05$ ), with females scoring higher than males. However, no significant differences on learner control ( $t(367) = 1.76, p > .05$ ) between female ( $M = 4.03, SD = .72$ ) and male ( $M = 3.87, SD = .82$ ) were identified (see Table 3).

**Table 3**

*Independent Samples T-test for Gender Differences in Online Learning Readiness*

| Variables           | Female ( $n = 262$ ) |     | Male ( $n = 107$ ) |     | $t$    |
|---------------------|----------------------|-----|--------------------|-----|--------|
|                     | M                    | SD  | M                  | SD  |        |
| OLR                 | 4.25                 | .52 | 4.05               | .70 | 2.99** |
| OLR_CSE             | 4.41                 | .63 | 4.24               | .86 | 2.09*  |
| OLR_SDL             | 4.21                 | .66 | 3.95               | .76 | 3.20** |
| OLR_LC              | 4.03                 | .72 | 3.87               | .82 | 1.76   |
| OLR_ML <sup>1</sup> | 4.34                 | .51 | 4.16               | .72 | 2.40** |
| OLR_OCSE            | 4.24                 | .63 | 4.05               | .78 | 2.50** |

Note: OLR: Online learning readiness  
 OLR\_CSE: Computer/internet self-efficacy  
 OLR\_SDL: Self-directed learning  
 OLR\_LC: Learner control  
 OLR\_ML: Motivation for learning  
 OLR\_OCSE: Online communication self-efficacy  
<sup>1</sup>: group being compared are unequal  
 \* $p < .05$ , \*\* $p < .01$

### ***Correlation Between Online Learning Readiness, Online Student Connectedness, and Continuance Intention***

To examine the relationships between online learning readiness, online student connectedness, and continuance intention, a multivariate correlational analysis was performed, and Pearson correlation coefficients were calculated. The results demonstrated that all three variables were significantly correlated (see Table 4). Online learning readiness had a stronger relationship with continuance intention ( $r = .63, p < .01$ ) than online student connectedness ( $r = .37, p < .01$ ), while online learning readiness had significant correlation with online student connectedness ( $r = .45, p < .01$ ).

**Table 4**

*Correlations Between Online Learning Readiness, Online Student Connectedness, and Continuance Intention*

| Variables                    | Online learning readiness | Online student connectedness | Continuance intention |
|------------------------------|---------------------------|------------------------------|-----------------------|
| Online learning readiness    | 1                         | .45**                        | .63**                 |
| Online student connectedness | -                         | 1                            | .37**                 |
| Continuance intention        | -                         | -                            | 1                     |

\*\*  $p < .01$

### ***Hierarchical Multiple Regression Analysis of Online Learning Continuance Intention***

The present study employed a hierarchical multiple regression analysis. The first model, only containing the individual characteristics (i.e., gender, age, course withdrawal, and class status variables), explained 7.1% of its variance, which was significant ( $F = 6.906, p < .001$ ); only age ( $\beta = .204, p < .01$ ) was a significant predictor of online learning continuance intention. The second model, containing the individual characteristics and the OLR (i.e., computer/internet self-efficacy, self-directed learning, learner control, motivation for learning, and online communication self-efficacy), could explain 42.7% of its variance, which was significant ( $F = 29.613, p < .001$ ). More specifically, the second model showed that age ( $\beta = .122, p < .05$ ), computer/internet self-efficacy ( $\beta = .223, p < .01$ ), self-directed learning ( $\beta = .189, p < .01$ ), learner control ( $\beta = .194, p < .01$ ), and motivation for learning ( $\beta = .228, p < .05$ ) were significant predictors of online learning continuance intention. The third model, containing the individual characteristics, OLR, and OSC (i.e., comfort, community, facilitation, and interaction and collaboration), explained 47% of the variance, which was significant ( $F = 34.121, p < .001$ ). To be more precise, the third model showed that age ( $\beta = .122, p < .05$ ), computer/internet self-efficacy ( $\beta = .207, p < .01$ ), self-directed learning ( $\beta = .173, p < .05$ ), learner control ( $\beta = .150, p < .05$ ), and motivation for learning ( $\beta = .247, p < .01$ ) were significant indicators of online learning retention intention. Moreover, the  $R^2$  increase from the first model to the second model was significant ( $R^2 = 35.7\%, F = 44.462, p < .001$ ), as was the  $R^2$  increase from the second model to the third model ( $R^2 = 4.3\%, F = 7.163, p < .001$ ). It is worth noting that within the third model, online communication self-efficacy was significantly and negatively associated with continuance intention ( $\beta = -.237, p < .05$ ).

**Table 5**

### ***Results of Hierarchical Multiple Regression Analyses of Online Learning Continuance Intention***

| Variable                                 | Model 1 $\beta$ | Model 2 $\beta$ | Model 3 $\beta$ |
|------------------------------------------|-----------------|-----------------|-----------------|
| <b><i>Individual characteristics</i></b> |                 |                 |                 |
| Gender (0 = Female)                      | -.089           | .006            | .001            |
| Age                                      | <b>.204**</b>   | <b>.122*</b>    | <b>.122*</b>    |
| Course Withdrawal (0 = No)               | .086            | -.059           | -.044           |
| Class Status                             | .054            | .002            | -.030           |
| <b><i>OLRS</i></b>                       |                 |                 |                 |
| Computer/internet self-efficacy          |                 | <b>.223**</b>   | <b>.207**</b>   |



|                                    |          |               |               |
|------------------------------------|----------|---------------|---------------|
| Self-directed learning             |          | <b>.189**</b> | <b>.173*</b>  |
| Learner control                    |          | <b>.194**</b> | <b>.150*</b>  |
| Motivation for learning            |          | <b>.228*</b>  | <b>.247**</b> |
| Online communication self-efficacy |          | -.127         | <b>-.237*</b> |
| <b>OSCS</b>                        |          |               |               |
| Comfort                            |          |               |               |
| Community                          |          |               | .063          |
| Facilitation                       |          |               | -.064         |
| Interaction and collaboration      |          |               | <b>.272**</b> |
|                                    |          |               | -.042         |
| $R^2$                              | .071     | .427          | .470          |
| $F$                                | 6.906*** | 29.613***     | 24.121***     |
| $p$ -value                         | .000***  | .000***       | .000***       |
| $\Delta F$                         | 6.906*** | 44.462***     | 7.163***      |
| $\Delta R^2$                       | .071     | .357          | .043          |

Note.  $n = 369$ ; \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

## Discussion

### Online Learning Readiness

The mean score of online learning readiness for this study was 4.19, indicating that students' readiness for online learning was above the midpoint of the scale. As a result, students were prepared to participate in online learning activities, which aligns with the findings of past research (Chung et al., 2020a; Chung et al., 2020b; Cigdem & Yildirim, 2014; Dorsah, 2021; Hung et al., 2010). Regarding the five dimensions, results indicate that participants scored highest in computer/internet self-efficacy and lowest in learner control. The results are consistent with those of Chung et al. (2020a), Chung et al. (2020b), and Hung et al. (2010), but differ from those of Cigdem and Yildirim (2014), and Dorsah (2021). Further analysis of readiness by gender revealed that women had significantly higher levels of readiness for online learning. Females are more proficient with technology, responsible for their own learning, committed to education, and confident in their ability to communicate effectively online. The present discovery contradicts results reported by Chung et al. (2020a; 2020b) and Hung et al. (2010), which indicated no significant gender-based variations, and Dorsah (2021), who established that males demonstrated a higher level of readiness. One possible explanation for the observed differences in research outcomes could be the cross-regional nature of the studies, in which the unique cultural, social, and economic characteristics of each country may have influenced the results.

### Online Student Connectedness

The mean score of connectedness indicates that students' sense of connectedness is greater than the midpoint of the scale. Meanwhile, comfort score is the greatest and community score is less than the midpoint of scale. According to Dallimore et al. (2010), students' comfort in participating in class discussions had a favorable effect on their learning. Kiener et al. (2014) underlined the necessity of creating an engaging learning environment in the classroom where students felt comfortable and motivated. It stimulates active learning, problem-solving, and a positive mindset, ultimately leading to academic success. However, the findings indicated that during the learning process, students might lack a sense of belonging, feel emotionally distant from one another, or be unfamiliar with one another despite feeling comfortable and safe in their academic environment. These concerns have been voiced in the past regarding the lack of peer engagement and participation. Lack of peer-to-peer connection may cause students to feel distanced from their peers in addition to possibly leaving them confused and upset with the assignments and course material (Allen et al., 2018; Garrison et al., 2005; Kaufmann et al., 2016).

### ***Correlation Between Online Learning Readiness, Online Student Connectedness, and Continuance Intention***

The correlational analysis results indicate that students' level of readiness has a greater influence on their intention to continue learning than their level of connectedness in the online environment. In addition, after controlling for individual characteristics (gender, course withdrawal, age, and class status), hierarchical multiple regression analysis results reveal that variables associated with online learning readiness and online student connectedness had a positive effect on students' intention to continue online learning. In the first regression model, students' individual characteristics explained only 7.1% of the variance in their intention to continue learning. In addition, when online learning readiness and connectedness variables were added to the regression analysis (Model 3), the model significantly explained 47% of the variance in students' intent to continue online learning. Thus, the findings indicate the importance of both factors in online education. This result is in accordance with Farsawang and Songkram's study (2022) that readiness predicts students' desire to continue online learning. More specifically, age, computer/internet self-efficacy, self-directed learning, learner control, and facilitation were considerably connected with the intention to continue learning online, while online communication self-efficacy was considerably and adversely correlated. Farsawang and Songkram (2022) additionally captured mediating factors, such as attitude, motivation, engagement, and satisfaction in the relationships between online learning readiness and continuance intention during the pandemic. They concluded that motivation and attitude were more influential than satisfaction on students' intention to continue. The context of forced online learning during the pandemic may have altered the traditional satisfaction-continuance relationship. Incorporating Self-Determination Theory elements (Deci & Ryan, 1985, 2000), Community of Inquiry framework (Garrison et al., 1999), and Social Cognitive Theory constructs (Bandura, 1989) into a model may lead to a more comprehensive prediction of online continuance intention and improved explanatory power.

Moreover, among five subscales of readiness, motivation had the strongest connection with continuance intention. This result is consistent with the studies of Chang et al. (2013) and Hung (2016), showing how motivation may foster students' willingness to continue their online education. It is worth noting that online communication self-efficacy has a substantial adverse association with continuing intention. Communication self-efficacy in this survey primarily

assessed respondents' comfort levels when utilizing online tools like email, discussion boards, and posting and other forms of text communication. Emailing, commenting, and publishing are common practices in social media and normal communication. However, it is probable that the skills and confidence required for these activities will not translate well in a classroom context. Online learning requires a broader range of abilities beyond basic computer literacy and communication skills, including comprehension of the course material, participation in conversations, and assignment completion. In addition, it is unclear how faculty have used these communication technologies for online teaching and how students have used them for online learning.

Another key finding is that course facilitation was positively and significantly related to the intention to continue participating in courses, demonstrating that online students were more likely to be interested in continuing to take online classes when they believed their courses were sufficiently facilitated. These findings are consistent with prior research indicating that facilitation affects students' continuing interest in one-to-one online learning (Liu & Pu, 2023). There are a number of underlying psychological and practical explanations for this. For instance, effective facilitation typically leads to greater perceived educational quality. When they believe their online courses are well structured, well supported, and instructed by qualified professors or facilitators, students are more likely to believe they are receiving a valuable educational experience. Learning can be productive as a result of effective facilitation. Students are more likely to engage with the course materials, contribute to conversations, and finish tasks if they feel supported and guided throughout the learning process. A supportive online learning experience, including timely and constructive feedback from the instructors and experiencing meaningful interactions with peers, has motivated students to continue their online learning journey (Rosser-Majors et al., 2022). Facilitating online learning entails leading, encouraging, and supporting student participation in a virtual learning environment to improve learning effectiveness and engagement (Martin et al., 2020b). In the classroom, instructors can promote facilitation by encouraging active learning, successful teamwork (Ku et al., 2013; Tseng et al., 2019), presence during the session, and other practices.

Finally, as students' age increase, they are more likely to express a desire to continue their online learning. The possible explanation is that older students have more life experience and might also have a greater understanding of their educational goals. Thus, older students tend to continue online learning. Few studies that evaluated the difference in continuing intention across age were reported in the literature. However, Almahami and Rub (2011) discovered that age had no impact on students' continuous intent to use e-learning technologies. Future studies should explore more deeply into the connections between demographic parameters like gender, age, class status and how these affect student's intent to stay in online learning. Understanding these factors is important as they can enable educational institutions to provide more personalized support, tailor interventions to address the specific challenges, and design adaptive learning systems based on the individual demographic characteristics and learning behaviors of students, enhancing their chances of persisting.

### ***Implications***

The results of the study have significant implications for online programs and instructors. Programs and instructors can contribute to the success of their online learners by evaluating and addressing students' readiness and connectedness for online learning, customizing training, establishing appropriate online learning environment, continuously enhancing course offerings,

and personalizing the learning experience. First, online programs and/or instructors should assess students' level of readiness and help those who might be having problems getting started their online learning. This could include providing additional resources, tutorials, or counseling to address specific challenges. Second, online courses should be designed based on the "universal design for learning" guidelines to meet the needs and capabilities of every student while also removing needless barriers to learning (Tang et al., 2022; Wright et al., 2023). Third, faculty need to foster a positive learning environment in the classroom by providing students with opportunities for collaboration and teamwork as well as by creating a sense of community among them, using a variety of teaching and learning methods, allowing students to interact with each other, and providing students with timely constructive feedback. Finally, by staying up to date with the most recent research and best practices, online programs and instructors should continuously improve the quality of programs and online learning environment. This could entail adopting new pedagogical concepts (Tseng et al., 2024), utilizing technological advancements, and routinely reviewing and evaluating the results of their online learning projects.

### ***Limitations and Future Directions***

Future research could investigate how gender intersects with other social identities such as race, ethnicity, and socioeconomic status to identify potential intervention and support areas and contribute to the creation of inclusive, effective online learning environments for all students. It is important to note that the study contains several limitations. This exploratory study is limited by its sample, which is restricted to one university, specifically female students up to the age of 24, and may not be representative of the general population. Additionally, the voluntary nature of the survey led to a low response rate, potentially resulting in self-selection bias and limiting the generalizability of the findings. When comparing gender differences of motivation for learning, the two groups were unequal in terms of sample size. As a result, the finding may be less capable of detecting genuine impacts or differences and should be carefully considered. Moreover, the relationships among these factors are complex and interrelated. For example, a student with high self-directed learning skills may be more motivated to engage in online learning, and their motivation can further boost their intention to continue. Similarly, students with strong computer/internet self-efficacy may feel more in control of their learning, which can enhance their motivation. These factors are not isolated but work together to influence students' continuous intention to participate in online learning. Educators and institutions can enhance online learning experiences by fostering these skills and promoting a supportive online learning environment, which can positively impact students' intentions to persist in online courses.

## **Conclusion**

The purpose of this study was to investigate how student readiness and connectedness affect online learning continuation intention. The results of this analysis suggest that online learning readiness and connectedness are indicators of online learning persistence. Factors such as age, computer/internet self-efficacy, self-directed learning, learner control, and facilitation influence students' intention to continue with online learning. Gender may play a role in influencing online learning readiness, and it would be beneficial to conduct additional research to determine the underlying causes of these differences. Gender should be considered in online

learning readiness when designing effective interventions for online learning. These findings have significant implications for online learning design and implementation, emphasizing the significance of fostering students' self-efficacy, motivation, and social connectivity to encourage their continuing engagement and success in online learning.

**Declarations**

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## Appendix 1

### Online Learning Readiness (OLR)

#### *Computer/Internet self-efficacy*

1. I feel confident in performing the basic functions of Microsoft Office programs (MS Word, MS Excel, and MS PowerPoint).
2. I feel confident in my knowledge and skills of how to manage software for online learning.
3. I feel confident in using the Internet (Google, Yahoo) to find or gather information for online learning.

#### *Self-directed learning*

1. I carry out my own study plan.
2. I seek assistance when facing learning problems.
3. I manage time well.
4. I set up my learning goals
5. I have higher expectations for my learning performance.

#### *Learner control (in an online context)*

1. I can direct my own learning progress.
2. I am not distracted by other online activities when learning online (instant messages, Internet surfing).
3. I repeated the online instructional materials on the basis of my needs.

#### *Motivation for learning (in an online context)*

1. I am open to new ideas.
2. I have motivation to learn.
3. I improve from my mistakes.
4. I like to share my ideas with others.

#### *Online communication self-efficacy*

1. I feel confident in using online tools (email, discussion) to effectively communicate with others.
2. I feel confident in expressing myself (emotions and humor) through text.
3. I feel confident in posting questions in online discussions.

### Online Student Connectedness (OSC)

#### *Comfort*

1. If I need to, I will ask for help from my classmates.
2. I feel comfortable expressing my opinions and feelings in online courses.
3. I feel comfortable introducing myself in online courses.
4. I can effectively communicate in online courses.
5. I feel comfortable asking other students in online courses for help.
6. I have no difficulties with expressing my thoughts in my online courses.
7. I feel my instructors have created a safe online environment in which I can freely express myself.
8. I feel comfortable in the online learning environment provided by my program.

#### *Community*

1. I feel emotionally attached to other students in my online courses.
2. I spend a lot of time with my online course peers.
3. My peers have gotten to know me quite well in my online courses.
4. I feel that students in my online courses depend on me.
5. I can easily make acquaintances in my online courses.
6. I have gotten to know some of the faculty members and classmates well.

*Facilitation*

1. Instructors integrate collaboration tools (e.g., chat rooms, wikis, and group areas) into online course activities.
2. In my online courses, instructors promote interaction between learners.
3. Instructors promote collaboration between students in my online courses.
4. My online instructors are responsive to my questions.
5. I receive frequent feedback from my online instructors.
6. My instructors participate in online discussions.

*Interaction and Collaboration*

1. I relate my work to others' work in my online courses.
2. I discuss my ideas with other students in my online courses.
3. I collaborate with other students in my online courses.
4. I work with others in my online courses.
5. I share information with other students in my online courses.

**Online Learning Continuance Intention (OLCI)**

1. I intend to continue taking online learning courses in the future.
2. I will continue taking online learning courses in the future.
3. I will strongly recommend online learning courses for others to take them.
4. I will keep taking online learning courses as regularly as I do now



# Social Capital in Online Environments: Effects of Social Structure on Academic Performance in an Online University

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## Abstract

The idea of social capital as the value obtainable from an individual's social relationships has been used to study many organizational and social settings, but rarely virtual environments. We used data from an online higher education institution to examine how an individual's social capital derived from her position in the social structure influences her performance levels. We confirmed that social capital has a significant effect on achievement. Firstly, we found that centrality and cohesion in social networks have a positive effect. Secondly, we showed how the network structure counts and how diversity in relationships is important. Having access to heterogeneous peers also increases the performance level in learning processes. These findings suggest that the proven importance of social capital in face-to-face situations might be translated into virtual environments and support the need to build or enhance ICT-mediated students' social networks in distance learning.

**Keywords:** Social capital, virtual organizations, social networks, academic performance, online universities

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The fundamental idea behind the concept of social capital is quite simple: relationships matter. This notion has influenced our view of the social world since the 1920s. However, it has become increasingly important in the social sciences since Pierre Bourdieu and James Coleman established its theoretical foundations in the 1980s. In the last decades, many scientific works have shown how social links allow individuals and collectivities to access valuable resources in many ways while they perform their daily activities.

Nowadays, many of those activities are transferred, in part or entirely, from traditional settings to online environments. We may wonder if things will remain the same in the new scenario. Do social capital benefits translate unchanged into the online world? Are the diverse social capital influence mechanisms similar in virtual settings, or do they show some specificities? Do we need to revise our current social capital theories or build new “online social capital” theories?

Social relationships today take place as much in online environments as face-to-face. Therefore, social networks also form online, and, as a consequence, social capital may be accumulated in that way. For instance, the effects of social capital have been shown as necessary in social media as in the “real world” (Arampatzi et al., 2018; Burke & Kraut, 2016; Ellison et al., 2007; J.-H. T. Lin, 2019; Phulari et al., 2010). Moreover, things may work differently than in traditional environments (Dunbar, 2016; Steinfield et al., 2013). The singular characteristics of social media may allow, for instance, new mechanisms of social capital use to appear or the power of traditional ones to rise exponentially. One clear example is the increasingly important figure of the “influencer” on Twitter and other social sites (Freberg et al., 2011). Does social capital work differently online?

Our aim here is to contribute to answering these questions by examining the case of a specific online environment: a technology-mediated distance university. Two main reasons support our choice. First, social capital influences the educational processes in academic institutions. In the literature, we can find many accounts of that in different educational and learning environments (Cho et al., 2007; Coleman, 1988; Krasny et al., 2015; Maroulis & Gomez, 2008; Ramírez Ortiz et al., 2004; Söllner et al., 2018). Second, as opposed to the case of social media, online education has its clear traditional counterpart, which facilitates the comparison of the effects of social capital in each case.

This paper will present theoretical ideas about how social capital may influence performance in online environments. Following the idea that social capital gives access to new resources through social connections, we will examine two primary resources that might be useful in an online community: information and social cohesion and the mechanisms through which they work. Then, we will test those ideas in a completely online academic environment: a virtual university.

The main findings we will present show how social capital is indeed still crucial in online settings. Based on the structure of the social network, we will suggest two social capital-based mechanisms that may act simultaneously: access to information and creating a cohesive local environment for individuals. We will see that both of them may contribute to improving performance in an online environment like an internet-based distance university.

The paper is structured as follows. First, we will introduce the concept of social capital and how we will approach it in our study. Second, we will present some ideas on the

mechanisms by which social capital may influence performance, specifically in online settings. Based on that, we will put forward some propositions on the effects of social structure on individual performance in online environments. After that, we will describe our research setting, the methodology we have used, and the results obtained. We will finish with a discussion of our results and some conclusions.

## **Theoretical Framework**

### ***Social Capital***

#### **The Social Capital Perspective**

The concept of social capital relies on the idea that “social networks have value” (Putnam, 1995). Networks enable people to cooperate for mutual advantage. This advantage comes from networks granting access to the resources possessed by the other individuals to whom one is connected. Social capital gives access to additional resources through social network connections (N. Lin, 2001b).

In the beginning, the term “social capital” appeared just as a metaphor based on its similarity to other forms of capital previously defined in the literature, like economic capital (Marx, 1867) or human capital (Becker, 1964). Much later, a similar process would occur with the concept of intellectual capital (Brooking, 1996; Edvinsson & Malone, 1997). The metaphor implied that social links are profitable; one could invest in them and expect a return, as with any other form of capital. Different kinds of capital provide individuals or communities with diverse resources. While the other types of capital usually give way to resources that belong to the actor that will put them into use, in the case of social capital, those resources typically belong to other actors that the focal actor accesses through her social links.

However, in the 1980s and 1990s, the metaphor gave way to more serious attempts to build a theoretical apparatus around the concept of social capital. Three seminal figures contributed decisively to give it contemporary significance: Pierre Bourdieu, James Coleman, and Robert Putnam (Field, 2008). Although each tackled the issue from a different angle, making it difficult to conciliate their respective theoretical frameworks, their works popularized social capital in sociology and other social sciences. The first two authors and later developments of their ideas constitute the foundations of the concept of social capital we will use in this work.

Bourdieu (1986) was the first sociologist to systematically analyze the concept of social capital. He approached the idea from an individualistic point of view. The social capital possessed by an individual is the sum of actual or potential resources that he can access through his network of relationships: “by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition” (Bourdieu & Wacquant, 1992, p. 119). Deeply influenced by Marxist sociology, Bourdieu saw social capital—like other kinds of capital, including what he called cultural capital—as a mechanism by which social inequality was created and reproduced. This way, the dominant class could maintain and reproduce group solidarity and preserve its dominant position (Bourdieu, 1986; N. Lin, 2001b). A remarkable aspect of Bourdieu’s view is that he distinguishes two elements in social capital: on the one hand, the social relationship that makes it possible for the individual to access resources, and, on the other hand, the quantity and quality of those resources (Portes, 1998). Bourdieu’s ideas on the suitability of

examining networks based on online interactions have lately been acknowledged, among others, by Julien (2015).

Coleman was mainly interested in social inequality and its effects on academic achievement in schools, and he developed his idea of social capital after several studies on this subject (Coleman, 1990). He identified social capital as critical in creating human capital in the education system (Coleman, 1988). His idea of social capital was less sophisticated than Bourdieu's since he equated it to the set of resources that may be accessed through social relationships. In his view, social capital is a set of entities, each consisting of some aspect of social structure, that facilitate specific actions for the individuals within that structure (Coleman, 1990, p. 302). He proposed that social capital is intangible and has three forms: (a) level of trust, (b) information channels, and (c) norms and sanctions that promote the common good over self-interest (Coleman, 1988). His idea of social capital bridged the individual and the collective views and tended to see it as a collective good. Coleman's works gave rise to many studies about the influence of different aspects of the families' social capital on children's education (Acar, 2011; Dika & Singh, 2002; Novak et al., 2018). However, as we will see below, it is not until recently that some authors have started investigating the influence of the actual students' social capital, especially in higher education contexts.

Social capital can be considered from two different points of view: the individual and the collective (Kadushin, 2012; Portes, 1998). Individual-level social capital is the social capital of individuals that allows them to access networked resources (Bourdieu, 1980; N. Lin, 2001a). The collective-level social capital view refers to social capital as an attribute of social systems like communities and organizations (Coleman, 1990; Putnam, 1995). We will focus our analysis on the individual-level social capital since we are interested in understanding how the structure of the social networks gives access to resources to the individual members of an online community. We aim to relate the benefits that social capital mechanisms provide to various aspects of the structure of social networks. Based on Coleman's theory, Sandefur and Laumann (1998) identify three benefits of social capital: access to information, influence and control, and social solidarity. We will rely on this classification of benefits for our analysis.

### Benefits of Social Capital

Social and organizational research has shown the importance of social capital for the performance of individuals, groups, and organizations. Social actors use the different kinds of resources they can reach through their social networks to increase their effectiveness and improve their efficiency. In his seminal work about weak ties, for instance, Granovetter (1973) showed how social links outside of their close social surroundings allowed individuals to get valuable and helpful information, in that case, about the job market. Later, Coleman (1988, 1990) stated the influence of social capital in creating human capital is a critical performance factor. This view hinges on the idea that when everyone is connected to everybody else, information flows easily, and the transfer and creation of knowledge are more effective. Network closure, thus, is the primary source of social capital.

By introducing the concept of structural holes, Ronald Burt (1992, 2005) explained how social structure could be, in fact, a source of competitive advantage for individual actors in another way. Some privileged positions in the social network make it possible to reach, transfer, or hoard information at the convenience of the individual occupying them, which

allows him to engage in brokerage activities for his benefit. Structural holes would constitute, therefore, a source of social capital more critical than closure (Burt, 2000, 2001).

Since then, many other contributions have assessed the positive effect of social capital on performance in different kinds of processes: learning (Leana & Pil, 2006), career success (Seibert et al., 2001), cooperative strategy (Dyer & Singh, 1998), product innovation (Tsai & Ghoshal, 1998), intellectual capital development (Nahapiet & Ghoshal, 1998), well-being (Burke & Kraut, 2016), or health (Billedo et al., 2019). In a more general study using pooled data from an international comparative survey in 28 countries, Finsveen and van Oorschot (2008) found that, although weak, there is a positive relationship between network characteristics and the people's capacity to access resources through this network, i.e., their social capital.

### Social Capital in Learning and Education

The theoretical developments of the concept of social capital carried out by Bourdieu and Coleman originated in explaining the educational process performance. Bourdieu developed his ideas on cultural and social capital as alternative explanations of unequal academic achievement (Bourdieu, 1986). Coleman used his social capital idea to explain aspects like the incidence of dropping out of school (Coleman, 1988). It is normal, thus, that both theoretical frameworks and other views of social capital based on them have been extensively used in the learning and education literature, with Coleman's framework guiding most of the work (Dika & Singh, 2002; Sun, 1999). This trend has increased in recent decades (Steinfeld et al., 2013).

In their thorough review of the applications of social capital in educational literature, Dika and Singh (2002) identify three main areas of research: (a) social capital influence on learning achievement (grades, test scores); (b) social capital influence on educational attainment (graduation, college enrollment); and (c) psychosocial factors that affect educational development (engagement, motivation, self-concept).

Within the first area of research, social capital influence on educational achievement, several contributions have appeared in the last years looking at the impact of the student's social capital on their academic performance in higher education (Demir, 2021; Mishra, 2020), in contrast to the effect of individual characteristics like psychological capital (Barratt & Duran, 2021). Different approaches and methodologies, both qualitative and quantitative, have been used, for instance, to tackle issues like the academic and professional identity formation in higher education (Jensen & Jetten, 2015), the influence of academic peers on academic achievement (Hasan & Bagde, 2013), or the role of knowledge sharing as a mediator between the three dimensions of social capital proposed by Nahapiet and Ghoshal (1998) and academic performance (Aslam et al., 2013).

With this work, we also aim to contribute to the first area of research identified by Dika and Singh. However, we will do that by conceptualizing social capital as access to institutional resources, closer to Bourdieu's view than to Coleman's. This approach will allow us to use network structure as in the study of social capital (Kadushin, 2012; N. Lin, 2001b) and overcome some of the limitations of Coleman's concept. Moreover, we will examine a new environment not often present in the literature: online higher education.

### ***Social Capital in Online Environments***

Most of the studied effects of social capital have been observed in settings where social interactions occur mostly face-to-face or through traditional means. We may wonder whether the conclusions reached in those studies still hold for online settings, where most—if not all—of the contact between individuals is over technological networks. Is it possible that the effects of social capital are different online? Is social capital still relevant for performance in online environments? Is it maybe even more important? Are the mechanisms of social capital influence different from those in place at more “traditional” turfs?

Like their face-to-face counterparts, online social interactions give rise to social networks and, therefore, offer the possibility of leveraging social capital. Nevertheless, some differences between face-to-face and online environments are beginning to be present. We know, for instance, that in online communities formed through social media sites, concepts like “friendship” take a completely different meaning and that access to social capital might be diverse (Ellison et al., 2007; Steinfield et al., 2013). However, those communities are not the place where performance is usually measured. It is advisable to examine other kinds of online environments where individuals interact socially but simultaneously have specific tasks to perform.

In one of the few research strands tackling this issue in the literature, Ahuja and Carley (1999), after studying the case of a virtual research group, conclude that virtual organizations are similar to traditional organizations in some ways but different in others. Based on this, they advocate for further studies in this subject matter. Later, Ahuja et al. (2003) maintain that the different roles (functional, status, or communication) of virtual R&D groups have direct effects on individual performance and indirect effects through individual centrality.

In one of the few studies comparing face-to-face with online higher education processes in detail, Lobel et al. (2005) detect substantive differences in communication patterns among students, particularly, in the structure of social networks. Later, several authors investigated different kinds of mechanisms by which social capital is formed in online settings, for instance, social presence (Oztok et al., 2015), language and communication (Joksimović et al., 2018), cultural capital and techno-capital (Hamilton et al., 2023), or core self-evaluation and online interaction quality (Diep et al., 2017). However, there is a lack of studies that empirically analyze the effects of social capital in online higher education settings, attending to the actual structure of social networks. We aim to contribute to covering this gap.

### ***Recent Studies on Academic Performance in Online Environments and Social Capital***

The study of academic performance and the factors influencing it is a long-standing topic in the learning and education field (Honicke & Broadbent, 2016; Vermunt, 2005; Wentzel & Wigfield, 1998). Recent studies have focused on the relationship between the academic performance of higher education students and a wide range of specific factors in specific contexts, such as student loans for financially disadvantaged students (Huang et al., 2018), student engagement (Ogunsakin et al., 2021), introduction of new teaching methodologies (Al Shloul et al., 2024; Cabrera-Mejía et al., 2021), emotions (Camacho-Morles et al., 2021), amount of coursework in online courses (Motz et al., 2021; Shea & Bidjerano, 2019), social disparities (Helbling et al., 2019), past performance (Nadasen & List, 2016), etc. For our research, we will focus more specifically on studies conducted mostly in online environments where social capital, as explained in previous sections, is a

significant factor considered. We consider online environments broadly, including fully online environments, blended learning environments, and emergency remote environments (such as those suddenly created because of COVID-19 lockdowns).

Many studies in small samples (tens of students) or medium samples (hundreds of students) shed some light on the relationship between performance and some specific facet related to social capital. For instance, Ensmann et al. (2021) conducted a qualitative study about the role and importance of the social presence of students in emergency-created online environments because of the pandemic. They use the concept of social presence proposed by Whiteside (2007), which is based on Wenger's ideas about communities of practice and social learning (Wenger & Snyder, 2000). Yang and Tang (2003) conducted a quantitative study and found evidence about the influence of the so-called friendship networks, advice networks, and adversarial networks on academic performance. Both Yang and Tang (2003) and Ensmann et al. (2021) are conducted on a small sample of students and devoted to specific concepts related to social capital.

Gay and Betts (2020) conducted an experimental study in a broader online setting (hundreds of students). They concluded that high-touch strategies, based on ideas of community development by Palloff and Pratt (1999) and Stanford-Bowers (2008), positively influence academic achievement. Also, Iqbal et al. (2021) conducted a survey study over a medium sample of hundreds of students and found a positive influence of academic social networking sites on academic performance.

Another recent stream of literature is represented by Yagci (2022) and previous related studies, such as Bernacki et al. (2020), Musso et al. (2020), Waheed et al. (2020), Ahmad and Shahzadi (2018), Xu et al. (2019), and Burgos et al. (2018). In broad terms, this research builds up and tests models to predict or explain academic performance in online, blended, or face-to-face contexts. They use different proxies for academic performance, such as grades, degree completion, dropout, etc. They propose different explanatory variables such as previous marks, demographic variables, logs in the learning management systems, learning strategies, internet usage, etc. They use algorithms such as machine learning, deep learning, or logistic regression. They work mostly with medium datasets of hundreds, with the exceptions of Waheed et al. (2020) and Xu et al. (2019), that work with huge datasets of thousands. None of these studies uses explanatory variables explicitly based on social capital. The only ones to consider demographic variables are Waheed et al. (2020), but no significance of gender or age is found related to performance.

Our work aims to build on this stream of literature devoted to models, combining a selection of explanatory variables previously used, including past grades, gender, and age, as well as social capital. It should be noted that we will work with a much larger dataset than the ones used in the previous studies mentioned and that it comprises students of a wider range of degrees.

## ***Social Structure and Performance***

### **Tie Structure**

As we have seen in our literature analysis, social capital has been shown to affect academic performance. This study aims to investigate the specific mechanisms through which social capital has this influence. For this, we will examine the three possible benefits of social capital identified by Sandefur and Laumann (1998): access to information, influence and control, and social solidarity.

**Reach and Centrality.** The first benefit of social capital that we consider is access to information. Indeed, accessing timely and trustworthy information has a definite positive effect on performance. The ability of a social actor to access that information will depend, structurally, on her centrality, i.e., on the possibility of reaching the other actors easily in the network. Among the large number of centrality measures offered by the literature (Borgatti et al., 1998; Wasserman & Faust, 1994), we choose **degree centrality** for our study since we assume that in online environments, especially those in which individuals pursue some definite objective, interactions are purposeful and direct. Because of that, we discard betweenness centrality (that measures to what extent the actor may intercept information flows) and closeness centrality (that measures the proximity to the rest of the actors in the network). Thus, we derive the following hypothesis:

**H1:** Actors with a higher degree of centrality will perform better.

**Brokerage and control.** In structural terms, influence and control may be associated with the possibility of brokerage through the spanning of structural holes. Possible measures of that capability in agents would be Burt's effective size or constraint (Burt, 1992). However, both measures are a function of ego network density (i.e., transitivity). In essence, social capital due to the brokerage capacity of an actor increases with the number of other actors she can access and decreases with the extent to which those are connected. Thus, we may omit direct measures for structural holes since we will use the transitivity measure. Instead, we will use the combination of **degree centrality** and **transitivity** as a proxy for brokerage capacity (Borgatti et al., 2013, p. 276).

If this benefit of social capital is relevant for performance in our online community, the following hypothesis will hold:

**H2:** The performance of an actor will increase with degree centrality and decrease with transitivity.

**Cohesion.** Social solidarity in online communities will be a benefit of social capital, leading to the improvement of performance as long as individuals build with those with whom they are in touch, have a common set of values, and develop trust (Sandefur & Laumann, 1998). Structurally, that will be more likely if they have a cohesive ego network, i.e., when their **transitivity** measure is high. Thus, we hypothesize:

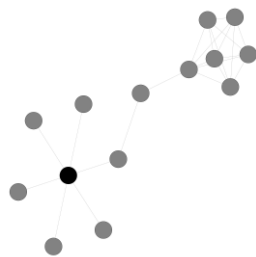
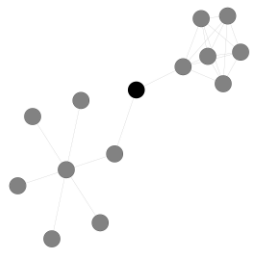
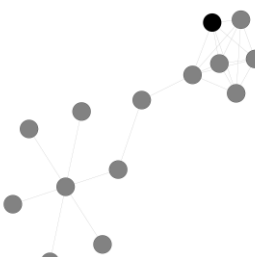
**H3:** Individuals with a higher level of transitivity in their network will perform better

Figure 1 shows the three benefits of tie structure and the associate measures we use.



**Figure 1**

*The Structure-Related Benefits and Their Associated Measures*

|                           | Reach and centrality                                                              | Brokerage and control                                                              | Cohesion                                                                            |
|---------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Benefit</b>            | Access to information                                                             | Influence and control                                                              | Cohesion                                                                            |
|                           |  |  |  |
| <b>Structural measure</b> | Degree centrality                                                                 | Burt's redundancy (structural holes)<br><br>~ Degree centrality – Transitivity     | Clustering coefficient (transitivity)                                               |
|                           | $k_i = \sum_{j=1}^n A_{ij}$                                                       | $R_i = f(k_i, C_i) \sim k_i - C_i$                                                 | $C_i = \frac{(\# \text{ triangles with } i)}{(\# \text{ pairs neighbors } i)}$      |

*Note.* Darker nodes in the example graphical representations correspond to the actors with a higher value for the respective measure (see the Measures section).

### ***Tie Quality***

Up to this point, we have related social capital benefits in online environments to the social network structure, considering all ties equally important. However, the importance of one actor's ties depends obviously on the actor's characteristics at the other end of that tie. We now introduce the idea that an individual's social capital will depend not only on the form of its ego network structure. It will also be affected by the quality of that network in terms of the attributes of her alters.

### ***Diversity***

We may assume, for instance, that those actors with a higher degree of heterophily in their relationships will have access to more diverse sources of information or that they will be able to build more supportive entourages. Thus, diversity will positively affect their performance (Granovetter, 1973; Page, 2007; Reagans & Zuckerman, 2001). We have, therefore, the following hypothesis:

**H4:** An actor's performance will increase with the level of heterophily in her social network ties

We may define different flavors of heterophily attending to diverse attributes of the students. In this case, we use gender, program, and age because these attributes have been found relevant in the literature. This allows us to split H4 into different sub-hypotheses:

- H4a:** An actor's performance will increase with the level of gender heterophily in her social network ties
- H4b:** An actor's performance will increase with the level of program heterophily in her social network ties
- H4c:** An actor's performance will improve with the level of age heterophily in her social network ties

#### Preferential Partners

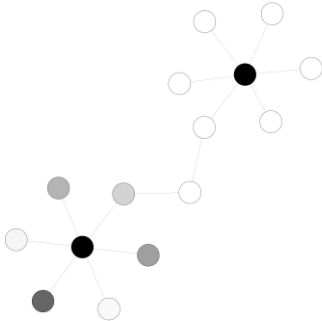
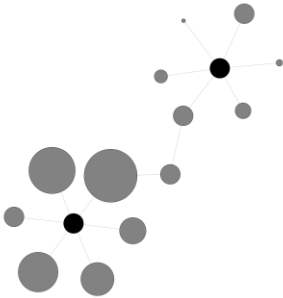
We may also assume that those actors who tie with others with a high **level of performance** will perform better (Hasan & Bagde, 2013). The following hypothesis captures this idea:

- H5:** An actor's performance will increase with the average level of performance of her social network ties

Figure 2 shows the two benefits of tie quality and the measures we use to assess them.

**Figure 2**

*Tie-Related Benefits and Their Associated Measures*

|                           | Diversity                                                                           | Preferential partners                                                                 |
|---------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Benefit</b>            | Draw upon knowledge heterogeneity (age, gender, program)                            | Learn from more knowledgeable others                                                  |
|                           |  |  |
| <b>Structural measure</b> | Link heterogeneity                                                                  | Positive performance difference                                                       |
|                           | $h_{ij} = \ x_j - x_i\ $                                                            | $d_{ij} = x_j - x_i$                                                                  |

*Note.* In the example graphical representation of the diversity benefit, the top dark node is surrounded by nodes of different characteristics. Therefore, it has higher link diversity than the dark node at the bottom of the image. In the example for preferential partners, the top dark node is surrounded by nodes with a higher level of performance (represented by their size), which implies a higher performance difference with its contacts, contrary to what happens with the bottom dark node. We use for them the measures of link heterogeneity and positive performance difference, respectively (see the Measures section).

# Research Design

## *Email Networks*

Informal social networks play an essential role in the internal dynamics of organizations, and their study provides interesting insights for organization scientists (Borgatti & Cross, 2003; D. Krackhardt & Hanson, 1993; D. J. Krackhardt et al., 2001). However, describing real social networks is not easy due to the difficulties associated with data gathering. Traditional methodologies relying on surveys or interviews are often challenging to interpret and represent a high cost in terms of time. Nowadays, electronic communication systems like mobile phones, email, instant messaging, or social media may provide a large amount of data on social interaction in the form of data stored in log files. This information presents a high degree of accuracy and thoroughness and is ready to be used and analyzed by automated means. Through the use of this information, it is quite feasible to identify and study social networks in diverse settings while being respectful of privacy issues (Kitchin, 2014).

Of course, not all social interactions occur electronically, and analyzing the networks built with data coming from electronic communication systems gives only a partial vision of reality. In some modern organizations where these systems are generalized, though, this partial vision may provide quite accurate insights into the structure of the social fabric (Adamic & Adar, 2003). In the case of virtual organizations where all interaction occurs online, the social structure inferred through the analysis of electronic data must be logically closer to the real one.

For instance, information gathered from email systems at organizations where it is extensively used and becomes one of the main communication channels is particularly well suited for this purpose. With data collected by the email server about the sender and receiver of each message—which are present in any log file—it is possible to build an email social network. Instances of this kind of network have been used in the study of different aspects of social networks, namely network topology (Ebel et al., 2002), search strategies (Adamic & Adar, 2005), information diffusion (Wu et al., 2004), spread of computer viruses (Newman, 2002), temporal dynamics (Eckmann et al., 2003), the strength of connections (Caldarelli et al., 2003), and community structure (Guimera et al., 2006; Tyler et al., 2003).

## *Research Setting*

To conduct our empirical research, we used the case of an online higher education institution, the UOC (Universitat Oberta de Catalunya—Open University of Catalonia), with headquarters in Barcelona (Cobarsí, 2008). We characterized the informal social network formed by the students of different undergraduate programs at UOC and relate it to their academic performance. UOC was founded in 1994 by the Catalan government and offers various undergraduate and graduate programs in Catalan, Spanish, and English. At the moment our data were gathered, UOC had more than 40,000 students, more than 2,000 members of the faculty (from them, about 200 were full-time academics, and the rest were academic collaborators on a part-time basis), and around 400 administrative personnel. Faculty at UOC is distributed among several *Estudis* (“faculties”) representing different academic areas. All of UOC’s courses are imparted online, making use of an in-house developed Learning Management System (LMS), the *Campus Virtual* (“Virtual Campus”), which includes an email system. This system is also meant for internal communication among faculty or administrative personnel members. The Campus Virtual is extensively used

due to the virtual character of the organization. A single LMS and a single educational model guarantees high technological and pedagogical standardization across programs.

We used the UOC network in our study for several reasons. On the one hand, it was a genuinely virtual organization in which students and faculty communicate among themselves almost exclusively through online channels, be it the classroom web spaces or the university's email system. Therefore, most informal interactions occurred through UOC's email system. The email social network was a valid approximation of the underlying general social network. On the other hand, the results of the students enrolled in the different programs in the form of grades obtained from the registrar's office provided us with an adequate measure of individual performance.

### ***Dataset and Network Definition***

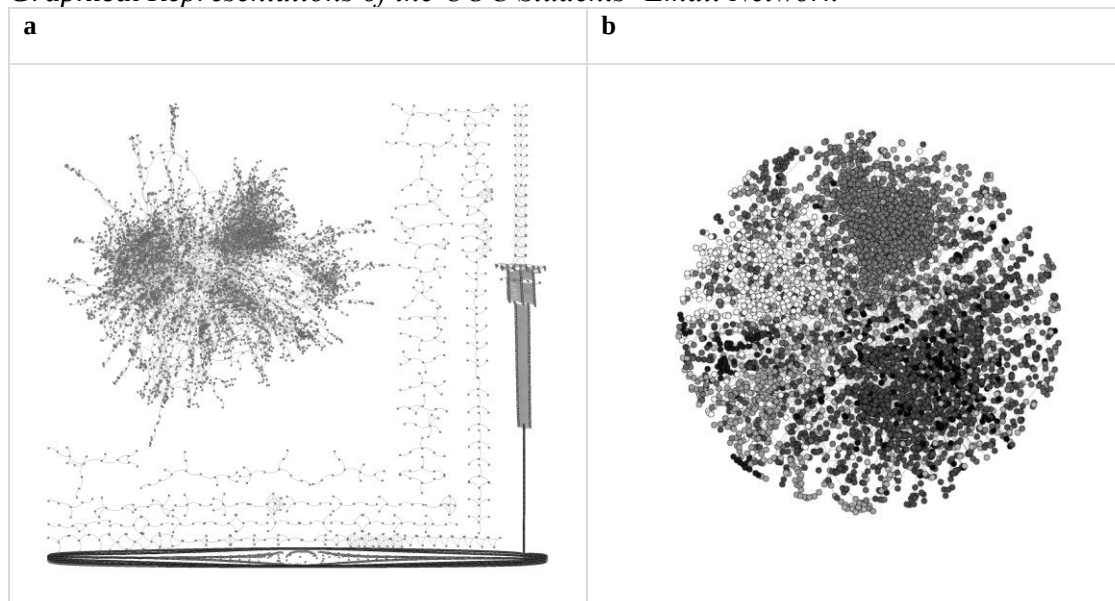
For the representation of the email social network of UOC, we used a database containing the log data recorded for one month. In that time, 854,522 messages were recorded, from which 462,033 can be considered internal (from one UOC email address to another UOC email address). We obtained this database from the UOC's IT department, which approved it after ensuring the data would be anonymized.

To obtain a measure of the performance of students in the period studied, we made use of the academic results for that semester and the previous one. We also gathered some features of the individual profiles of students to be used as control variables: age, gender, program to which they belong, and the number of courses to which they have enrolled in the focal semester.

To build the social network we used in our study, we selected all students' email user addresses. We considered that a link exists between two users if they had exchanged at least two messages in one month and, second, they had exchanged messages in both directions. This undirected network represents, thus, the social network of all the undergraduate students at UOC (see Figure 3a). It is a considerably sparse network composed of 18,857 nodes and 8,327 links. It can be seen in the structure of the greatest component (see Figure 3b) that there is a relevant percentage of links between students of different education programs.

**Figure 3**

*Graphical Representations of the UOC Students' Email Network*



*Note.* In (a), we show all network components, with a large greatest component and an important number of smaller components. In (b), we represent the greatest component. Node shades distinguish students from different education programs.

**Measures**

As a dependent variable, we will have our object of study: **academic performance**. Adopting the same practice of several of the works we have described in our literature review, we use as a proxy of academic performance the average of the grades obtained by UOC students in the spring semester of the academic year. Each student enrolled in a course is graded with a final mark between 0 and 10. The student's overall grade is the average of her grades in the courses she has been enrolled in. This measure represents, therefore, the student's semester GPA. These data are collected from the university registrar's office information system and anonymized appropriately. Academic performance is represented in a ratio scale from 0 to 10.

We estimate student grades using the following usual linear model:

$$Y = \beta X + \varepsilon$$

where  $Y$  is the dependent variable,  $\beta$  a vector of parameters for the effects of independent and control variables,  $X$  is the vector of independent and control variables, and  $\varepsilon$  is the error term.

We make use of five control variables. Firstly, the **age** and **gender** of students. Among the few additional pieces of information we could gather about the students, those that showed relevance to individual performance were those relevant to our preliminary analysis. Besides, these explanatory variables have been identified in the literature as personal variables that influence academic performance (Vermunt, 2005). As mentioned above, age and gender will also be used to define two different flavors of heterophily in hypotheses H4a and H4c.

Age is calculated using the students' date of birth, which the registrar's office provided. It is represented in a ratio scale. The ages of the students present in the final sample range from 18.33 years to 73.42 years, with a mean of 33.92 years. Gender is provided by the same source and is represented in a nominal scale (M for male, F for female). In the final sample, there are 6,989 females and 6,912 males.

We also use the **number of courses taken** by each student. The academic performance of individual students may be affected by the number of courses taken because not all students cope with the same workload in a semester. The performance of students taking a higher number of courses may be affected because they can devote less time to each of them. Again, these data are provided by the registrar's office.

We also control for the students' average grades **in the previous semester**. As in the case of the dependent variable, these data represent the previous semester's student GPA and are provided by the registrar's office. It helps to account for students' constant characteristics that would be significant predictors of academic performance but are outside our disposal, i.e., intelligence, work capacity, or level of competency previously developed. It will also contribute to establishing the causality in the detected effects beyond the mere correlation.

Finally, we control for the **academic program** in which each student is enrolled. There are 17 programs represented in our sample. This measure is represented on a nominal scale, with a category for each program. The academic program allows us to define a new heterophily flavor used in hypothesis H4b. Students from different programs may behave quite differently regarding social relationships, especially when they belong to distant knowledge areas like, for instance, engineering and humanities. Moreover, this avoids the need for standardizing grades to account for possible differences in program grading policies.

The UOC registrar's office provides all the above measures after ensuring the data will be anonymized. Of course, the anonymization codes used are the same as those used for the network database provided by the IT department. Our work does not involve the direct participation of human subjects, and we use only secondary data.

The first set of independent variables we use are purely network measures. As stated before, we will use degree centrality and transitivity. For **degree centrality**, we employ the definition proposed by Freeman (1979), as presented by Wasserman and Faust (1994). The degree centrality of an actor is just the number of links of that actor:

$$C_D(n_i) = \sum_j x_{ij} = \sum_i x_{ji}$$

where  $n_i$  represents the node  $i$  and  $x_{ij}$  represents the adjacency matrix of the network.

**Transitivity** at the vertex level (or local clustering coefficient) is defined in Watts and Strogatz (1998) as:

$$C_i = \frac{\text{number of triangles connected to node } i}{\text{number of triples centered around node } i}$$

where a triple centered around node  $i$  is a set of two edges connected to node  $i$ . We obtain the network measures from the analysis of the network described in the previous section.

The second set of independent variables are combined measures relating to the ego network structure of the focal individual with attributes of her connections in that ego network. **Gender heterophily** accounts for the ratio of individuals of the opposite gender in the focal individual ego network. A male actor having all his connections with other male actors will have gender heterophily 0. If he is connected only with female actors, he will have gender heterophily 1. Similarly, **program heterophily** will measure the ratio of connections with programs different from the one in which the focal individual is enrolled. **Age heterophily** measures the average of the absolute differences in age between the focal agent and her connections. Finally, **performance difference** accounts for the average difference in performance between the focal actor and her connections measured in the grades scale. The performance difference will be positive if the average of the alters' grades is higher than the ego grade and negative in the opposite case.

### **Data Analysis**

To perform the linear regressions, we selected the students from 17 different programs for which we have data corresponding to all the variables used, resulting in a total  $N$  of 13,901 students. Network measures are calculated in the whole network containing all students before selecting.

We use the standard linear model to calculate the regression coefficients. However, we cannot use the classical significance tests to test for those coefficients. This is because we are testing node-level (in terms of social network analysis) hypotheses in a social network environment. Here, we do not have a sample, but the entire population and the university is a "sample of one" chosen non-randomly. We are dealing with the whole network (and not just a sample), and our data do not seem to fulfill the normality assumption (the Shapiro-Wilk normality test for our best model gives  $W = 0.9431$ ,  $p < 2.2e-16$ ).

As Borgatti et al. (2013) point out, the classical significance is not adequate in these circumstances, and it is safer to run a randomization test. They advise running ordinary least squares as usual to obtain regression coefficients but constructing the significance values using the permutation technique. Thus, we follow their suggestion and use randomization to determine the significance tests instead of the usual procedure. We apply the bootstrapping methodology to calculate 95% Confidence Intervals as described in Fox (2008) and Fox and Weisberg (2011).

Data analysis and calculations have been made using the *igraph* network analysis package, the R statistical environment, and the Wolfram Mathematica™ software.

**Table 1***Results of Regression Analysis Predicting Academic Performance*

| Variable                        | Model 1 |   |                     |       | Model 2 |   |                     |       | Model 3 |   |
|---------------------------------|---------|---|---------------------|-------|---------|---|---------------------|-------|---------|---|
|                                 | B       | * | Bootstrap<br>95% CI |       | B       | * | Bootstrap<br>95% CI |       |         |   |
|                                 |         |   | LL                  | UL    |         |   | LL                  | UL    |         |   |
| <b>Controls</b>                 |         |   |                     |       |         |   |                     |       |         |   |
| Age                             | 0.029   | * | 0.024               | 0.034 | 0.028   | * | 0.023               | 0.033 | 0.023   | * |
| Gender <sup>a</sup>             | -0.066  |   | -0.146              | 0.024 | -0.037  |   | -0.123              | 0.048 | -0.065  |   |
| Number of courses taken         | 0.019   |   | -0.008              | 0.048 | -0.019  |   | -0.050              | 0.011 | -0.019  |   |
| Avg. grade previous semester    | 0.462   | * | 0.445               | 0.478 | 0.453   | * | 0.435               | 0.474 | 0.404   | * |
| <b>Network measures</b>         |         |   |                     |       |         |   |                     |       |         |   |
| Degree                          |         |   |                     |       | 0.091   | * | 0.073               | 0.111 | 0.064   | * |
| Transitivity                    |         |   |                     |       | 0.389   | * | 0.224               | 0.555 | 0.368   | * |
| <b>Combined measures</b>        |         |   |                     |       |         |   |                     |       |         |   |
| Gender heterophily              |         |   |                     |       |         |   |                     |       | 0.378   | * |
| Program heterophily             |         |   |                     |       |         |   |                     |       | 0.115   |   |
| Age heterophily                 |         |   |                     |       |         |   |                     |       | 0.003   | * |
| Performance difference          |         |   |                     |       |         |   |                     |       | 0.520   | * |
| <b>Interactions</b>             |         |   |                     |       |         |   |                     |       |         |   |
| Degree × Gender heterophily     |         |   |                     |       |         |   |                     |       |         |   |
| Degree × Program heterophily    |         |   |                     |       |         |   |                     |       |         |   |
| Degree × Age heterophily        |         |   |                     |       |         |   |                     |       |         |   |
| Degree × Performance dif.       |         |   |                     |       |         |   |                     |       |         |   |
| Transitivity × Gender heter.    |         |   |                     |       |         |   |                     |       |         |   |
| Transitivity × Program heter.   |         |   |                     |       |         |   |                     |       |         |   |
| Transitivity × Age heter.       |         |   |                     |       |         |   |                     |       |         |   |
| Transitivity × Performance dif. |         |   |                     |       |         |   |                     |       |         |   |
| <b>Intercept</b>                |         |   |                     |       |         |   |                     |       |         |   |
| Constant                        | 2.061   | * | 1.833               | 2.283 | 2.178   | * | 1.944               | 2.405 | 2.620   | * |
| R <sup>2</sup>                  | 0.2253  |   |                     |       | 0.2326  |   |                     |       | 0.3241  |   |
| Adjusted R <sup>2</sup>         | 0.2241  |   |                     |       | 0.2314  |   |                     |       | 0.3228  |   |

Note. N = 13,901.

<sup>a</sup> 0 = female; 1 = male.

\* Significant with bootstrap 95% CI.

An additional control variable, program, is omitted from the table.



## Results

Table 1 shows the results obtained from the different regressions performed. Model 1 uses only control variables and explains about 22.5% of the variance. From the four control variables used, only two, age and average grade in the previous semester, contributed significantly, both positively. In Model 2, we achieve an additional 1% in  $R^2$  by including the two network measures, degree and transitivity. Both of them have a significant positive effect. Model 3 also includes the combined measures. Three of them (gender heterophily, age heterophily, and performance difference) significantly affect performance positively. This model explains nearly 32.4% of the variance, which signifies a substantial increase from the previous model.

In Model 4, we introduced an additional analysis by including all possible interaction terms between network measures and combined measures. This new model slightly improves the variance's explanation level to 32.8%. Looking at the regression coefficients in this model, we may extract several consequences. The variable *age* significantly contributes to academic performance with a coefficient  $B = 0.223$ , which belongs to the 95% confidence interval  $CI = [0.018, 0.028]$ . That means that every year of age makes a student, on average, improve their grade by 0.223 points. *Gender*, on the contrary, does not show a differential contribution since its coefficient lies out of the confidence interval ( $B = -0.039$ ,  $CI = [-0.118, 0.045]$ ). The same happens with the *number of courses taken* ( $B = -0.022$ ,  $CI = [-0.050, 0.005]$ ). The student's courseload does not seem to significantly affect academic performance. Contrarily, there is a strong effect of the *average grade in the previous semester* ( $B = 0.401$ ,  $CI = [0.382, 0.421]$ ). This is normal since we use this variable as a proxy of each student's competence level regardless of the circumstances of the studied semester.

Both network variables, *degree* ( $B = 0.173$ ,  $CI = [0.145, 0.213]$ ) and *transitivity* ( $B = 0.373$ ,  $CI = [0.102, 0.550]$ ), show a positive effect on performance. Relying on the model we put forward in Figure 1, this means that two of the proposed mechanisms of social capital work. First, those students who occupy a more central position in their network perform better because they have better access to information. Therefore, H1 is supported. Second, students with a higher clustering coefficient (transitivity) develop a higher social cohesion that improves knowledge transfer and generation, supporting H3. Looking at both coefficients, we notice that the effect of social cohesion is more important than the effect of centrality.

The third mechanism proposed does not seem to work since this would require the presence of a structural hole, simultaneously a positive effect of degree centrality and a negative effect of transitivity. This means that influence and control are not important for performance in higher education settings. In our case, thus, H2 is not supported. However, this result might change in a business environment with higher competition.

All four combined measures have a significant positive effect. The initial three measures capture the first mechanism described in Figure 2: using diversity as a source of knowledge. In the case of *gender heterophily* ( $B = 0.542$ ,  $CI = [0.369, 0.654]$ ), it means that those students who have more relationships through the network with students of the other gender perform better. This is the strongest effect of the four combined measures. H4a is supported. A similar effect

occurs for *program heterophily* ( $B = 0.253$ ,  $CI = [0.071, 0.393]$ ): students with more contact with colleagues in other programs perform better. Thus, H4b is also supported. *Age heterophily* ( $B = 0.008$ ,  $CI = [0.005, 0.035]$ ) also has a positive effect, although very small. Having contact with other students of different ages gives a slight plus in performance. This supports H4c. Finally, those students who mingle with others with higher capacities tend to perform better. This is captured by the performance difference variable ( $B = 0.480$ ,  $CI = [0.449, 0.508]$ ) and relies upon the mechanism of preferential partners represented in Figure 2. H5 is supported.

Only the interaction terms with the performance difference variable are significant and positive, which implies that the positive effect of having connections with better-performing students is enhanced when degree centrality and transitivity increase. The other three interaction terms with degree centrality are indeed significant but with a negative coefficient. This could point to a decrease in performance when actors have to maintain a higher number of connections when those have a heterophilic nature. Most of the interaction terms for transitivity are insignificant.

In Table 2, we summarize the hypotheses we have formulated above and whether they are corroborated or not.

**Table 2**

*Hypotheses and Testing Results*

|     | Hypothesis                                                                                            | Test          |
|-----|-------------------------------------------------------------------------------------------------------|---------------|
| H1  | Actors with a higher degree of centrality will have better performance                                | Supported     |
| H2  | The performance of an actor will increase with degree centrality and decrease with transitivity       | Not supported |
| H3  | Individuals with higher level of transitivity in their network will have better performance           |               |
| H4a | An actor's performance will increase with the level of gender heterophily in her social network ties  | Supported     |
| H4b | An actor's performance will increase with the level of program heterophily in her social network ties | Supported     |
| H4c | An actor's performance will increase with the level of age heterophily in her social network ties     | Supported     |
| H5  | An actor's performance will increase with the average level of performance of her social network ties | Supported     |

## Discussion

The results exposed above contribute to the literature in several ways. Firstly, they contrast the importance for academic performance in a purely online environment of different factors proposed in previous studies such as friendship networks or social learning (Ensmann et al., 2021; Yang & Tang, 2003), social disparities (Helbling et al., 2019), past performance (Nadasen & List, 2016), amount of coursework (Motz et al., 2021), or community development (Palooff & Pratt, 1999; Stanford-Bowers, 2008). Secondly, the more 'traditional' regression

model developed here can be compared to the products of the late stream of literature proposing models based on AI algorithms like machine learning to predict academic performance (Ahmad & Shahzadi, 2018; Bernacki et al., 2020; Burgos et al., 2018; Musso et al., 2020; Waheed et al., 2020; Xu et al., 2019; Yağcı, 2022). Our model has the advantage of making the relationships between the variables understandable, which is hardly possible in AI models. However, in our view our most important contribution is establishing a series of structural measures that correspond to different mechanisms for obtaining benefits from social capital in a social network. Those benefits are access to information, influence and control, cohesion, drawing upon heterogeneity of social contacts, and learning from more knowledgeable others. They have shown their validity in our study, and we believe could be applied in other environments to assess the benefits of social capital.

Several meaningful insights from our work may be drawn specifically for virtual educational institutions. First, the mere structural position of a student in the social network influences her performance. This effect may be produced through two possible mechanisms: a position with higher centrality allows for better access to information, and a higher degree of cohesion may bring social solidarity into play through help or collaborative work. Both mechanisms work, although the latter's effect is much higher. Contrarily, influence and control by bridging structural holes do not work in this environment.

Second, even more important are the effects of the combination of structural position with the quality of a student's ties. Diversity of contacts in terms of gender, the program of study, and age (to a lesser extent) has a noticeably positive effect on student performance. Also, students with contacts with a higher level of performance show better achievement.

Third, interaction effects between centrality and diversity attenuate the mechanisms above, probably because a higher number of contacts lowers the importance of the diversity each contributed. Instead, the interaction effects between cohesion and diversity show nearly no impact.

Thus, our results stress the importance of social interaction for education. Consequently, we infer that distance learning institutions that offer social interaction instruments through ICTs will have an advantage over traditional distance universities, where there is often only one-to-one interaction between students and their teachers. It might make sense to think that the described behavior also applies to brick-and-mortar universities where interaction occurs face-to-face. The difficulties associated with capturing social interaction in those institutions may make the conclusions of studies like the present one about online universities particularly valuable.

Although a university is a specific kind of organization and an online university a particular sort of virtual organization, we believe that these ideas are consistent enough to be potentially generalized for any virtual organization and be subjected to test in further research.

It is interesting to point out that in a community where members have the objective of performing knowledge-related processes (e.g., students pursuing a higher education degree), a social structure that facilitates interaction and cohesion is more important for performance than a structure that makes it possible for individuals to benefit from structural holes. Therefore, we

may deduce that performance is reinforced by dense interaction while the corresponding gains are distributed among all individuals involved. In this case, creating value through collaboration and knowledge generation would be more valuable than appropriating value, even for individual players by information brokerage.

What we see here might reflect that the structure of the social network is essential not only for the structural dimension of social capital (Nahapiet & Ghoshal, 1998). The relational and cognitive dimensions of social capital also rely, to some extent, on some structural characteristics of the network. In other words, individual structural features may mediate the effects of other social characteristics, as Ahuja et al. (2003) proposed.

These results should be generalized with caution. As stated before, it must be considered that students are not in a situation where they directly compete between themselves—although they may indirectly fight for scholarship grants or, in some grading systems, for higher rankings. Privileged access to information and control may probably result in more substantial benefits in other places with direct competition. There, the role of measures like structural holes might become more relevant.

## **Conclusion**

We are aware of some of the limitations that affect the present study, especially if we pretend to generalize our results to other online and offline organizations. For instance, the social network that we identify through the email system might represent only part of the complete social network of students. However, that part may be significant in the specific case of an online university. Also, we did not have access to other control variables (i.e., rate of access to virtual classrooms) that could provide alternative explanations for performance or, at least, increase the soundness of the results.

Nevertheless, our results are robust enough to constitute a modest step in understanding how social networks influence performance in virtual organizations. Specifically, they shed some light on the learning processes at online higher education institutions. That is a social environment that has yet to be much studied, and that may show some features that will be common in most virtual organizations that will be more and more prevalent in the near future.

## **Acknowledgments**

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## **Conflict of Interest**

All authors declare that they have no conflicts of interest.



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# Encouraging Self-Regulation in an Online University Course for Preservice Teachers: An Intervention Study

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## Abstract

Although self-regulation (SR) has long been seen as an important educational concept, we know little about how to foster it in higher education online student populations. This research addresses this need by introducing an SR intervention into a preservice teacher course. The 30 students who participated used an intervention consisting of weekly student goal setting and self-reflection. Using data collected from a self-regulation survey, weekly reflections, final exam reflections, and interviews, all but one student indicated that the process of setting a goal weekly and especially reflecting on their actions during the week increased their self-regulation abilities. More than half the students focused on improving their study environment or their time management. Findings indicated that, although the process of the weekly intervention improved students' self-reflection abilities, the growth was uneven with good weeks intermingling with bad weeks. Findings also showed students' growth in SR influenced their work in other courses during the semester and in subsequent semesters. In addition, students noticed that the SR process helped them become more self-aware, allowing them to adapt SR dimension to their needs.

**Keywords:** Self-regulation, distance learning, higher education, intervention, preservice teachers, qualitative research

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Online learning is a growing educational option. Between 2012 and 2020, higher education enrollment rates shifted from almost three-fourths of students enrolled in completely in-person institutions to almost three-fourths enrolled in at least one online course (National Center for Education Statistics [NCES], 2013, 2021).

With such an increase in online enrollment, ensuring that students have the necessary tools for success in online modalities is imperative. One of these tools is self-regulation (SR). Although definitions differ, most include a cyclical structure containing elements of goal-setting, strategy use, and self-evaluation. Self-regulation has been connected to improved learning outcomes (Delen & Liew, 2016), as well as to increased motivation (Adnan et al., 2013), satisfaction, and engagement (Sun & Rueda, 2012). In online modalities, students with high SR skills had fewer struggles and were more willing to enroll in online courses and more confident in their ability to succeed than students with lower SR abilities (Barak et al., 2016).

However, students were often unprepared for the SR demands of online learning and struggled with completing work and engaging in learning processes (Biwer et al., 2021). While online learning increased students' autonomy, which has been shown to increase engagement (Arnesen et al., 2019), it can also hinder students who do not have the necessary SR skills to create a self-made learning plan (Bol & Garner, 2011; Mokhtar et al., 2023).

The purpose of this research was to introduce an intervention designed to encourage higher education students enrolled in an online course. Using both quantitative and qualitative data, we examined the students' perceptions of the intervention as it relates to the decline or growth of the SR abilities.

## Literature Review

The number of students participating in online courses in higher education has accelerated over the past decade. This acceleration quickened with the use of emergency remote teaching during the COVID-19 pandemic, causing a rapid rise in the number of students enrolled in online courses. See Table 1.

Table 1

### *Growth in Number of Students Taking Online Courses*

| Year | No online courses | At least one but not all online courses | Fully online |
|------|-------------------|-----------------------------------------|--------------|
| 2012 | 74.22%            | 13.29%                                  | 12.49%       |
| 2019 | 63.04%            | 19.43%                                  | 17.53%       |
| 2020 | 25.98%            | 28.54%                                  | 45.47%       |
| 2022 | 45.76%            | 27.80%                                  | 26.44%       |

*Note.* Data from NCES (2013, 2020–2021, 2021–2022).



Although, in 2022, post-pandemic online enrollment decreased, it is still higher than enrollment in 2019 before the pandemic, indicating a more sustained growth. This growth has changed perceptions about online learning. Povejsil (2021), for example, reported that this shift led leaders in higher education to evaluate traditional educational practices. They recognized that online learning increased flexibility in meeting the needs of students and allowed for greater inclusivity and diversity in student populations.

However, research also indicated that some students struggled in online courses. They were not prepared for the extra organizational and self-governance demands of an online modality (Dabbagh & Kitsantas, 2004; Whipp & Chiarelli, 2004). Online learning gave students more autonomy and flexibility, but autonomy came with its own impediments. Students struggled to implement SR strategies and to maintain motivation (Rannastu-Avalos & Siiman, 2020). They had difficulties with attention, effort and time management. They felt they had to spend more effort and time to achieve the type of results they obtained in their in-person courses (Biwer et al., 2021).

For these students, providing SR instruction is one method educators can use to help prepare students for the greater SR demands of online learning. Research has indicated that online students who receive SR instruction are more capable of using the autonomy and flexibility of an online course wisely, as well as overcoming other SR challenges (Gupta & Bamel, 2023; McClannon et al., 2018; McGowan, 2017; Stephen et al., 2020). This study explores one way of providing that instruction.

## Self-Regulation

In the 1990s, Barry Zimmerman, Albert Bandura, and others began discussing SR (Bandura, 1991; Zimmerman & Bandura, 1994; Zimmerman et al., 1992). Understanding that “neither intention nor desire alone has much effect if people lack the capability for exercising influence over their own motivation and behavior” (Bandura, 1991, p. 249), they proposed frameworks to explain and foster SR. These frameworks included constructs such as goal setting and some kind of student-initiated action that led to accomplishment of the goals (Lin et al., 2016; Odionokaya et al., 2019).

Zimmerman’s framework has three phases: forethought, performance control, and self-evaluation. These phases are divided into processes or dimensions that students enact in order to participate in each phase. For example, in the forethought phase, students analyze the learning task and set goals to achieve it. They use self-control (time management, help-seeking, study strategies, environment structuring, and self-made consequences) and self-observation (metacognition) in the performance control phase and self-judgment (causal attribution and self-evaluation) and self-reflection, making changes for future cycles, in the self-evaluation phase (Cleary & Zimmerman, 2004; Wandler & Imbriale, 2017; Zimmerman & Risemberg, 1997).

This framework is often cited in recent research of SR in online contexts. Leite et al. (2022) used the framework to examine algebra students’ SR and the role of the teacher. They found that students who demonstrated a high level of SRL strategies were more likely to have higher levels of achievement. Similarly, in a review of 22 articles on SR interventions in wholly

online courses (Arneen, 2024), all but one used constructs based on the cyclical model of three phases proposed by early pioneers of SRL. Thirteen of these articles were published in 2020 or later, and their citations include the following: Zimmerman, 65 citations; Pintrich, 24; Schunk, 15; and Bandura, 13.

The theoretical basis of the research in this paper adds to the tradition of intervention studies designed to increase SR, but also adds insight through an examination of students' perceptions of SR and of the process of improving in SR.

## Self-Regulation Outcomes

Helping students grow in their capacity in each of these phases and dimensions can influence their abilities to enroll and succeed in online courses. For example, Barak et al. (2016) studied the activity and attitudes of 84 undergraduate students studying science and engineering. They were enrolled in the same educational psychology course, 29 in an online section and 55 in a face-to-face section. The online students expressed confidence in their ability to succeed in an online course: they understood the metacognitive and self-control demands and valued the flexibility. Face-to-face students, on the other hand, were fearful of enrolling in an online class. They felt they did not have the necessary self-discipline, that they often procrastinated assignments and felt unable to succeed without a high level of interaction. This research suggested that increased online SR skills not only helped students succeed in online courses but also led to their enrolling in them in the first place.

Self-regulation also significantly increased learning outcomes (Delen & Liew, 2016; McGowan, 2017). Alotaibi et al. (2017) researched preparatory year students in a Saudi Arabian community school to investigate the connection between the students' SR abilities and their academic outcomes. They found that the SR constructs of goal-setting, time management and planning, study strategies, and help seeking were positively and significantly related to academic achievement in English and mathematics courses.

In addition, SR impacts other areas of learning. It helped students maintain and increase motivation (Adnan et al., 2013; Lim & Yeo, 2021) and resulted in higher satisfaction, engagement, and perceived learning (Kara et al., 2021; Landrum, 2020). It was also associated with intrinsic goal orientation and self-efficacy, helped students maintain effort (Koçdar et al., 2018), impacted learner readiness (Stritto et al., 2023), and significantly mediated task value and control of learning attitudes (Lim & Yeo, 2021).

### ***Modality Specific***

Self-regulation appears to be modality specific. Online courses present unique SR challenges, including having fewer interactions with and reminders from the instructor, a diminished group of friends, and studying more at home, where students feel they should be able to relax. This change in location was one of the most difficult challenges students faced (Wood et al., 2022). Online students, although they appeared in class, did not ask the questions or respond to instructor's questioning as they did in face-to-face modalities (Neuwirth et al., 2021). Students in online courses appeared to be unprepared for the time, effort, and motivational demands of online learning. They often started an online course with high motivation but were unable to maintain it. They were unprepared for class and did not complete assignments or pass exams. They also had poor time management skills, often underestimating the amount of time and effort needed to complete

assignments (Yukselturk & Bulut, 2007). Thus, if students did not have self-regulated learning (SRL) abilities appropriate for online learning, they often did not adapt well and struggled to succeed. Similarly, Broadbent and Poon (2015), in a systematic review of 10 years of literature, found that effect sizes of effort regulation, time management, critical thinking, and metacognition were lower in online contexts than in traditional face-to-face contexts. They suggested that the online environment could “dampen” (p. 12) the effects of SR and recommended that online courses be designed explicitly to foster SRL. These outcomes suggest that SR instruction targeted specifically for use in online courses could increase students’ success in online modalities.

### ***Effects of SRL Instruction in Online Courses***

Given the importance of SR, helping students gain these skills can help them overcome the challenges of online learning and use its affordances.

In a review of 10 articles, McGowan (2017) found that, in studies testing the impact of SR instruction, students in experimental groups performed significantly better than students in control groups. Students in one study were separated into a treatment and a control group. Students in the treatment group received direct SR instruction and executed a plan based on the instruction. Results showed a significant difference between the two groups. The experimental group showed significant gains in metacognitive attitudes and skills, as well as in time management (Dignath-van Ewijk et al., 2015).

Much of the literature that examined methods for increasing students’ SR focused on goal setting and self-evaluation, two areas that seem to help students start and continue SR activities (Dignath-van Ewijk et al., 2015; Wandler & Imbriale, 2017; Willems et al., 2021). Martin-Delpozo, & Martin-Sánchez (2022) introduced 39 undergraduate students in an Early Childhood Education program in Spain to a weekly self-reflection exercise. Students responded to a weekly survey in which they assessed and reflected on their performance. Students with high SR were more realistic in their assessment than non-self-regulated learners, and even when they did not have the highest grades in the course, they felt that self-reflection on the quality of their work helped them improve on end of semester projects.

Although research suggests that the need for students to develop high SR skills and dispositions is urgent and that SR instruction could be efficacious in fulfilling this need, research on SR interventions is sparse and much of it relies solely on quantitative analysis (Arnesen, 2024), which overlooks how students perceive and respond to the instruction or intervention. The present research attempts to address this gap in a way that increases understanding of student experience and gives instructors and designers insight into what the students see as helpful or unhelpful. We access these insights by introducing weekly student-directed SR goals and self-reflection and using both quantitative and qualitative data to understand the students’ experiences.

To achieve this purpose, this study addressed the following research questions:

1. How do preservice teachers perceive the effectiveness of a weekly self-evaluation and

goal setting exercise in growing their self-regulation?

2. Does a weekly self-evaluation and goal setting activity improve preservice teachers' online self-regulation skills?

## Methods

### ***Research Design***

The purpose of this study was to explore preservice teachers' perceptions of and experiences with SR in an undergraduate, online course. To answer the research questions, we used a mixed methods approach. Because we were interested in “understanding how people interpret their experiences” and used “words as data,” we examined this phenomenon primarily through a qualitative lens (Merriam & Tisdell, 2016, p. 6), using limited statistics to triangulate the data and add richness and insight to the analysis.

### ***Context***

This research took place in a one-credit, online, required course about teaching in K–12 online and blended contexts. The 14-week course met synchronously over Zoom for 11 weeks and asynchronously for 3 weeks.

The course included an SR intervention. Students took a pre- and post-SR survey at the beginning and end of the semester, set an SR goal (which they could change as needed), and reported on their progress in a weekly self-reflection.

### ***Participants***

The participants for this research were undergraduate preservice teachers who were enrolled in one of two sections of the course. All 40 students enrolled in the two sections were invited to participate in the research through a link to a consent form given in a class Zoom meeting. None of the students were aware of other students' decisions. Thirty gave consent. All students were under the age of 25 and white; 83% were female and 17% were male.

### ***Data Collection***

In order to look at SR from students' varying perspectives and to triangulate the data in order to show evidence supporting the main ideas in the qualitative analysis, the researchers collected data from multiple sources described below. All the data were deidentified and kept in a secure file, to which only the researchers had access.

### ***Pre and Post Self-Regulation Survey Scores***

Before the first-class meeting and during the final exam, students took a SR survey. The survey was adapted from the Online Self-Regulated Learning Questionnaire (OSLQ) (Barnard et

al., 2009). We chose this survey because it was designed to measure SR in online contexts and it was structured on students' perceptions of their abilities in five SR dimensions we used as means of evaluation in their weekly self-reports: goal setting, time management, environment structuring, help-seeking, and self-evaluation (Wandler & Imbriale, 2017). In addition, the format was readily adapted to fit our context. Confirmatory factor analysis showed that goodness of fit measures for the survey varied from adequate to good. (See Table 2.) The survey data showed quantitatively any differences the students experienced in their perceptions of SR dimensions from the beginning to the end of the course.

**Table 2**

*Goodness of Fit Statistics of the SR Survey*

| Measure                                         | Survey Value | Optimal Value | Goodness of Fit Category |
|-------------------------------------------------|--------------|---------------|--------------------------|
| Root Mean Square Error Of Approximation (RMSEA) | 0.051        | <0.05         | Adequate                 |
| 90% Confidence Interval (CI)                    | 0.048–0.054  | <0.05         | Adequate                 |
| Comparative Fit Index (CFI)                     | .904         | >0.95         | Adequate                 |
| Tucker-Lewis Index (TLI)                        | .889         | >0.95         | Adequate                 |
| SRMR (Standardized Root Mean Square Residual)   | .051         | <0.08         | Good                     |

Note. Goodness of fit statistics for the OSLQ, upon which this survey was based, include the following: RMSEA, 0.06; CFI, 0.95; TLI, 0.93 (Barnard et al., 2009).

***Self-Regulation Goal(s)***

Based on their pretest survey results, students set a goal for improvement in at least one SR dimension. The goals were fluid and students could change them as desired.

***Weekly Self-Reports and Final Reflections***

Each week students filled out a self-report in which they reflected on their progress with their SR goal. The self-report included two questions. The first asked students to evaluate their efforts in improving their SR that week on a 10-point scale from “lousy” to “excellent.” The second was a free response question, asking students to respond to this prompt:

SELF-REGULATION consists of gaining skills in these areas: (1) goal setting, (2) environment structuring, (3) time management, (4) help-seeking, and (5) self-evaluation. Review the self-regulation goal you made at the beginning of this semester. Share one specific thing you have done this week to work on your self-regulation skills. How

successful were you? What could you change to be more successful? Do you need to change your goal? If so, what is your new goal?

These weekly SR reflections were compiled into a chronological file for each student, allowing researchers to see the students' changes in SR over time. In addition, students wrote a final reflection over the whole semester as part of their final exam.

### ***Semi-structured Interviews***

After the semester concluded, students were invited to participate in a semi-structured interview of 30–40 minutes. Nine students consented and participated in an interview.

## **Data Analysis**

Both the qualitative and quantitative data captured students' perceptions. Thus, we analyzed the data in a way that organized these perceptions of SR and its influence on the students' work. Researchers especially looked for unexpected insights, differences, and discrepancies that could deepen understanding of SR or give insight into students' perceptions of or experience with SR. Table 3 shows a summary of how the data and its analysis related to the research questions.

**Table 3**

### ***Data and Analysis Related to Research Questions***

| RQ                                                                                                                                         | Data Source                                                               | Analysis                        |
|--------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|---------------------------------|
| RQ1: How do preservice teachers perceive the effectiveness of a weekly self-evaluation and goal setting exercise on their self-regulation? | Weekly self-report reflections, interviews, final exam reflections, goals | Thematic Analysis               |
| RQ2: Does a weekly self-evaluation and goal setting activity improve preservice teachers' online self-regulation skills?                   | Pre- and post-SR surveys                                                  | Paired t-test with effect sizes |
| RQ2: Does a weekly self-evaluation and goal setting activity improve preservice teachers' online self-regulation skills?                   | Interviews, weekly self-report and final exam reflections, goals          | Thematic Analysis               |

### ***Quantitative: Paired Sample T-test***

We analyzed the pre- and post-survey data with a paired sample t-test to examine the significance and effect sizes. This test charted the changes in the students' perceptions of their SR understanding and use over the time of the semester, allowing us to triangulate the data and give another measure of the impact of the intervention. The quantitative data allowed us to compare these findings to the qualitative data, giving a more complete understanding of students' experiences.

### **Qualitative Analysis**

In qualitative research, investigators approach coding and analysis in a way that helps establish trustworthiness. Therefore, it is critical that the coding process be both discernable and thorough. Creswell and Poth (2018) suggested several processes for creating trustworthiness. In this research we used the strategies of prolonged engagement, triangulation, peer debriefing, and negative case analysis.

Because one of the researchers was also the instructor for the courses, thus giving her prolonged access to the students, she was able to develop a trusting relationship with them. The instructor and students communicated through emails; Zoom class meetings; instructor, TA, and peer feedback to assignments; and individual conferences as needed. The course included both online and Zoom discussions, where issues were explored deeply. Breakout rooms enabled small group conversations. The students felt comfortable with each other and with the instructor.

Nowell et al. (2017) suggested that a first step in data analysis is getting to know the data. They suggest reading through the text several times, looking for patterns, asking questions, and identifying meanings and insights. The researchers followed this process, reading through the data as it was collected and again in its entirety, recording ideas and impressions.

One researcher initially coded all qualitative data (interviews, final reflections, and self-reports), identifying phrases, sentences, or larger excerpts that communicated a single thematic idea. While some of these themes included five dimensions of self-regulated learning (Zimmerman, 1989), other themes also emerged and were coded. These codes included challenges the students encountered, affective and academic difficulties and successes, and reasons students gave for their success or failure in improving their SR. The researchers remained open to new themes in the texts and coded them accordingly. As codes were created, they were reviewed, defined, and later refined as new sections of text were added to the codes.

Two researchers worked together on finalizing the coding. One coded all texts independently then shared the coding structure and themes with the other, who provided peer-debriefing by reading and analyzing each iteration of the coding structure. They analyzed problem areas and suggested changes. The coding structure was then modified to represent a consensus between them.

A sample of the coding structure (see below) is indicative of the ways we created and organized the codes. Each code included quotations from the students.

### **Sample of the coding structure:**

#### **Outcomes**

- Increased self-awareness
- Affective
  - Negative emotions associated with low SR
    - Increased stress and anxiety
    - Low self-regard

- Positive
  - Increased confidence
  - Less stress
  - Increased productivity
- Academic
  - Outcomes associated with low SR
    - Procrastination
    - Falling behind
    - Low motivation
  - Outcome associated with high SR
    - Increased engagement, interest, excitement, and focus
    - Ability to do better work
    - More time to seek help
    - Increased learning

Finally, researchers conducted a negative case analysis with one researcher rereading all the data and looking for any data that was not accounted for or contradicted the thematic structure they had created. They modified the structure as needed.

### ***Ethical Considerations***

The research participants in this study were considered a vulnerable population because one of the researchers was also an instructor in the two sections of the course. However, because the instructor was part of the research, she was able to have prolonged access to the students, which helped establish trust. To mitigate concerns, the instructor introduced the research to the students, indicated she was part of the research, and explained how the data would be secured. In addition, most of the data was drawn from regular class activities and assignments, which the instructor already had access to and for which students gave consent to use in the research. None of the students knew who gave consent, and participants were assured that their participation or nonparticipation would not affect their grades in the course. Students who participated in interviews were asked to fill out an additional consent document with the same assurances. All interviews were conducted after grades were submitted. The data was deidentified and available only to the research team. It was secured in a password protected file. The institutional review board approved this process before any of the research was conducted.

### ***Limitations***

Because this research did not include a control group, the findings, especially the quantitative findings from the survey, may not reflect the efficacy of the intervention but only a natural growth over time. In addition, this research included only 30 students, giving enough for parametric statistical measures. However, a larger sample size could enhance the results. Finally, the findings are limited to two sections of one course over one semester. Research that covered longer periods of time, included a larger and more diverse population, and used contexts with different content areas could add further insight.



## Results

### *Pre- and Post-test Survey*

Because probability theory suggests that a population of 30 justifies using a parametric test, we ran a paired sample t-test to determine the significance of the change in the survey scores over time. Except for a few anomalies, the pre and posttest scores showed significant changes. The t-test and effect sizes (Table 4) showed that the changes in all the dimensions except environment structuring (ES) and time management (TM) were significantly higher in the posttest than in the pretest. Because the two most common student goals were in the dimensions of ES and TM, these findings could suggest either that the students perceived no growth in the areas on which they concentrated or that their perceptions of their abilities changed as they worked more closely with each dimension. In other words, the students who worked to increase time management, for example, may have grown in their understanding of what time management meant and how to improve in it. The qualitative data seems to suggest this latter paradigm.

Also suggestive are the Cohen's *d* effect sizes of the differences in the pre and post surveys. Self-evaluation, the one SR activity that students engaged in every week, had the largest effect size. Again, the two constructs that most students worked on had the lowest effect size, a finding that the qualitative data helped explain.

**Table 4**

### *Paired Sample T-test and Effect Size Results*

| Construct Pairs         | Mean     | Standard Deviation | t      | Two-sided | Cohen's <i>d</i> | Effect size category |
|-------------------------|----------|--------------------|--------|-----------|------------------|----------------------|
| Goal-Setting            | -1.83333 | 4.32832            | -3.322 | .027      | -.424            | Small                |
| Environment Structuring | -.7000   | 5.22692            | -.734  | .469      | -.134            | Small                |
| Time Management         | .33333   | 3.11097            | .587   | .281      | .107             | Medium               |
| Help-Seeking            | -1.80000 | 3.44814            | -2.859 | .008      | -.522            | Medium               |
| Self-Evaluation         | -2.80000 | 4.27825            | -3.585 | .001      | -.654            | Medium               |
| Total                   | -7.56667 | 14.04349           | -2.951 | .006      | -.539            | Medium               |

*Note.* A negative Cohen's *d* indicates that the post-test score was higher than the pretest score, indicating students' perceived growth. Time management was the only construct with a positive Cohen's *d*, (or a score lower at the end of the semester than at the beginning, suggesting that students' perceptions of their abilities in time management fell during the semester.

### ***Weekly Self-report Data***

The weekly self-reports revealed that students' SR journeys and experiences varied over time. During some weeks students felt they successfully completed their goal; in other weeks they did not. However, the weekly reports also showed that only one student reported more unsuccessful than successful weeks across the semester. Successful goal completions outweighed unsuccessful goal completions as reported in the weekly reflections, with 224 reported as successful and 71 reported as unsuccessful, even and especially in the two areas that statistically showed the least growth. These reports suggest that the insignificant findings for time management and environment structuring may be indicative of students' becoming more aware of their SR activities and/or more careful in their evaluations, recognizing more accurately where they were falling short than they indicated in the pretest. Thus, the statistical data and weekly comments complement each other and may show the real-life messiness of SR growth.

### ***Students' Perceptions of Using the Weekly Self-report***

The qualitative data explained, added nuance to, and sometimes contradicted the quantitative data. Although the students' experiences with SR varied from week to week, in their final exam reflection and subsequent interviews, they revealed that, in general, they found the self-reports to be helpful in tracking and improving their SR. In the final test reflections, one student indicated that she "made a lot of progress in time management and goal setting, which I accredit to the weekly checks that required me to reflect on my goal." Hazel noted that the self-report gave her structured time for self-reflection.

We all know that it's such a good thing to reflect and think back on how we can improve, [but] a lot of times we don't do it. . . . [The weekly self-report] was a helpful exercise because even just setting the goal made me think and evaluate myself.

### ***Students' Perceptions of Goal-setting***

For many students the inclusion of a goal in the self-report helped them focus their efforts and their self-evaluation. Student's final exam self-reflections included statements like these: "Setting goals is something I have definitely taken away from this course." And "reflecting on my habits before this semester, I never really set goals for myself. . . . This semester I was able to set goals more frequently because of our self-regulation focus [each] week."

One student found himself with unexpected SR demands. He was hired as an eighth grade U.S. history teacher early in the semester.

I was simultaneously enrolled as a full-time student and felt the pressure of lesson preparation and homework nearly every day," he said. "It was through careful planning and goal setting that I was able to achieve my goals and make it through the semester with decent grades and confidence in my classroom.

For each of these students, setting goals became a way of organizing demands on their time and improving their study.

Even students who struggled to meet their goals found that the process of reflecting on them increased their awareness. Clara, for example, did not always feel that setting a goal helped her achieve the goal.

But it helped me be more aware of it. And I was like, okay, I did really bad this week. I did my homework 10 to 20 minutes before it was due. What can I do differently next week? And then it's like, okay, I'm going to do this online homework first.

These insights reflected both the uneven growth of SR as indicated in the weekly reports and the overall growth illustrated in the pre- and post-tests, the final exam reflections, and the interviews. The students' experiences suggested that the lack of immediate success might still contribute to SR growth, especially when it was paired with self-reflection.

### ***Outcomes***

Students experienced both positive and negative outcomes in self-awareness, affect, and academic achievement. They often recorded negative outcomes during their weekly reports but found more positive gains as they reflected on the entire semester. Importantly, they also found that their increased understanding of and skills in SR helped their studies in other courses and in the next semester.

### ***Self-Awareness***

One of the most telling outcomes of the students' reflection and goal-setting was an increased self-awareness that helped them design goals and plans that fit their individual needs. Most of the growth in self-awareness centered in two dimensions: environment structuring (mentioned by 40% of the students) and time management (mentioned by 23.33% of the students).

In the area of environment structuring, students found individual solutions for creating an environment conducive to studying. Hazel, for example, knew from past experience that "I couldn't be in a super quiet environment," but during this semester "I kind of discovered that being in a busy environment, but not . . . in a group was what I needed." For Ava an effective environment was one where she was "not with a friend. I like to be by myself." Clara found that her environment could vary according to the task: if she were reading, she needed quiet, but if she were working on something less demanding, such as making a lesson plan, she could have music or a movie in the background or study in a louder section of the library. Each of these students discovered through their SR goals, reflections, and efforts what environment was most conducive to their learning needs.

The process of setting goals for time management led to self-discovery that strengthened how students planned and used their time. These discoveries included such strategies as taking "a quick break, which helped refocus my mind" or noticing that "I do best during the day. When . . . 5 or 5 o'clock hits, I start to crash." Some of the students found that understanding how to best use time helped them overcome challenges in other areas. For example, one student said

I have discovered this semester that if I sit down and block out time for each assignment, such as setting a timer for one hour and working hard until the timer goes off, I am able to get a lot done. I have also found out that most assignments are a lot easier than I think. The hardest part is simply getting started. Once I begin an assignment, I am able to crank it out and avoid any meltdowns that I first foresaw.

Understanding the negative results of procrastination and their best times and structures for study helped students plan more effectively.

However, not all students grew in self-awareness. Benjamin struggled with the weekly self-reports and was not often aware of his lack of progress. In his final test reflection, he said, “This survey does not reflect how I did as a student or how I grew, as the ways in which it expects me to act are opposite of what I found useful in certain situations.” He did not explain this conclusion, and his actions in class did not support it. He continued, “The progress I have made during this semester in most or all of my classes and not simply in this class has been that I turned in every single assignment no matter what.” Again, the record did not support this statement. In class, he did not turn in 3 assignments and 10 were late. His judgment of how he was doing did not match his academic record.

### ***Affective Outcomes***

Seven students in their weekly self-reports and two in their final exam reflections reported negative emotions associated with a failure to self-regulate, including increased levels of stress and anxiety. William wrote the following:

Several times this semester . . . I came home and I did not follow the plan that I had set at the beginning of the week. This caused me to get behind and, frankly, increased my stress and anxiety.

Another negative outcome students experienced when they were unregulated was low self-regard. Sadie wrote, “I end[ed] up feeling bad about myself because [I spent] 5 hours on Hulu,” and Camilla reported, “I hate going to bed and feeling like I just wasted an entire day.” Many students shared similar experiences. They became absorbed in video games, television, cooking for roommates, and playing intramural sports. They struggled to manage their time and interests, resulting in feelings of disappointment or self-reproach.

On the other hand, students reported positive emotional outcomes from their successful attempts at SR. Three students reported feeling increased confidence because they realized they were capable of managing their productivity. Clara wrote in her weekly report, “I did so good on my goal this week! I wanted to finish my assignment . . . so that I wouldn't be rushing to get it done. . . . I got it done which was awesome!” And Camilla wrote, “I felt productive each day and accomplished.”

Several students reported feeling less stressed as they managed their time. For example, Ava stated, “I have been working to stay ahead this week, and it has paid off! I have been less stressed.” Leah agreed:

I continue to focus on time management and really enjoy it because I have been noticing a change not only in this class, but my life in general. I am better equipped to prioritize my time and I've noticed that I've been able to get all of my work done AND still have time to myself to enjoy.

### ***Academic Growth***

Just as students experienced changes and growth in self-awareness and affect, they also experienced changes in their academic growth.

Five students reported short-term negative academic outcomes. Three of the students had difficult weeks when they strayed from their SR goals and “procrastinated and got behind,” “got really off track,” and “felt a little behind.” Alena wrote:

I feel like my week has been absolutely insane and I'm so upset with myself that I let it get this out of hand... I reached out to the professor and told her I was sorry I turned in the assignments late, and she was very understanding.

These negative experiences often led to improved outcomes. Alena, for example, described a difficult week, but instead of giving up, she talked with the instructor, worked diligently, and got back on track.

Alena's experience is representative of the majority of the students. Their SR goals enabled them to focus, have time to reach out for help, finish early, and feel prepared for class, resulting in their feeling that they learned more and were able to do good work.

Students who finished early were excited about their success: “I was able to have fun creating the bitmoji and got it done well before the due date”; and “[I] got this assignment [done] with plenty of time to spare.” Charlotte described an especially successful week:

My goal for this past week was to get all my homework done before the weekend. In 4/6 of my classes, I got it all done. . . . I liked that goal because it allowed me to have a more enjoyable weekend.

Working on assignments early facilitated help-seeking, giving students “time to reach out and receive help” and to talk with instructors “at a time that is convenient” for them, thus relieving the stress of unanswered questions or unavailable instructors. It also helped students feel better prepared for class. Ava worked “to stay ahead this week, and it has paid off. I have been . . . more involved in classroom discussions, and overall feel more prepared for class.”

Strong SR helped one student “do my assignments better because I wasn't on a time crunch.” Oliver noted that when he didn't “wait until the very last minute to complete assignments, [he] put in a lot better work.” Students also found that working diligently and strategically gave them more time to grasp concepts and remember them. Chloe was excited when her “time management went well this week! I completed the assignment at a time I wasn't rushed and could pay attention to details.” Each of these students discovered that planning their

time, paying attention to strategies, and starting early not only helped them finish their assignments but also facilitated learning.

### ***Influence on Current and Future Courses***

Eight students reported that SR growth facilitated by the weekly self-report began to help them in their other classes. Hazel noticed that her SR skills “started to bleed into my other classes and overall improve my classwork.” Similarly, Maya said that SR “was a part of the class, but it was like that’s where I learned it, and then I applied it everywhere else.” Students were gratified as they found their overall SR improving in many contexts.

Because the nine student interviews took place after the conclusion of the semester, students were able to discuss the effects of their SR experience on a new semester. Five students indicated that SR growth played an important role in a new semester. Madison was scheduled to start one of her practicum experiences midway through the semester. “I’ve been trying to get the work done, that I . . . can get done before [practicum starts,] so . . . once harder things come I can . . . prioritize what I need to do to get all my work done.” Sadie agreed: “Because I tried so hard last semester,” she said, “it became more of a habit to do those things. It’s easier for me . . . to stay on top of it, and I feel better about myself and my self-regulation.”

Eleanor had a slightly different experience. “Last semester was kind of a mess, but especially with this semester, I feel like it actually . . . clicked in my brain.” Although Eleanor did not feel successful in building SR during the semester of the intervention, she saw marked improvement in the following semester.

These outcomes indicate that the practice of weekly self-reflection and goal setting influenced students in a variety of ways. It increased their self-awareness, helping them make better decisions about building SR; yielded increased positive affect toward their work and their ability to complete it; and resulted in positive academic outcomes. In addition, students indicated that the knowledge and skills they gained through the weekly self-report influenced their work in other courses and semesters.

## **Discussion**

With the addition of qualitative data triangulated with quantitative data, this research adds and expands insight in previous research on SR in higher education, online contexts. It seems to clearly indicate that a weekly self-reflection and goal-setting experience can help preservice teachers grow in SR. The quantitative data showed the growth in SR throughout the semester, while the qualitative data explained the students’ experiences. Most students expressed excitement and confidence as they were able to overcome obstacles and experience self-directed improvement in their SR. In addition, some students indicated that their SR growth was not limited to the course that included the intervention but influenced both concurrent and future courses. Although the students’ experiences highlight themes of this growth, limitations on the context and findings of this research indicate areas for future research.

### ***Growth of SR Using a Weekly Reflection and Goal Setting Activity***

This research focused on the self-evaluation phase of SR models, which acts as a catalyst for change. Students reflected on and evaluated past SR performance, targeted areas of needed improvement, and set goals to enact that improvement. Such growth in SR was not linear. However, these findings indicated that weekly reflection seemed to help most students focus on and engage in the process in a way that led to positive experiences and growth. As such, the findings support those of Andrade and Bunker (2009), Anderton (2006), and Martin-Del-pozo and Martin- Sánchez (2022).

Andrade and Bunker proposed a model of SR instructional activities and self-reflection, which they introduced into post-secondary English language courses with preliminary, positive results. Anderton used a weekly self-reflection with preservice teachers, reporting only quantitative results. Martin-Del-pozo introduced a weekly reflection into a course for students studying early childhood development. All three studies showed the potential for self-reflection to increase SR. This article, combining both qualitative and quantitative data, validated and expanded the work done by these researchers.

### ***Importance of Becoming Self-Aware***

The SR survey was most useful if it helped students recognize general areas in which they needed to improve. However, students were best able to grow in those areas when self-reflection aided them in becoming self-aware. The students' weekly and final reflections, as well as the interviews, revealed that those who engaged in self-reflection understood their own specific weaknesses and created targeted goals based on overcoming them. These findings amplify those of Wang and Lu (2020), who used mindfulness to develop self-awareness and Blackmore et al. (2021), who tied metacognition to the development of self-awareness. Similarly, Kalman et al. (2020) found that undergraduate students who were aware of what techniques worked and did not work for them were able to successfully adjust to online learning during the COVID-19 pandemic. The intervention implemented in this research indicates that such self-awareness could be fostered through weekly self-reflection.

### ***Weakness of SR Instruments***

Self-regulation research relies heavily on two SR surveys, the Motivated Strategies and Learning Questionnaire (MSLQ) (Pintrich et al., 1991) and the Online Self-Regulated Learning Questionnaire (OSLQ) (Barnard et al., 2009). This study used a modified version of the OSLQ and contained items that specifically addressed SR actions or attitudes pertinent to the context of preservice teachers in an online course. The original surveys contain statements designed to measure SR in different dimensions and may not be appropriate for all students. For example, an item in the OSLQ states, "I read aloud instructional materials posted online to fight against distractions" (Barnard et al., 2009, p. 5). Similarly, an item in the MSLQ includes "When I study for this class, I practice saying the material to myself over and over" (Pintrich et al., 1991, p. 18). These statements target a specific action a student might take to increase SR. However, although these statements may help students begin to target areas of SR weakness, the specific actions indicated may not be helpful for each student. Some students, for example, do not need to read instructional materials aloud or to repeat material over and over. They may indeed have

problems with distractions or retention but find unique, more helpful, methods for overcoming them. Such students would indicate a lower score on these statements, lowering their overall SR score, but still have found ways to overcome the problem, thus becoming more self-regulated. This phenomenon does not make the survey invalid or unnecessary but suggests caution in basing conclusions solely on the scores.

### ***The Contribution of Both Quantitative and Qualitative Data***

In this study all the data was grounded in the students' perceptions; thus, neither source provided empirical data. However, understanding how the students perceive their own SR is important to creating pedagogies and instruments that can aid SR growth. The quantitative survey resulted in important data: in most areas it showed students' perceptions of growth over time. However, in two areas—time management and environment structuring—the conclusions were limited and sometimes inaccurate. For example, the paired sample t-test showed that students improved least in the two areas they worked on most. Relying only on the quantitative data could have obscured and oversimplified the students' experiences. The qualitative data, although also grounded in student perceptions, expanded and refined the quantitative data, creating a more robust, more precise narrative of the students' experiences over the semester. Merriam and Tisdell (2016) describe the purposes of such data, noting that “discovery, insight, and understanding from the perspectives of those being studied offers the greatest promise of making a difference in people's lives” (p. 1). This research used qualitative data to fulfill these purposes, showing how students grew in their understanding of specific SR dimensions and illustrated their struggles and triumphs in developing SR in that dimension. Thus, while the quantitative data indicated students experienced no or negative growth in time management and environment structuring, the qualitative data suggested that the students understood where they were weak and made specific plans to improve. The students saw this process as growth. Their end of semester survey results may reflect the journey more accurately than did the pretest results with the students understanding better at the end of the course where they needed to improve than they did at the beginning and, therefore, rated themselves more accurately. Their self-awareness may also have led them to different methods for improving SR than the quantitative data measured. The quantitative data suggested questions that the qualitative data attempted to answer. Both were important to understanding the students' SR experiences.

## **Conclusion**

Self-regulation intervention literature in online higher education contexts is sparse and rarely includes qualitative data (Arnesen, 2024). The present research added to this body of literature, supporting similar findings using both quantitative and qualitative data. The quantitative data showed general trends, while the qualitative data added insight into the process of SR growth. The findings indicated that preservice teachers enrolled in an online course perceived that an SR intervention focusing on weekly self-reflection and goal setting could become a catalyst for SR growth. The research highlighted the experiences of the students as they worked to improve their SR abilities. The results of the research revealed four themes: the success of the intervention; the importance of reflection that leads to self-awareness; the weakness in SR surveys; and the value of using both quantitative and qualitative data in SR studies. The research emphasized the need for interventions that can increase SR and



demonstrated that a simple self-reflection and goal-setting intervention could help students become aware of their attitudes, actions, and habits in a way that directed their goals towards self-improvement. It also suggests that SR development should be ongoing, that habits develop and self-awareness grows over time and needs continual re-evaluation.

Future research could involve interventions that are introduced in secondary education and continue in higher education. It could also investigate more robust methods of accountability, perhaps having students check in regularly with an instructor or teacher's assistant to discuss progress and offer suggestions and support. Also, the context of the study, students enrolled in a private Western university, precluded more diverse populations of students—students of varying socio-economic classes, gender, and ethnic groups, as well as students in diverse majors. More extensive SR intervention research in online courses serving many types of students studying a variety of subjects could result in a body of literature that identifies similarities as well as differences in many contexts, allowing practitioners to target specific students and subject matters.

**Declaration of Interest**

The authors declare no conflict of interest.

**Declaration of Ethics**

The Institutional Review Board approved this research before the research took place.

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## Appendix A

### Semi-structured Interview Protocol

1. Do you normally think of yourself as a good student? Why or why not?
2. Does your ability to self-regulate influence your perceptions of yourself as a student?
3. Do you think it is important to be self-regulated as a student, or are other characteristics, habits, or abilities more important? Explain.
4. What personal characteristics do you think a good student has?
5. What methodological skills do they have? That is, what do they do to be a good student?
6. How did making a goal and doing a weekly self-report influence your self-regulation skills for this class during each week?
7. What goal did you set for this class? Did you ever change your goal? Why or why not?
8. What else might we have done as instructors/designers of this course to help you grow in self-regulation?
9. Can you share an experience from this class of a time you were self-regulated? Not self-regulated? What was the difference between the time you were and the time you were not self-regulated? Why do you think you sometimes are self-regulated and sometimes not?
10. Did you feel motivated to do the homework for this class? Was your motivation constant? What made it change? How did the changes affect your work for this class?
11. Did your efforts to be self-regulated influence your feelings about the class or the work for this class?
12. Do you feel you have grown in self-regulation this semester? Why or why not? Is self-regulation an important concept to you? Why or why not?
13. What is the best environment for you to study in?
14. Can you share an example of a time you reached out for help in this class? How do you

feel about asking for help? (help-seeking)

15. How do you typically structure your environment when you study? Where do you typically study? What do you do about distractions? What are your greatest distractions? (environment structuring)

16. What kinds of strategies did you use in doing your work for this class? Did they work? Did you modify those that didn't work? Did you learn anything about yourself through the strategies you used? Did you try any new strategies this semester? Were they effective? (learning strategies)

17. Did you read the feedback from your instructor/TA for this class? Why or why not? How did you respond to the feedback? (self-evaluation)

18. Did the weekly self-report help you evaluate your self-regulation each week? Did you make any changes as a result of your weekly self report? (self-evaluation)

19. How do you decide when to study? Do you make plans for when you will study? (time management)

20. Do you set goals for your study? What kinds of goals? Do you achieve your goals? Why or why not? (goal setting)

21. Are there any parts of self-regulation that you do automatically, that you don't have to think about?

22. What do you do about interruptions or invitations that might take you away from your studies? How do you evaluate them?

23. How do you juggle demands on your time? How do you decide what to do when you have competing demands on your time?



## Appendix B Instruments

### Self-Regulation Survey

#### Introduction

Self-regulation is an important skill for online students to develop. This questionnaire is to help you evaluate your own self-regulation abilities in online and blended courses. For each of the following statements, check the box that best represents your learning practices. Make sure you read the statement carefully. Your accurate evaluation of these questions will allow you to honestly reflect on where your own self-regulation abilities are in five important dimensions that will be shared when you are finished. Please select your level of agreement with the following statements.

[Possible levels of agreement include “Strongly disagree (1),” “Disagree (2),” “Somewhat disagree (3),” “Somewhat agree (4),” “Agree (5),” and “Strongly Agree.” The computer randomizes the questions and gives each student a report.]

#### Statements

I set goals for my performance on online assignments. (GoalSet1)

I set weekly goals to help me succeed in an online course. (GoalSet2)

I set a goal to review assignments requirements well ahead of the due dates. (GoalSet3)

I set goals to help me manage my study time for this online course. (GoalSet4)

I remove myself from digital distractions (phone, social media, email, games) when I study. (EnviroStruc1)

When I study, I exit/minimize browser windows not related to my work. (EnviroStruc2)

I organize my digital resources so I can easily access them when I study. (EnviroStruc3)

I study in a clean, organized physical space. (EnviroStruc4)

I study in physical places that help me avoid distractions from other people. (EnviroStruc5)

I often listen to distracting music or sounds when I study. (EnviroStruc6) [reverse]

I plan time to complete all of the assigned reading. (TimeMan1)

I set aside time each week to study for my online courses. (TimeMan2)

I begin working on my assignments well before the due date. (TimeMan3)

I often find that I don't spend very much time on online courses. (TimeMan4)

When I need help, I reach out to my instructor/TA online. (HelpSeek1)

I work online with other students to complete assignments. (HelpSeek2)

I communicate online to get help with my course assignments. (HelpSeek3)

I use online resources to find answers to questions on my own. (HelpSeek4)

I evaluate the strategies I use when studying to see if I can improve them. (SelfEval1)

I evaluate the strategies I use when studying to see if I can improve them. (SelfEval2)

I regularly reflect on the personal effort I am devotion to an online course. (SelfEval3)

I use online feedback from the instructor to improve my learning and skills. (SelfEval4)

I reevaluate my course-related goals when necessary. (SelfEval5)

# Factors Associated with Student Engagement in Online Learning During COVID-19 Pandemic: A Systematic Review

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## Abstract

While extant literature reveals various factors associated with student engagement in online learning during the COVID-19 pandemic, the findings are inconsistent. A systematic review of the factors influencing student engagement in online learning during the pandemic will provide state-of-the-art knowledge of existing literature and offer future research directions. This study systematically reviews factors driving college student engagement in online learning during the COVID-19 pandemic. Performed in accordance with the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses, a systematic search of four databases identified 50 eligible studies. The most prevalent factors associated with student engagement were student-related factors (e.g., student self-efficacy, emotion, motivation, attitude, personality traits, and student-student interaction). These were followed by instructor-related factors (e.g., self-efficacy and readiness, instructor warmth, support and motivation, instructor-student interaction, and organization), demographics (e.g., gender, age, college year, and ethnicity), learning technology and system-related factors (e.g., learning technology and perceived usefulness), course material and design-related factors (e.g., pedagogical approach, learning format, and learning activities), social factors (e.g., peer and family support), institutional support (e.g., college and university support), and environmental factors (e.g., learning environment and family health). These results provide a guide for future educational initiatives aimed at maximizing student engagement in an increasingly digital learning landscape, especially during exceptional times such as the pandemic. University resources should be directed at ensuring a smooth transition from face-to-face classroom experiences to remote learning during an emergency period. This should include insights from students on which online practices foster the greatest engagement, motivation, and learning.

**Keywords:** Student engagement, online learning, higher education, COVID-19, systematic review

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The COVID-19 pandemic upended traditional face-to-face modalities for education, forcing higher education institutions to migrate instruction online. During this time, higher educational institutions faced the challenge of engaging students in a manner consistent with face-to-face learning (Hollister et al., 2022; Wu & Teets, 2021). Any loss in student engagement could have detrimental effects, as this factor is linked to both greater academic success and positive mental health (Appleton et al., 2008; Miliszewska, 2007; Steele & Fullagar, 2009). Student engagement (SE) refers to the interrelationship between relevant resources, including effort and time, utilized by students and academic environments to maximize both student experience/learning outcomes (Trowler, 2010). The concept of student engagement derives from Astin's (1984) conceptualization of student involvement. He defined student involvement as "the amount of physical and psychological energy that the student devotes to the academic experience" (p. 298). Pascarella and Trezini (1991) further articulated the term engagement, pairing it with student involvement and educational outcomes (Barkley & Major, 2020). Thus, presently, engagement "is the term usually used to represent constructs such as quality of effort and involvement in productive learning activities" (Kuh, 2009, p. 6). In the online learning context, we define "student engagement in online learning" as the level of engagement while using online learning platforms. Three dimensions of student engagement are incorporated in the definition: behavioral, cognitive, and emotional (Fredricks et al., 2004; Hu et al., 2016; Hu & Li, 2017). Behavioral engagement reflects student active participation in academic-related activities and their concentration and effort into tasks. Cognitive engagement is tied to a student's investment of mental energy and effort in thinking and learning to understand and master complex concepts and skills. Finally, emotional engagement includes positive feelings experienced when performing academic-related tasks (Fredricks et al., 2004).

Numerous studies have examined a wide range of factors influencing SE in online learning during the COVID-19 pandemic (Baloran & Hernan, 2021; Wester et al., 2021; Wu & Teets, 2021). Unfortunately, the findings across studies are inconsistent, contradictory, and limited to specific geographic regions and populations. For example, some studies reported a positive association between students' learning technology-related self-efficacy and SE in online learning (Maini et al., 2021; Adeshola & Agoyi, 2022; Kara, 2022). However, Heo et al. (2021) found the opposite. Similarly, conflicting results were reported about the role of gender in SE. For example, Wu and Teets (2021) and Li et al. (2023) reported a higher level of SE among female students compared to male students; however, these findings contradict the result reported by Owusu-Agyeman et al. (2021). Thus, despite a large number of studies addressing this issue, no systematic review has been carried out to summarize and synthesize the studies that have examined factors influencing SE. While a study conducted a systematic review to synthesize the findings on SE in Latin American higher education institutions during the COVID-19 pandemic (Salas-Pilco et al., 2022), the investigation centered solely on the characteristics of SE, but it did not explore the factors driving SE. There is a need for a systematic review of the factors associated with SE in online learning during the COVID-19 pandemic that provides state-of-the-art knowledge of existing literature in the domain and offers future research directions. Therefore, the current study aims to fill the gap by providing a broader examination of findings across all published global investigations to highlight factors driving college/university SE in online learning during the pandemic. More specifically, this systematic review contributes to the literature in several ways. First, it identifies the most prevalent factors associated with SE. Second, these factors are further classified into broader themes (e.g., student-

related and instructor-related factors) and subthemes (e.g., student-related subthemes may include students' self-efficacy, readiness, skills, personality traits, emotion, and motivation). Third, this investigation provides a guide for future educational initiatives aimed at maximizing SE in online learning during an emergency period. Finally, this study offers several directions for future research.

Overall, this investigation aims to increase understanding of the antecedent factors impacting SE in online learning during an emergency period. By shedding light on these central factors, the findings can help higher education instructors, administrators, instructional designers, and others involved in developing and implementing online learning to take the necessary actions to enhance student engagement. Maintaining adequate student engagement—particularly during unexpected/unplanned shifts to online instruction (i.e., public health emergencies)—is critical to driving student satisfaction and performance (Appleton et al., 2008; Miliszewska, 2007). Based on the above review, this systematic review aims to address the following research question:

During the COVID-19 outbreak, what were the most prevalent factors associated with student engagement in online learning?

## Method

This review was performed in accordance with the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Liberati et al., 2009).

### Search Strategy

A systematic search of four databases—Education Resources Information Center (ERIC), Education Research Complete (ERC), PsycINFO, and Web of Science (WoS)—was performed to obtain studies using a set of search keywords. The ERIC and ERC were chosen as they are two widely used databases for education research. The WoS, the world's leading publisher-neutral citation index, was chosen to locate multidisciplinary articles. Finally, we used the PsycInfo database to capture articles on the psychological and behavioral aspects of education. As shown in Table 1, various terms (e.g., e-learning, online learning, virtual learning, remote learning, or distance learning; student engagement, student involvement, student interest, student/learner/learning motivation, student attention; coronavirus or COVID or SARS-CoV-2; college, university, or higher education) were used in combination to search the databases. In addition, we used several Boolean operators to locate relevant studies. Additional filters were performed during the search, following the article inclusion and exclusion criteria discussed in the next section.

**Table 1**

*Key Terms or Boolean Operators Used for Search*

| Search | Search terms (Boolean operators)                                                                                                                         |
|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1      | “student engagement” OR “student involvement” OR “behavioral engagement” OR “cognitive engagement” OR “emotional engagement” OR “learning engagement” OR |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | “learner engagement” OR “learning motivation” AND “predictor” OR “factor influencing” OR “determinant” AND “COVID” AND “college” OR “university” OR “higher education” AND "english"[Language] AND “peer-reviewed”[journal] AND “2020/01/01”[Date - Publication] : “2024/03/31” [Date - Publication]                                                                                                                                                                |
| 2 | “student engagement” OR “student involvement” OR “behavioral engagement” OR “cognitive engagement” OR “emotional engagement” OR “learning engagement” OR “learner engagement” OR “learning motivation” AND “predictor” OR “factor influencing” OR “determinant” AND “coronavirus” AND “college” OR “university” OR “higher education” AND "english"[Language] AND “peer-reviewed”[journal] AND “2020/01/01”[Date - Publication] : “2024/03/31” [Date - Publication] |
| 3 | “student engagement” OR “student involvement” OR “behavioral engagement” OR “cognitive engagement” OR “emotional engagement” OR “learning engagement” OR “learner engagement” OR “learning motivation” AND “predictor” OR “factor influencing” OR “determinant” AND “SARS-CoV-2” AND “college” OR “university” OR “higher education” AND "english"[Language] AND “peer-reviewed”[journal] AND “2020/01/01”[Date - Publication] : “2024/03/31” [Date - Publication]  |

### ***Criteria for Inclusion and Exclusion***

We systematically searched for studies published in peer-reviewed journals from January 2020 to March 2024. As shown in Table 2, this review included primary research and quantitative empirical studies published in English, which examined the factors associated with SE in online learning in higher education during the COVID-19 pandemic. We excluded qualitative studies, conceptual papers, non-peer-reviewed studies, conference proceedings, and grey literature as our systematic review aimed to conduct a systematic review of correlational and causal evidence to identify the factors associated with SE. All abstracts and full texts were screened and reviewed independently by two trained researchers.

**Table 2**

### ***Study Inclusion and Exclusion Criteria***

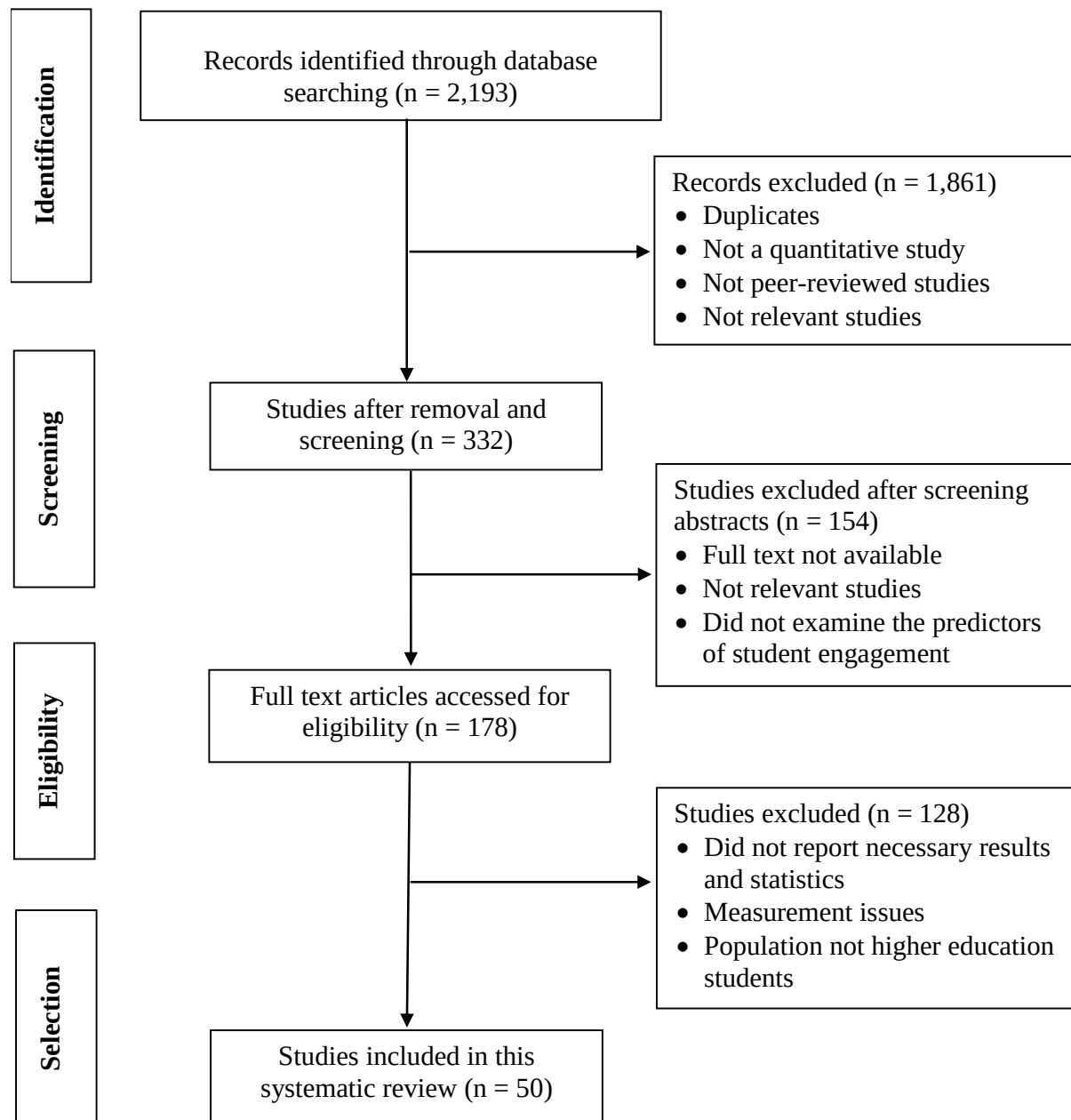
| <b>Inclusion criteria</b>                                                                                                                                                                                                                                                                      | <b>Exclusion criteria</b>                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Studies examining the factors associated with SE in online learning in higher education during the COVID-19 pandemic</li> <li>• Quantitative empirical studies</li> <li>• Written in English</li> <li>• Published in peer-reviewed journal</li> </ul> | <ul style="list-style-type: none"> <li>• Studies that did not examine the predictors of SE in online learning in higher education during the COVID-19 pandemic</li> <li>• Qualitative studies</li> <li>• Not written in English</li> <li>• Published in non-peer-reviewed journal</li> <li>• Books (textbooks), book chapters, conference papers, dissertations, and grey literature</li> </ul> |

As depicted in the PRISMA flow diagram below (see Figure 1) which describes how records are identified, screened, and eligible for inclusion (Moher et al., 2010), the search strategy identified 1,403 records. After removing duplicates, qualitative studies, non-peer-reviewed studies, and non-relevant studies, 275 studies were further screened. Of these, 139 studies were excluded after screening the abstracts, as they were not relevant studies or did not examine the factors related to student engagement, and full texts were not available. The

remaining 136 full text studies were further assessed for eligibility. Of these, 104 studies were removed as they did not report the necessary results or had been measurement and methodological issues, and the study population was not higher education students. The remaining 50 studies met the inclusion criteria.

**Figure 1**

*PRISMA Flow Diagram Showing Search Strategy and Study Selection Process*



### ***Data Extraction and Analysis***

The same two researchers who screened articles extracted data independently of one another. As presented in Table 3, the data extracted from the articles included title, author(s), publication year, data collection year, country, sample size, study objective, study design, dimensions of student engagement (e.g., cognitive, behavioral, and emotional), factors influencing SE, and key findings. We coded the information related to factors associated with SE and their associations with various dimensions of SE and identified broader themes and sub-themes, as presented in Table 4. All discrepancies in data extraction between the two researchers were resolved by discussion to reach consensus.

We analyzed the data using IBM SPSS Statistics 27. First, we summarized the characteristics of the studies included in our review using descriptive statistics. Then, we presented the frequencies of factors associated with student engagement in online learning and charts showing those factors by theme.

## **Results**

### ***Description of Included Studies***

This systematic review included fifty studies from thirty-two countries, including nine from China, five from the USA, four from South Korea, four from India, three from Colombia, and three from Turkey (see Table 3). Thirty-five studies collected data from Asia, followed by eleven from Europe, ten from North America, five from South America, and four from Africa. Nineteen studies were published in 2021, thirteen in 2022, thirteen in 2023, and five in 2024. Most studies ( $n = 27$ ) collected data in 2020. All studies, except a longitudinal investigation, were cross-sectional. In addition, the bulk of the studies (48 out of 50) employed the survey method (the remaining two projects utilized experimental methods). The studies included in this review totaled 45,601 student respondents, with an average sample size of 914.02 respondents (standard deviation = 2227.847), ranging from 16 to 14935.

**Table 3**

#### *Study Characteristics and Factors Associated with Student Engagement*

| Author(s)                    | Country      | Sample size | Dimension/measure of student engagement       | Factors associated with student engagement                                                                                 |
|------------------------------|--------------|-------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Adeshola & Agoyi (2022)      | Cyprus       | 274         | Cognitive, behavioral, emotional              | Student academic self-efficacy<br>student computer self-efficacy                                                           |
| Aldaghri & Oraif (2022)      | Saudi Arabia | 148         | Skills, emotional, participation, performance | Instructor providing students with additional study materials, students' feelings (pleased) about attending online classes |
| Aldhaen (2024)               | Bahrain      | 442         | Cognitive, behavioral, affective              | Instructor digital competency                                                                                              |
| Almusharraf & Bailey (2021)  | South Korea  | 329         | Agentic engagement                            | Collaborative learning orientation                                                                                         |
| Azila-Gbetteor et al. (2023) | Ghana        | 310         | OSE (learning engagement)                     | University support                                                                                                         |



|                            |                                                              |       |                                                           |                                                                                                                                                    |
|----------------------------|--------------------------------------------------------------|-------|-----------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| Baloran et al. (2021)      | Philippines                                                  | 529   | Skills, emotional, participation, performance             | College year, course satisfaction in online learning                                                                                               |
| Bozan et al. (2024)        | USA                                                          | 329   | OSE                                                       | Student–teacher relationship, learning confidence                                                                                                  |
| Cleofas (2021)             | Philippines                                                  | 202   | OSE (skills, emotional, participation, performance)       | Self-care practices (physical care, supportive relationships, self-compassion and purpose, supportive structure, mindful relaxation)               |
| Daniels (2021)             | Canada                                                       | 98    | Cognitive, behavioral, emotional                          | Students' mastery-approach goals                                                                                                                   |
| Dubey et al. (2023)        | India                                                        | 1137  | OSE (cognitive, behavioral, emotional)                    | Perceived usefulness, hedonic motivation, attitude toward online learning                                                                          |
| Duron-Ramos et al. (2022)  | USA, Mexico, El Salvador, Columbia, Peru, Dominican Republic | 1723  | Cognitive, behavioral, emotional                          | Orientation to happiness (pleasure, meaning, engagement)                                                                                           |
| El-Sayad et al. (2021)     | Egypt                                                        | 330   | Cognitive, behavioral, emotional                          | Student academic self-efficacy, perceived usefulness, teaching presence                                                                            |
| Fabian et al. (2022)       | UK                                                           | 178   | Skills, participation                                     | Transactional distance between student and student, perceived usefulness of the learning activities, e-learning capital                            |
| Fu et al. (2024)           | China                                                        | 436   | Cognitive, behavioral, emotional                          | Mastery motivation climate                                                                                                                         |
| Gamage et al. (2021)       | Sri Lanka                                                    | 120   | OSE                                                       | Mentor's ability to facilitate learning, mentors encourage mentees to be focused on their goals                                                    |
| Gherghel et al. (2023)     | Japan                                                        | 1167  | Emotional, behavioral                                     | Opportunities for social interaction                                                                                                               |
| Gopinathan et al. (2022)   | Malaysia                                                     | 142   | OSE                                                       | Digital collaborative tools, interactivity, motivation                                                                                             |
| Heidari et al. (2021)      | Iran                                                         | 308   | Academic/study engagement (vigor, dedication, absorption) | Students' digital competence, digital informal learning                                                                                            |
| Heo et al. (2021)          | South Korea                                                  | 1205  | OSE (learning engagement)                                 | Student's self-efficacy in technology use (-), self-efficacy in time management, self-efficacy in an online learning environment                   |
| Huang & Wang (2023)        | China                                                        | 14935 | Cognitive, behavioral, emotional                          | Autonomy satisfaction, competence satisfaction, relatedness satisfaction                                                                           |
| Iqbal et al. (2022)        | China                                                        | 338   | Cognitive                                                 | Self-awareness, self-motivation, regulate the emotions, social skills                                                                              |
| Kara (2022)                | China                                                        | 563   | OSE                                                       | Digital literacy, self-directed learning, motivation for learning                                                                                  |
| Kaspar et al. (2024)       | Germany                                                      | 413   | Course engagement                                         | Age, neuroticism, conscientiousness, openness, self-regulation skills, academic self-efficacy, digital media self-efficacy, COVID-19 anxiety (-)   |
| Kedia & Mishra (2023)      | India                                                        | 300   | OSE                                                       | Instructor-student interaction, social media use, family support, technical support,                                                               |
| Koob et al. (2021)         | Germany                                                      | 559   | Study/academic engagement (vigor, dedication, absorption) | Digital learning format, social support, resilience, active self-care, academic self-efficacy, health concerns about family and friends            |
| Ladino Nocua et al. (2021) | Colombia                                                     | 16    | Cognitive                                                 | Active learning activity                                                                                                                           |
| Li et al. (2023)           | USA                                                          | 351   | OSE                                                       | Gender, race, conscientious, openness, sense of community, instructor's nonverbal immediacy, time management skills, digital skills, health status |

|                                    |                           |      |                                                                                                           |                                                                                                                                                                   |
|------------------------------------|---------------------------|------|-----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lim et al. (2022)                  | Korea                     | 219  | Skills, emotional, participation, performance                                                             | Prior online learning experiences, instructor warmth and openness (teaching approaches and demeanors), instructor organization (activity preparedness)            |
| Luan et al. (2023)                 | China                     | 615  | Behavioral, cognitive, emotional, social                                                                  | Teacher support, peer support                                                                                                                                     |
| Lux et al. (2023)                  | Canada                    | 422  | OSE                                                                                                       | Stress/anxiety (-), social interactions, instructor strategy, technological accessibility, delivery mode flexibility                                              |
| Maini et al. (2021)                | India                     | 489  | OSE                                                                                                       | Teachers' structured approach, teachers' technical readiness, teachers' self-efficacy, students' technical readiness, students' autonomy, students' self-efficacy |
| Mizani et al. (2022)               | Indonesia                 | 324  | OSE                                                                                                       | Student loneliness                                                                                                                                                |
| Owusu-Agyeman et al. (2021)        | Ghana                     | 425  | OSE                                                                                                       | Online learning environment, instructional resources, institutional support system, type of device used by students, female (-)                                   |
| Pham & Chau (2024)                 | Vietnam                   | 263  | OSE                                                                                                       | Adaptive cognition, adaptive behavior, Anxiety                                                                                                                    |
| Poon et al. (2024)                 | Malaysia                  | 212  | OSE (cognitive, behavioral, emotional, social)                                                            | Expectation to adopt e-learning                                                                                                                                   |
| Quigley et al. (2022)              | UK                        | 301  | Skills, emotional, participation, performance                                                             | Conscientiousness, extraversion, neuroticism, agreeableness, openness to experience                                                                               |
| Reflianto et al. (2021)            | Indonesia                 | 117  | OSE (skills, affective, cognitive)                                                                        | Online flipped learning scheme using Microsoft Team                                                                                                               |
| Reynell van der Ross et al. (2022) | South Africa              | 1663 | OSE (emotional, physical/participation, cognitive engagement in class, cognitive engagement out of class) | Psychological conditions of meaningfulness (study resources), availability (burnout risk), safety (student-leader-member exchange), study demands                 |
| Roque-Hernández et al. (2023)      | Mexico                    | 1417 | OSE                                                                                                       | Perceived instructor presence                                                                                                                                     |
| Salta et al. (2022)                | Greece                    | 360  | Behavioral, emotional                                                                                     | Human interaction (student-student, student-instructor, or student-tools interactions), college year (senior)                                                     |
| Shah et al. (2021)                 | Pakistan                  | 689  | OSE (skills, emotional, participation, performance)                                                       | Need satisfaction, need dissatisfaction (-)                                                                                                                       |
| Sharif Nia et al. (2023)           | 9 countries               | 6489 | OSE (cognitive, behavioral, emotional)                                                                    | Course content, online interaction, eLearn acceptance                                                                                                             |
| Sun et al. (2023)                  | China                     | 497  | Cognitive, behavioral, emotional                                                                          | Perceived value of knowing learning goals                                                                                                                         |
| Tan et al. (2024)                  | Malaysia                  | 609  | OSE                                                                                                       | Perceptions towards online learning                                                                                                                               |
| Vezne et al. (2023)                | Turkey                    | 293  | Skill, emotional, participation, performance                                                              | Attitude towards attending online courses intrinsic goal orientation, extrinsic goal orientation                                                                  |
| Wu & Teets (2021)                  | USA                       | 431  | Skills, emotional, participation, performance                                                             | Gender (female), first-year student status (-), underrepresented people of color (-)                                                                              |
| Yang et al. (2021)                 | China                     | 377  | OSE (learning engagement)                                                                                 | Student online learning self-efficacy, students' subjective well-being                                                                                            |
| Zapata-Cuervo et al. (2023)        | US, South Korea, Colombia | 523  | OSE                                                                                                       | Self-efficacy, anxiety                                                                                                                                            |
| Zhang et al. (2021)                | China                     | 1119 | OSE (behavioral, emotional)                                                                               | Students' adaptability, perceived academic emotion, negative academic emotion (-)                                                                                 |

|                    |       |     |                                  |                                                           |
|--------------------|-------|-----|----------------------------------|-----------------------------------------------------------|
| Zhoc et al. (2022) | China | 965 | Cognitive, behavioral, emotional | Students' subjective well-being, suppression, reappraisal |
|--------------------|-------|-----|----------------------------------|-----------------------------------------------------------|

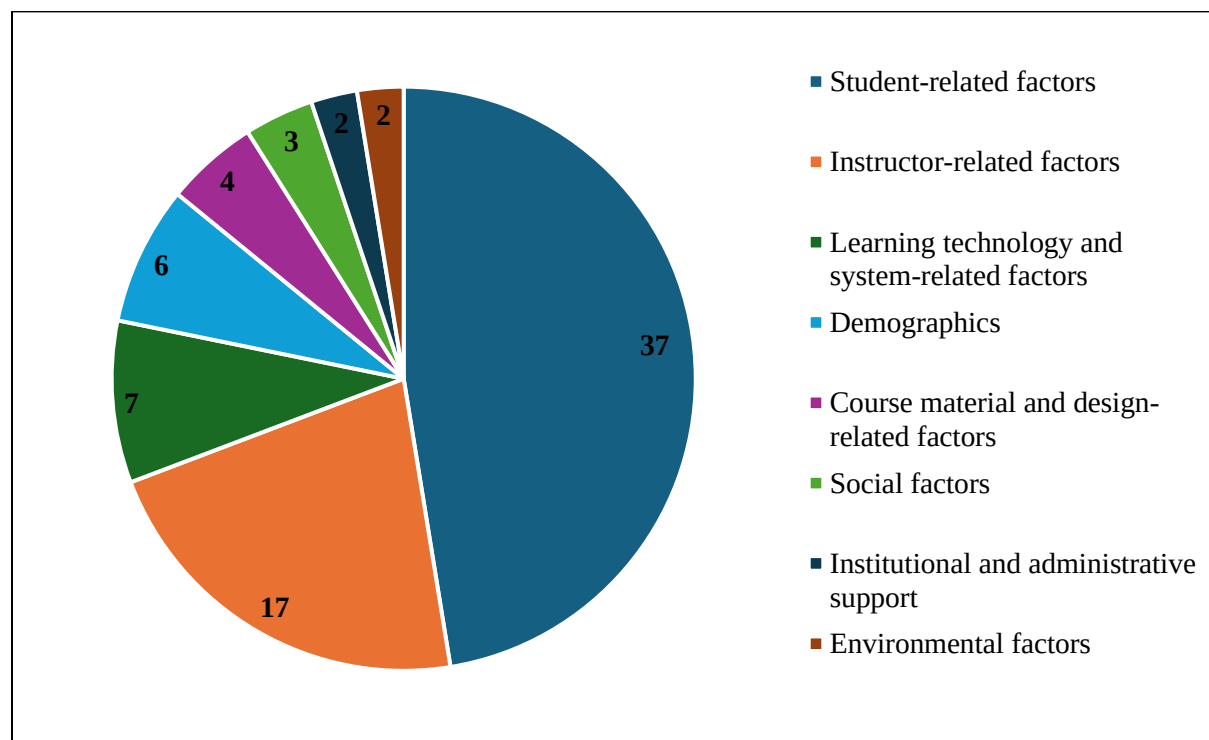
Note: OSE = Overall Student Engagement; Unless otherwise noted, all data were collected by cross-sectional survey, with the exception of Ladino Nocua et al. [heart rate assessment], Reflianto et al. [experiment], and Zhang et al. [longitudinal survey].

### ***Factors Associated with Student Engagement in Online Learning***

The majority of the reviewed studies examined student-related factors as predictors of student engagement in online learning (see Figure 2 and Table 4). Other significant influences that were associated with SE were instructor-related factors, demographics, learning technology and system-related factors, course material and design-related factors, social factors, institutional and administrative support, and environmental factors.

**Figure 2**

*Number of Studies by Factors Associated with Student Engagement in Online Learning by Themes*



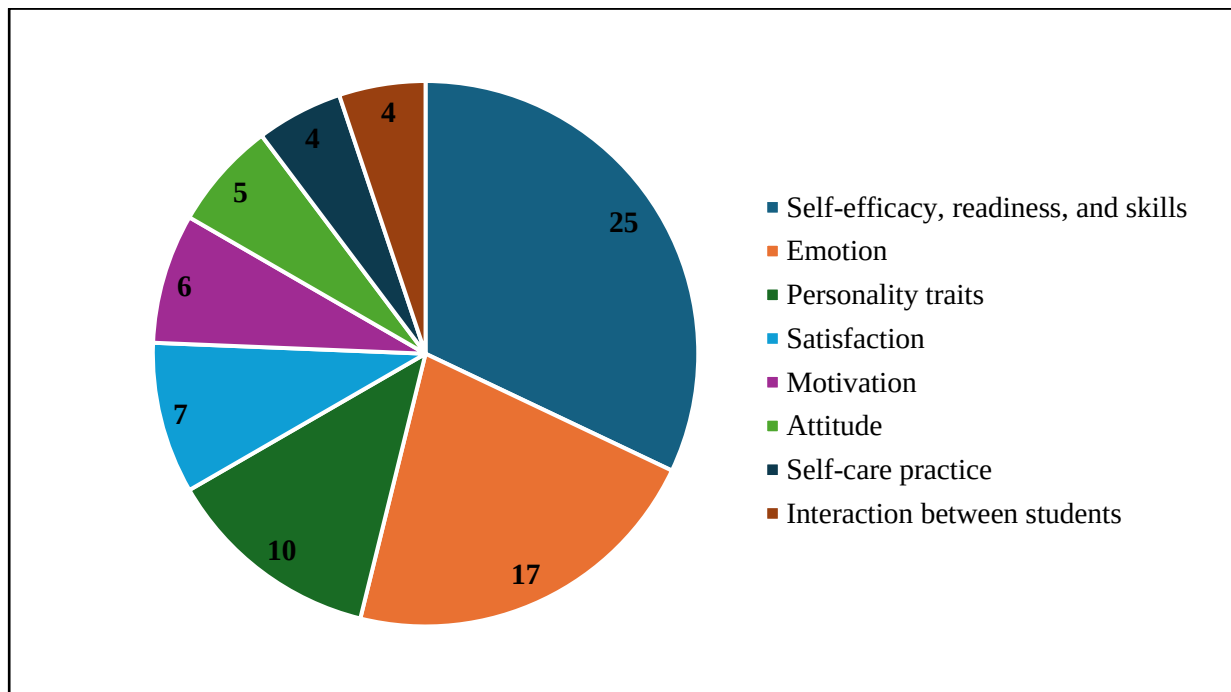
Note: some studies examined multiple themes.

### Student-Related Factors

Thirty-seven studies examine student-related factors (see Figure 2) with many exploring multiple factors. Figure 3 presents the student-related factors impacting SE in online learning during the COVID-19 pandemic. Students' self-efficacy, readiness, and skills were found to be the most frequently demonstrated predictors of SE, followed by emotion, personality traits, satisfaction, motivation, attitude, self-care practices, and interaction between students. As presented in Table 4, numerous studies showed that different aspects of self-efficacy (e.g., academic, computer, digital, and technology) were significantly associated with student engagement. Academic self-efficacy (students' beliefs in their ability to accomplish learning tasks and confidence in their own skills to successfully perform these tasks) on OSE (Adeshola & Agoyi, 2022), behavioral and emotional engagement (El-Sayad et al., 2021), course engagement (Kaspar et al. 2024), and study engagement (Koob et al., 2021). Learning technology-related self-efficacy was positively associated with OSE (Maini et al., 2021; Adeshola & Agoyi, 2022; Kara, 2022; Li et al., 2023), course engagement (Kaspar et al., 2024) and academic engagement (Heidari et al., 2021). Conversely, Heo et al. (2021) found a significant negative relationship between self-efficacy in technology use and learning engagement. Other forms of student self-efficacy that were positively related to student engagement include students' self-efficacy in time management (Heo et al., 2021; Li et al., 2023), self-efficacy in an online learning environment (Heo et al., 2021), resilience (Koob et al., 2021), social skills (Iqbal et al., 2022), and self-directed learning skills (Kara, 2022; Kaspar et al., 2024). Moreover, students' adaptability or adaptive behavior (i.e., the ability to respond to changing, new, and uncertain conditions appropriately) was positively associated with SE (Zhang et al., 2021; Pham & Chau, 2024).

**Figure 3**

*Student-Related Factors Associated with Student Engagement in Online Learning*



Note: some studies examined multiple sub-themes.

Several studies focused on student emotions. While positive academic emotion (i.e., enjoyment) was positively correlated with student engagement (e.g., Aldaghri & Oraif, 2022; Duron-Ramos et al., 2022), negative academic emotion (i.e., anger, hopelessness, boredom, sadness, fear, anxiety) was associated with lower SE (Zhang et al., 2021; Lux et al., 2023; Kaspar et al., 2024). Research demonstrated that students' loneliness and anxiety with online learning negatively influenced their engagement in online learning during the COVID-19 pandemic (Zapata-Cuervo et al., 2023; Mizani et al., 2022). In contrast, Pham and Chau (2024) found a positive and significant influence of anxiety on SE. The regulation of emotions, which is defined as redirecting emotions and predicting repercussions before acting, and self-awareness (i.e., the ability to identify one's own and other's emotions) were positively related to cognitive engagement (Iqbal et al., 2022). Zhoc et al. (2022) examined the two emotion regulation strategies. They found that cognitive reappraisal positively influenced behavioral, cognitive, and emotional engagement, but expressive suppression was positively associated only with behavioral engagement.

Some studies revealed a significant influence of personality traits on SE. For example, Quigley et al. (2022) examined the Big Five personality traits as predictors of four types of engagement (i.e., participation, performance, skills, and emotional). Conscientiousness predicted all types of engagement, and extraversion predicted participation and performance. In addition, neuroticism was significantly related to engagement skills, performance, and emotional engagement, while agreeableness and openness to experience predicted participation and emotional engagement, respectively. Kaspar et al. (2024) reported a positive impact of conscientiousness, neuroticism, and openness on course engagement. Li et al. (2023) showed that conscientiousness and openness are positively associated with student engagement.

Numerous studies explored the impacts of pleasure, subjective well-being, and meaningfulness on SE in online learning during the COVID-19 pandemic. Aldaghri and Oraif (2022) found that students' feelings of pleasure about attending online classes were positively associated with skills, emotions, participation, and performance. Other research found that student orientation to happiness (i.e., pleasure, meaning, and engagement) was a significant predictor of behavioral, cognitive, and emotional engagement (Duron-Ramos et al., 2022). Students' subjective well-being (i.e., students' positive emotional and cognitive evaluations of online instruction, positive mood, vitality, and general interest) predicted higher learning engagement (Yang et al., 2021) and behavioral and cognitive engagement (Zhoc et al., 2022). Students' psychological conditions of meaningfulness, such as study resources (e.g., lecturer support, peer support, growth, and information accessibility), positively contributed to student engagement (Reynell van der Ross et al., 2022). In addition, self-compassion and purpose (experiencing meaning in life and accepting challenges) were positively correlated with online student engagement (Cleofas, 2021).

Research showed that student satisfaction was positively related to SE during the COVID-19 pandemic. For example, Huang and Wang (2023) examined the influence of three dimensions of students' psychological need satisfaction (autonomy, competence, and relatedness) on three dimensions of SE (emotional, cognitive, and behavioral). They found that autonomy and competence were positively related to all three dimensions of SE. In addition,

relatedness was positively associated with behavioral and emotional engagement. Conversely, the relationship between relatedness and cognitive engagement was negative. Shah et al. (2021) revealed that students' perceptions of their psychological need satisfaction and/or dissatisfaction positively influenced student engagement with online learning. Baloran et al. (2021) demonstrated a positive impact of course satisfaction in online learning on skills, emotions, participation, and performance engagement.

Student motivation for online learning (i.e., students' desire to learn in online environments) was found to be a significant driver of student engagement (Gopinathan et al., 2022; Iqbal et al., 2022; Kara, 2022). For example, intrinsic goal orientation (i.e., participation in a learning task for reasons such as mastery, curiosity, or challenge) was positively related to skills and emotional engagement. However, extrinsic goal orientation (i.e., participation in a learning task for reasons such as getting a good grade, performance, or competition) was only significantly associated with performance engagement (Vezne et al., 2023). Dubey et al. (2023) found a significant effect of hedonic motivation (i.e., perceived pleasure) on OSE.

Students' attitudes toward online learning and instructional materials significantly influenced SE. For example, students' attitudes toward online learning (Dubey et al., 2023), perceptions towards online learning (Tan et al., 2024), and online learning acceptance (Sharif Nia et al., 2023) were significantly related to OSE. While students' attitudes toward attending online lectures impacted on the skills and emotional dimensions of SE, their attitudes toward doing assignments and homework online influenced the skills and participation aspects of SE (Vezne et al., 2023).

Student–student interactions among individual students, opportunities for social interaction during online classes, or students working in small groups positively predicted higher levels of emotional engagement (Salta et al., 2022; Gherghel et al., 2023). Another study showed that low transactional distance between student and student (i.e., high-quality dialogues that are perceived to support students in their learning) increased student participation engagement (Fabian et al., 2022).

Student engagement was also influenced by students' self-care practices. Cleofas (2021) found that self-care practices such as physical care (e.g., exercising, eating healthy foods and hydration), mindful relaxation (active engagement in relaxation activities), and supportive relationships (interacting with significant others) were positively associated with OSE. Students' active self-care (ability to maintain daily self-care, structure, and planning in terms of sleep, work, or physical activity) was a significant predictor of study engagement (e.g., a positive, fulfilling state of mind such as high levels of energy, concentration, and involvement in study); dedication refers to being strongly involved in one's studies and experiencing a sense of significance, and absorption implies being fully concentrated on and immersed in one's study activities (Koob et al., 2021).

Other student-related factors that increased student engagement with online learning during the COVID-19 pandemic include prior online learning experiences (Lim et al., 2022), mastery-approach goals (i.e., students' learning to gain competency through mastering tasks) (Daniels et al., 2021), autonomy (Maini et al., 2021), collaborative learning orientation (i.e.,

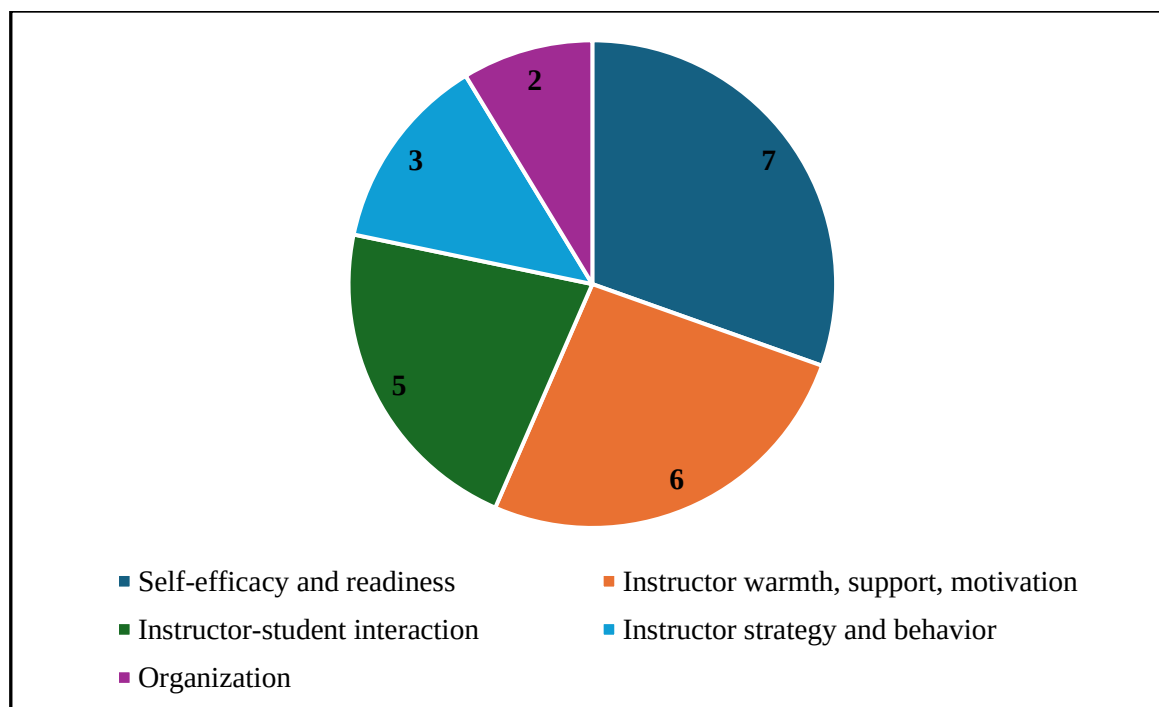
students working collectively to achieve learning goals) (Almusharraf & Bailey, 2021), supportive relationships (i.e., students' interactions with significant others) (Cleofas, 2021), sense of community (Li et al., 2023), and informal learning behaviors in their daily life while using digital technology (Heidari et al., 2021). Burnout risk (e.g., personal burnout, study-related burnout, and peer-related burnout) was negatively associated with student engagement (Reynell van der Ross et al., 2022).

#### Instructor-Related Factors

Seventeen studies examined the instructor-related factors (see Figure 2). Figure 4 shows the instructor-related factors associated with student engagement in online learning during the COVID-19 pandemic. Instructors' self-efficacy and readiness were frequently established determinants of student engagement. For example, the mentor's ability to facilitate learning and encourage mentees to be focused on their goals were significant factors that affected SE in online learning (Gamage et al., 2021). Instructors' self-efficacy (i.e., preparedness and confidence in the delivery of content), digital competency (Aldhaen et al., 2024), and technical readiness (i.e., efficacy and comfort or ease of use of learning technology) significantly affected SE (Maini et al., 2021). Research also revealed that instructor/teaching presence (i.e., instructor's ability to facilitate, support, and guide the student learning process) was positively related to SE (El-Sayad et al., 2021; Roque-Hernández et al., 2023).

#### **Figure 4**

*Instructor-Related Factors Associated with Student Engagement in Online Learning*



Note: some studies examined multiple sub-themes.

Interactions between instructors and students also served as a significant determinant of SE during the COVID-19 pandemic. Interactivity, the extent to which an educator expects communication from students while teaching (Gopinathan et al., 2022), and psychological safety or instructor–student exchange that occurs during learning activities such as lectures and communication in online forums (Reynell van der Ross et al., 2022) positively contributed to increased student engagement. In addition, instructor–student interaction (i.e., online dialogue between students and teachers) affected students’ emotional engagement (Salta et al., 2022). Two studies reported a positive influence of instructor–student interaction on OSE (Kedia & Mishra, 2023; Sharif Nia et al., 2023).

Several studies investigated instructors’ warmth, support, and motivation. Lim et al. (2022) found that instructors’ encouragement of student participation and teaching approaches and demeanors (e.g., warmth and openness) positively affected emotional engagement. Teacher support was associated with behavioral engagement (Luan et al., 2023). In addition, students who were provided additional study materials by their instructors demonstrated a higher level of skill and participation engagement (Aldaghri & Oraif, 2022). Student-teacher relationships (i.e., instructors fostering student confidence and motivation, with the ultimate goal of positive learning outcomes) were positively related to OSE (Bozan et al., 2024). Furthermore, mastery motivational climate (i.e., students’ perception of motivational climate in online learning) was linked to improved behavior, emotional, and cognitive engagement (Fu et al., 2024).

Studies showed that instructors’ strategies and behaviors could impact OSE. For example, instructors’ nonverbal immediacy (i.e., students’ perceptions of instructors’ vocal variety, facial expression, postures, and gestures) had a significant effect on OSE. Instructors’ teaching strategy and delivery mode flexibility were associated with increased student



engagement (Lux et al., 2023). Instructors' organizational skills or a structured approach, such as activity preparedness and active learning favorably influenced OSE (Lim et al., 2022; Maini et al., 2021).

#### Course Material and Design-Related Factors

Only four studies examined course material and design-related factors (see Figure 2). Sharif Nia et al. (2023) found that students' perception of course content quality in online learning positively impacts OSE. Reflianto et al. (2021) reported that an online flipped learning scheme using Microsoft Teams increased OSE. In addition, learning format (Koob et al., 2021) and active learning (Ladino Nocua et al., 2021) were positively related to study engagement.

#### Learning Technology and System-Related Factors

Seven studies investigated learning technology and system-related factors (see Figure 2). Research showed that accessibility of learning technologies (Lux et al., 2023) and technical support (Kedia & Mishra, 2023) enhanced OSE during the COVID-19 pandemic. Similarly, digital collaborative tools (i.e., tools or platforms used in online learning) had a significant and favorable influence on OSE (Gopinathan et al., 2022). Learning systems and technologies and types of devices used by students enhanced student engagement during the COVID-19 pandemic (Owusu-Agyeman et al., 2021). Perceived usefulness of online learning systems was positively related to behavioral engagement, cognitive engagement, emotional engagement (El-Sayad et al., 2021), participation (Fabian et al., 2022), and OSE (Dubey et al., 2023).

#### Demographics

Six studies reported demographic variables such as gender, education, age, and ethnicity as significant factors associated with student engagement. However, the evidence is contradictory. For example, female students demonstrated significantly higher participation engagement than male students (Wu & Teets, 2021). In addition, Li et al. (2023) reported a lower level of OSE among males than females. On the contrary, Owusu-Agyeman et al. (2021) indicated a lower level of OSE among female students compared to male students.

Student college year was associated with student engagement in a few studies. For example, the level of engagement in the second-year students' online learning was significantly different from that of third-year students (Baloran et al., 2021). Moreover, students who had already spent at least four years in their undergraduate studies reported higher levels of emotional engagement than those who were in the first (freshman) or second (sophomore) year of their studies (Salta et al., 2022). One study found that first-year students had lower performance engagement than non-first-year students (Wu & Teets, 2021).

Race was a significant predictor of SE during the COVID-19 pandemic. Wu and Teets (2021) found that Underrepresented People of Color (URPOC) students in the U.S. were less engaged (skills, participation, and performance) than non-URPOC students. On the contrary, Li et al. (2023) reported a lower level of OSE among white students compared to non-white students. Only one study reported the relationship between age SE; older students demonstrated a higher level of online course engagement compared to younger students (Kaspar et al., 2024).

#### Other Factors

Social factors such as family and peer support were significant predictors of SE during the COVID-19 pandemic (Kedia & Mishra, 2023; Koob et al., 2021; Luan et al., 2023). Two studies revealed that students who received support from colleges and universities during the pandemic demonstrated higher levels of OSE (Owusu-Agyeman et al., 2021; Azila-Gbette et al., 2023). Owusu-Agyeman et al. (2021) showed that the online learning environment positively and significantly affected OSE. Reynell van der Ross et al. (2022) found a significant and positive relationship between study demands (i.e., time and study pressure) and OSE. A study demonstrated that health concerns about family and friends significantly influenced study engagement (Koob et al., 2021). Student usage of social media was positively associated with student engagement during the pandemic (Kedia & Mishra, 2023).

Finally, some studies included in this review reported two or more factors associated with SE (see Table 4). For example, eleven investigations (Aldaghri & Oraif, 2022; Bozan et al., 2024; El-Sayad et al., 2021; Gopinathan et al., 2022; Li et al., 2023; Lim et al., 2022; Lux et al., 2023; Maini et al., 2021; Reynell van der Ross et al., 2022; Salta et al., 2022; Sharif Nia et al., 2023) examined the impact of both student- and instructor-related factors on SE. Along with student- and instructor-related factors, other studies investigated learning technology and system-related factors (El-Sayad et al., 2021; Gopinathan et al., 2022; Lux et al., 2023), course material and design-related factors (Sharif Nia et al., 2023), study demand (Reynell van der Ross et al., 2022), and demographics (Salta et al., 2022; Li et al., 2023). Koob et al. (2021) explored student-related (e.g., academic self-efficacy, active self-care), course material and design-related (e.g., digital learning format), social (e.g., social support), and environmental factors (e.g., health concerns about family and friends). Kedia and Mishra (2023) have shown that instructor-related factors, learning technology and system-related factors, social factors, and media use are associated with SE. Fabian et al. (2022) focused on student-related and learning technology and system-related factors. Luan et al. (2023) investigated instructor-related and social factors. Owusu-Agyeman et al. (2021) reported the influence of institutional and administrative support, learning technology, and demographics on SE.

**Table 4***Factors Associated with Student Engagement by Themes*

| Themes and sub-themes                | Factors associated with dimensions of student engagement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Student-related factors</b>       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Self-efficacy, readiness, and skills | <p>academic self-efficacy → OSE (Adeshola &amp; Agoyi, 2022)</p> <p>academic self-efficacy → BE, EE (El-Sayad et al., 2021)</p> <p>academic self-efficacy → course engagement (Kaspar et al., 2023)</p> <p>academic self-efficacy → study engagement (Koob et al., 2021)</p> <p>computer self-efficacy → OSE (Adeshola and Agoyi, 2022)</p> <p>learning confidence → OSE (Bozan et al., 2024)</p> <p>digital competence → academic engagement (Heidari et al., 2021)</p> <p>digital literacy → OSE (Kara, 2022)</p> <p>digital media self-efficacy → course engagement (Kaspar et al., 2023)</p> <p>digital skills → OSE (Li et al., 2023)</p> <p>technical readiness → OSE (Maini et al., 2021)</p> <p><i>self-efficacy in technology use → learning engagement (Heo et al., 2021)</i></p> <p>e-learning capital → skills (Fabian et al., 2022)</p> <p>online learning self-efficacy → learning engagement (Yang et al., 2021)</p> <p>self-efficacy → OSE (Maini et al., 2021; Zapata-Cuervo et al., 2023)</p> <p>self-efficacy in time management → learning engagement (Heo et al., 2021)</p> <p>self-efficacy in an online learning environment → learning engagement (Heo et al., 2021)</p> <p>resilience → study engagement (Koob et al., 2021)</p> <p>self-directed learning → OSE (Kara, 2022)</p> <p>time management skills → OSE (Li et al., 2023)</p> <p>self-regulation skills → course engagement (Kaspar et al., 2023)</p> <p>students' adaptability → OSE (Zhang et al., 2021)</p> <p>adaptive behavior → OSE (Pham &amp; Chau, 2024)</p> <p>social skills → CE (Iqbal et al., 2022)</p> |
| Emotion                              | <p>positive academic emotion → OSE (Zhang et al., 2021)</p> <p><i>negative academic emotion → OSE (Zhang et al., 2021)</i></p> <p>emotion regulation → CE (Iqbal et al., 2022)</p> <p>self-awareness → CE (Iqbal et al., 2022)</p> <p>suppression (emotion regulation) → BE (Zhoc et al., 2022)</p> <p>cognitive reappraisal (emotion regulation) → BE, EE, CE (Zhoc et al., 2022)</p> <p><i>student loneliness → OSE (Mizani et al., 2022)</i></p> <p><i>anxiety → OSE (Zapata-Cuervo et al., 2023)</i></p> <p>anxiety (Pham &amp; Chau, 2024)</p> <p><i>stress/anxiety → OSE (Lux et al., 2023)</i></p> <p><i>COVID-19 anxiety → course engagement (Kaspar et al., 2023)</i></p> <p>students' feelings (pleased) about attending online classes → skills, emotional, participation, performance (Aldaghri &amp; Oraif, 2022)</p> <p>orientations to happiness: pleasure, meaning, and engagement → BE, EE, CE (Duron-Ramos et al., 2022)</p> <p>students' subjective well-being → learning engagement (Yang et al., 2021)</p> <p>students' subjective well-being → BE, CE (Zhoc et al., 2022)</p> <p>psychological conditions of meaningfulness (study resources) → OSE (Reynell van der Ross et al., 2022)</p> <p>self-compassion and purpose → OSE (Cleofas, 2021)</p>                                                                                                                                                                                                                                                                                                                              |

|                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Personality traits                | <p>conscientiousness → participation, performance, skills, emotional (Quigley et al., 2022)</p> <p>conscientiousness → course engagement (Kaspar et al., 2023)</p> <p>conscientiousness → OSE (Li et al., 2023)</p> <p>extraversion → participation, performance (Quigley et al., 2022)</p> <p>neuroticism → skills, emotional, performance (Quigley et al., 2022)</p> <p>neuroticism → course engagement (Kaspar et al., 2023)</p> <p>agreeableness → participation (Quigley et al., 2022)</p> <p>openness → course engagement (Kaspar et al., 2023)</p> <p>openness to experience → EE (Quigley et al., 2022)</p> <p>openness → OSE (Li et al., 2023)</p>                                                                                                                                                                                                |
| Satisfaction                      | <p>course satisfaction → skills, emotional, participation, performance, OSE (Baloran et al., 2021)</p> <p>need satisfaction → OSE (Shah et al., 2021)</p> <p><i>need dissatisfaction</i> → OSE (Shah et al., 2021)</p> <p>autonomy satisfaction → BE, EE, CE (Huang &amp; Wang, 2023)</p> <p>competence satisfaction → BE, EE, CE (Huang &amp; Wang, 2023)</p> <p>relatedness satisfaction → BE, EE (Huang &amp; Wang, 2023)</p> <p><i>relatedness satisfaction</i> → CE (Huang &amp; Wang, 2023)</p>                                                                                                                                                                                                                                                                                                                                                      |
| Motivation                        | <p>motivation → OSE (Gopinathan et al., 2022)</p> <p>self-motivation → CE (Iqbal et al., 2022)</p> <p>motivation for learning → OSE (Kara, 2022)</p> <p>intrinsic goal orientation → skills, emotional (Vezne et al., 2023)</p> <p>extrinsic goal orientation → performance (Vezne et al., 2023)</p> <p>hedonic motivation → OSE (Dubey et al., 2023)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Attitude                          | <p>attitude toward online learning → OSE (Dubey et al., 2023)</p> <p>perceptions towards online learning → OSE (Tan et al., 2024)</p> <p>attitude of attending online lectures → skills, emotional (Vezne et al., 2023)</p> <p>attitude of doing assignment and homework online → skills, participation, performance (Vezne et al., 2023)</p> <p>online learning acceptance → OSE (Sharif Nia et al., 2023)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Self-care practice                | <p>physical care → OSE (Cleofas, 2021)</p> <p>active self-care → study engagement (Koob et al., 2021)</p> <p>mindful relaxation → OSE (Cleofas, 2021)</p> <p>supportive structures → OSE (Cleofas, 2021)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Interaction between students      | <p>student–student interaction → EE (Salta et al., 2022)</p> <p>opportunities for social interaction → emotional (Gherghel et al., 2023)</p> <p>low transactional distance between student and student → participation (Fabian et al., 2022)</p> <p>social interactions → OSE (Lux et al., 2023)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Others                            | <p>prior online learning experiences → performance engagement (Lim et al., 2022)</p> <p>perceived value of knowing learning goals → BE, EE, CE (Sun et al., 2023)</p> <p>adaptive cognition → OSE (Pham &amp; Chau, 2024)</p> <p>expectation to adopt e-learning → OSE (Poon et al., 2024)</p> <p>students' mastery-approach goals → BE, EE, CE (Daniels et al., 2021)</p> <p>students' autonomy → OSE (Maini et al., 2021)</p> <p><i>burnout risk</i> → OSE (Reynell van der Ross et al., 2022)</p> <p>students' collaborative learning orientation → agentic engagement (Almusharraf &amp; Bailey, 2021)</p> <p>supportive relationships → OSE (Cleofas, 2021)</p> <p>sense of community → OSE (Li et al., 2023)</p> <p>health status → OSE (Li et al., 2023)</p> <p>digital informal learning behavior → academic engagement (Heidari et al., 2021)</p> |
| <b>Instructor-related factors</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-efficacy and readiness                           | <p>instructor's ability to facilitate learning → OSE (Gamage et al., 2021)</p> <p>instructor's ability to encourage students to be focused on their goals → OSE (Gamage et al., 2021)</p> <p>instructor's self-efficacy → OSE (Maini et al., 2021)</p> <p>instructor digital competency → BE, EE, CE (Aldhaen, 2024)</p> <p>instructor's technical readiness → OSE (Maini et al., 2021)</p> <p>teaching presence → BE, EE, CE (El-Sayad et al., 2021)</p> <p>instructor presence → OSE (Roque-Hernández et al., 2023)</p> |
| Instructor warmth, support, and motivation            | <p>instructor warmth and openness (teaching approaches and demeanors) → EE, performance, OSE (Lim et al., 2022)</p> <p>teacher support → behavioral (Luan et al., 2023)</p> <p>instructor's encouragement of student participation → EE (Lim et al., 2022)</p> <p>instructor providing students with additional study materials → skill, participation (Aldaghri &amp; Oraif, 2022)</p> <p>student-teacher relationship → OSE (Bozan et al., 2024)</p> <p>mastery motivational climate → BE, EE, CE (Fu et al., 2024)</p> |
| Instructor-student interaction                        | <p>instructor-student interaction → OSE (Kedia &amp; Mishra, 2023)</p> <p>interactivity → OSE (Gopinathan et al., 2022)</p> <p>student-instructor interaction → EE (Salta et al., 2022)</p> <p>online interaction → OSE (Sharif Nia et al., 2023)</p> <p>student-leader (instructor)-member exchange → OSE (Reynell van der Ross et al., 2022)</p>                                                                                                                                                                        |
| Instructor strategy and behavior                      | <p>instructor strategy → OSE (Lux et al., 2023)</p> <p>nonverbal immediacy → OSE (Li et al., 2023)</p> <p>delivery mode flexibility → OSE (Lux et al., 2023)</p>                                                                                                                                                                                                                                                                                                                                                          |
| Organization                                          | <p>instructor organization (activity preparedness, active learning activity) → OSE (Lim et al., 2022)</p> <p>instructors' structured approach → OSE (Maini et al., 2021)</p>                                                                                                                                                                                                                                                                                                                                              |
| <b>Course material and design-related factors</b>     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Pedagogical approach and format                       | <p>online flipped learning scheme using Microsoft Team → OSE (Reflianto et al., 2021)</p> <p>learning format → study engagement (Koob et al., 2021)</p>                                                                                                                                                                                                                                                                                                                                                                   |
| Learning content [                                    | course content → OSE (Sharif Nia et al. 2023)                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Activity                                              | active learning activity → CE (Ladino Nocua et al., 2021)                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Learning technology and system-related factors</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Technology and tools                                  | <p>digital collaborative tools → OSE (Gopinathan et al. 2022)</p> <p>learning systems and technologies → OSE (Owusu-Agyeman et al., 2021)</p> <p>technological accessibility → OSE (Lux et al., 2023)</p> <p>type of device used by students → OSE (Owusu-Agyeman et al., 2021)</p> <p>technical support → OSE (Kedia &amp; Mishra, 2023)</p>                                                                                                                                                                             |
| Usefulness                                            | <p>perceived usefulness → BE, EE, CE (El-Sayad et al., 2021)</p> <p>perceived usefulness → participation (Fabian et al., 2022)</p> <p>perceived usefulness → OSE (Dubey et al., 2023)</p>                                                                                                                                                                                                                                                                                                                                 |
| <b>Demographics</b>                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Gender                                                | <p>gender (female) → participation (Wu &amp; Teets, 2021)</p> <p><i>gender (male) → OSE (Li et al., 2023)</i></p> <p><i>gender (female) → OSE (Owusu-Agyeman et al., 2021)</i></p>                                                                                                                                                                                                                                                                                                                                        |
| Age                                                   | age → course engagement (Kaspar et al., 2024)                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| College year                                          | <p>college year (Baloran et al., 2021)</p> <p>college year (senior) (Salta et al., 2022)</p> <p><i>college year (first-year) → performance (Wu &amp; Teets, 2021)</i></p>                                                                                                                                                                                                                                                                                                                                                 |

|                                          |                                                                                                                                                       |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ethnicity                                | <i>underrepresented people of color</i> → skills, participation, performance (Wu & Teets, 2021)<br><i>White</i> → OSE (Li et al., 2023)               |
| <b>Other factors</b>                     |                                                                                                                                                       |
| Institutional and administrative support | institutional support system → OSE (Owusu-Agyeman et al., 2021)<br>university support → OSE (Azila-Gbette et al., 2023)                               |
| Social factors                           | social support → study engagement (Koob et al., 2021)<br>peer support → behavioral (Luan et al., 2023)<br>family support → OSE (Kedia & Mishra, 2023) |
| Environmental factors                    | online learning environment → OSE (Owusu-Agyeman et al., 2021)<br>health concerns about family and friends → study engagement (Koob et al., 2021)     |
| Study demand                             | study demand → OSE (Reynell van der Ross et al., 2022)                                                                                                |
| Media use                                | social media use → OSE (Kedia & Mishra, 2023)                                                                                                         |

Note: Italicized text indicates negative relationship. OSE = Overall Student Engagement, BE = Behavioral Engagement, EE = Emotional Engagement, CE = Cognitive Engagement.

## Discussion

This systematic review provides a comprehensive analysis of the most consistent factors associated with student engagement via online instruction during COVID-19. During this tumultuous period, the most consistent findings highlight a diverse array of student dynamics—self-efficacy, skills, emotion, personality traits, satisfaction, motivation, attitude, and student interaction—as the most prevalent predictors of student engagement. In particular, multiple student-related sub-themes emerged as driving student engagement across the fifty studies examined. Various aspects of self-efficacy (e.g., academic, computer, digital, and technology) emerged as the most common predictor of different forms of student engagement (e.g., behavioral, emotional, and cognitive). These findings show that at times like the COVID-19 pandemic, when social interactions are limited to virtual experiences, fostering students' feelings of self-confidence may help mitigate the challenges posed by a sudden transition from face-to-face classroom experiences to remote learning. Therefore, during such challenging periods, instructors and university administrators should focus on enhancing students' belief in their ability to accomplish learning tasks and confidence in their skills to perform them successfully. In addition, it is essential to evaluate students' competency and confidence in handling online learning technologies early in the semester, identify students with lower levels of competency through a survey or a focus group study, and enhance their technology self-efficacy by providing necessary accommodations.

While the bulk of the findings suggested positive relationships between various learning factors and student engagement, feelings of loneliness, negative emotion, and minority/female identification were linked to less engagement. Educators must be alert to the challenges facing these individuals and seek to address concerns effectively. In particular, being wary of psychosocial challenges students are facing, as well as combating structural barriers that impede student learning, should be the focus of such efforts.

Research suggests that students relied on instructors to create online environments that mimicked face-to-face encounters. This likely includes optimal student–student and student–

instructor interactions. To actively engage students in online learning, instructors should consider creating an interactive online learning environment that promotes student–student interaction by employing various strategies, including group projects, peer review, peer mentoring, online discussion forums, and collaborative tools. Student–instructor interaction can be enhanced through various learning approaches, including online discussions, personalized feedback, interactive tools, virtual office hours, etc.

Self-efficacy was again a critical factor influencing student engagement, with instructor self-perception of remote teaching skills driving outcomes, including student engagement. Instructors' self-efficacy and readiness in online learning during an emergency period can be enhanced by offering them professional development opportunities, training on learning technology and system, and virtual technology support.

In terms of the collective findings, our analyses suggest that there are various factors that mitigate the negative impact of the upending of traditional course delivery on student engagement. When students and faculty/staff faced an extreme public health crisis, the quality of learning technologies, student psychosocial outcomes (e.g., efficacy, subjective well-being, social support), and the dynamics of virtual instruction fostered student engagement. Presumably, technologies utilized for remote learning will continue to improve along with the digital skills of both instructors and students. However, universities must invest in workshops, tutorials, and outreach efforts to ensure student engagement can remain at adequate levels when instruction shifts (either planned or driven by crisis) online.

Our research showed that accessibility and preparedness of learning technologies and technical support played critical roles in enhancing student engagement during the COVID-19 pandemic. Thus, higher educational institutions should devote their resources to updating their learning management systems and offering training to their students, faculty, and staff on state-of-the-art learning technologies, including web-based learning platforms, collaboration and communication tools, and video conferencing applications to meet specific needs during an emergency period. However, it is essential to focus on the system quality by ensuring students' perceived reliability, usefulness, and ease of use of online learning systems (Pham et al., 2019).

In conclusion, higher educational institutions should focus on student-, instructor-, system/technology-, and course-related factors when developing and implementing effective online learning, especially in extraordinary situations such as the COVID-19 pandemic (Limbu & Pham, 2023).

## **Limitations and Future Research Directions**

Table 5 highlights topic areas that should be investigated more thoroughly. This investigation employed a systematic review approach to examining factors related to student engagement. However, we could not conduct a meta-analysis because of high heterogeneity across studies, measures, designs, and populations. Thus, future meta-analytic studies should consider determining the overall effect sizes that each significant predictor contributes to explain student engagement. In addition, this review excluded qualitative studies as it aimed to conduct a systematic review of correlational and causal evidence to identify the factors associated with

student engagement. Hence, future research should involve qualitative systematic reviews, such as thematic synthesis, to synthesize the findings of qualitative studies and provide a complete picture of key themes related to student engagement with online learning.

The studies examined in our review almost exclusively employed cross-sectional survey designs. Future investigations should investigate the potential long-term effects of different determinants on student engagement. Manipulating different digital environments via experimental analysis could help identify specific cause-effect relationships. Finally, the studies reviewed engaged in primary analyses of student engagement within specific institutions. Secondary analysis of data collected across a range of students may add more generalizable conclusions as to what drives student engagement across countries.

This systematic review included studies published from December 2020 to March 2024. Future research can replicate this study by extending the period and including the articles published after March 2024.

Across the studies examined, few distinguished between different student engagement dimensions (cognitive, emotional, behavioral). Future research should examine how different predictors contribute uniquely to these different elements of engagement. In terms of more descriptive data, focus group studies examining online student engagement would provide richer explanations/interpretations of what students found most challenging as well as most beneficial. Student engagement reflects a complex array of student motivation, skills, resources, and ideal environments. Having university students provide in-depth accounts of how specific factors contribute to their success (or lack thereof) offers insights on how best to improve online course instruction.

One of the critical areas is “learning technology and system quality.” This includes the technology employed, broader system infrastructure, and digital collaborative tools. As educational technologies further advance, it is critical to address the benefits and drawbacks of machine learning to student engagement. Our findings also indicate a relative lack of research exploring systemic/external factors driving engagement, including family, environment, role of institutions, administration, advisors, university helplines, and social norms. Adapting to university environments—independent of a pandemic—poses various social/psychosocial challenges to students (Hudd et al., 2000; Segrin & Flora, 2006). Identifying the most effective ways to mitigate the negative effects these factors have on student engagement is critical as more course offerings appear online. In particular, institutional and administrative support provided by the university, such as university counseling, career/advising services, and broader administrative services (e.g., student services and registrar offices), should be more thoroughly examined. In our analysis, we located only two studies addressing administrative support tied to aspects of online learning (Owusu-Agyeman et al., 2021). During a public health crisis, students have limited, if any, face-to-face contact with the broader administrative university community. How well these services are administered virtually may be key to maintaining student connection to both the broader university and specific course content.

Similarly, there were few studies addressing course material and design-related factors. Certain course content may be more adaptable to online environments, whereas other material



(i.e., performance-based offerings) may face challenges in online settings. In addition, how student engagement varies based on synchronous vs. asynchronous online instruction as well as the diversity of mediated channels (video, audio, text-based) employed, warrants further investigation.

Pre-Covid-19 longitudinal research highlights the critical role self-efficacy plays in driving student engagement as well as potentially mitigating the adverse effects of student burnout on student engagement (Maricutoiu & Sulea, 2019). The current systematic review adds to the literature by indicating the contribution of efficacy during a major public health crisis. Researchers must continue to explore how this factor affects not only student engagement but also other key factors driving effective learning environments (e.g., instructor skills/motivation and student well-being).

Finally, the preliminary identification of empirical investigations surprisingly showed only five studies conducted within U.S. contexts that investigated factors driving student engagement during the COVID-19 pandemic. At the same time, the lack of university student engagement during the pandemic has been documented within U.S. contexts (Hollister et al., 2022; Wester et al., 2021; Wu & Teets, 2021). In addition, no study had been conducted to examine the factors influencing student engagement in Oceania countries, including Australia and New Zealand. Given the highly publicized challenges to student engagement posed by the pandemic, it is unclear why a relatively limited number of studies from these geographic locations have addressed what contributes to these challenges. These gaps should be addressed in future research.

**Table 5**  
*Topics for Future Research*

| Main topic   | Sub-topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study design | <ul style="list-style-type: none"> <li>○ longitudinal study, experimental study, interventions, observational study</li> <li>○ secondary data, machine learning, artificial intelligence</li> <li>○ qualitative study (e.g., focus group/in-depth interview with students or instructors)</li> <li>○ objective and behavioral measures, different engagement measures, development of pandemic related measures</li> <li>○ comparative study to explore both students' and instructors' viewpoints</li> <li>○ testing engagement theories and models</li> </ul> |

|                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Course material and design-related factors | <ul style="list-style-type: none"> <li>○ online learning models (e.g., synchronous, asynchronous, hybrid)</li> <li>○ diversity of mediated channels (e.g., video, audio, text-based)</li> <li>○ pedagogical approaches (e.g., peer learning, active learning, community-based learning such as e-service learning)</li> <li>○ collaborative learning (e.g., team/group work, online forum, group discussion, discussion models, group project, group project/case presentation)</li> <li>○ online class involvement (e.g., class activity, class game, formative quiz, creative thinking, brainstorming activities, learner-content engagement)</li> <li>○ virtual guest speakers, virtual field trips</li> <li>○ course attributes (e.g., interestingness, complexity, flexibility, length, quality)</li> <li>○ course design factors (e.g., usability, ease of use, layout, organization)</li> <li>○ assessment factors (e.g., methods, tools, individual vs. group-level, Bloom's taxonomy)</li> </ul> |
| Administrative and support service quality | <ul style="list-style-type: none"> <li>○ academic advising services</li> <li>○ counseling and career services</li> <li>○ broader administrative services (e.g., registrar offices, helpline)</li> <li>○ access to academic resources (e.g., library services, bookstore, technology support, virtual computer lab, tutoring and writing center services)</li> <li>○ student health services (e.g., medical services, mental health services)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Learning technology and system quality     | <ul style="list-style-type: none"> <li>○ system infrastructure (e.g., learning management system, video conferencing, digital learning resources, Web 2.0 technologies)</li> <li>○ system quality (e.g., software quality such as usability, accessibility, reliability)</li> <li>○ collaboration and communication tools</li> <li>○ technology acceptance theories and models</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Instructor-related factors                 | <ul style="list-style-type: none"> <li>○ readiness, trust, digital media literacy, approach, responsiveness, feedback and communication</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Student-related individual factors         | <ul style="list-style-type: none"> <li>○ subjective wellbeing, health status, mental status, anxiety, emotion, loneliness</li> <li>○ readiness, experience, motivation, confidence, belief, value, enjoyment</li> <li>○ cultural values, cultural identity, cultural orientation, cultural differences (e.g., individualistic vs. collectivist)</li> <li>○ access to internet and personal computers at home</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Institution                                | <ul style="list-style-type: none"> <li>○ type (e.g., private vs. public, four-year vs. community college vs. universities, small vs. big institution)</li> <li>○ student engagement across disciplines and courses</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Demographic                                | <ul style="list-style-type: none"> <li>○ sociodemographic status</li> <li>○ disadvantaged populations; underrepresented people of color (URPOC) education level</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Geographical                               | <ul style="list-style-type: none"> <li>○ student population (e.g., Eastern vs. Western culture; developed vs. developing countries; rural vs. urban; different regions)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| External factors                           | <ul style="list-style-type: none"> <li>○ community, parents, family, government</li> <li>○ social norms</li> <li>○ learning environment</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Conclusion

This investigation involved a systematic review of studies examining factors influencing university students' engagement via online instruction during COVID-19. Our comprehensive exploration of cross-country investigations indicates that the most consistent findings highlight a diverse array of student dynamics—skills, motivation, attitude, knowledge, and well-being—as critical to student engagement. Among the student-related factors, student self-efficacy emerged as the most frequent determinant of engagement. In addition, the research suggests that students likely relied on instructors to create online environments that mimicked face-to-face encounters. This likely includes optimal student-to-instructor and student-to-student communication.

### Declarations

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\* = studies included in the systematic review.

# Fostering Higher-Level Inquiry in Online Asynchronous Discussion with Kit-Build Concept Mapping: A Case in Learning Linear Algebra

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## Abstract

Online collaborative learning (OCL) based on the community of inquiry (CoI) framework is often implemented in the form of an online discussion activity for teaching subjects that require learners to revise their understandings and invent ways to solve problems. However, implementing OCL is challenging due to the difficulty of fostering higher-level inquiry stages. Such an issue could hinder the effectiveness of the discussion and might lead to low participation. Prior studies on OCL showed that facilitation strategies are insufficient for fostering higher-level inquiry stages. There is a need for an alternative strategy that could complement the existing approaches. Providing a preparatory activity that increases engagement with learning contents related to the discussion topic through a kit-build concept mapping (KBCM) activity could enable the participants to engage in a productive discussion by increasing their awareness of discussion-related concepts and their relationship. Such an activity may help the participants progress through the inquiry stages. This study aims to propose a preparatory activity for organizing knowledge using KBCM to support learners in advancing through practical inquiry stages during the discussion. In this article, we report the implementation of the proposed method in an online discussion about linear algebra. The results show that participants who did KBCM showed a higher rate of triggering event, exploration, and integration compared to those who did summary writing. Therefore, KBCM has the potential to help learners progress through inquiry stages in a more productive way up until integration compared to the traditional method of writing a structured summary.

**Keywords:** Online collaborative learning, community of inquiry, cognitive presence, online discussion, kit-build concept mapping, structured summary

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Online collaborative learning (OCL) is a popular learning model that has been implemented in various educational contexts across the globe. In OCL, learners are expected to work together to generate, organize, and achieve convergence of ideas; thus, they have the opportunity to develop understanding beyond what they could achieve alone (Harasim, 2017; Mende et al., 2021). Therefore, OCL is suitable for teaching subjects that require learners to collaboratively explore ways to solve problems, think critically through identifying both their misconceptions and others', revise their understanding, and gain deeper knowledge.

One of the most popular ways of implementing OCL is an online asynchronous discussion conducted in a forum, usually by applying the community of inquiry (CoI) framework, which is also the most widely researched framework in online learning (Bates, 2022; Garrison et al., 2001; Maranna et al., 2022; Park & Shea, 2020; Valverde-Berrocoso et al., 2020). In the forum, the learners are usually instructed to discuss a particular topic by giving them a triggering question or case study consisting of a problem that fits for collaborative problem-solving. This kind of activity offers flexibility and the potential for enhancing learning (McCarron et al., 2021).

According to the CoI framework, the learners are expected to exhibit three presences that make up their learning experience during the discussion: social presence (e.g., expressing their authentic self when interacting with others), cognitive presence (e.g., thinking critically in problem-solving activities), and teaching presence (e.g., facilitating the activity) (Garrison, 2016). Furthermore, these four iterative stages define different levels of cognitive processes that make up the cognitive presence: *triggering event*—posing, identifying, and confirming problems; *exploration*—sharing resources and transactions of ideas; *integration*—synthesizing various ideas; and *resolution*—applying and defending solutions (Garrison, 2016). *Triggering event* and *exploration* are considered lower-level stages, while *integration* and *resolution* are considered higher-level stages because they require higher-order thinking (Chen et al., 2019).

Achieving higher-level inquiry stages is indeed not the goal for all instructions (Olesova et al., 2022). Such a goal depends on the intended purpose of the instruction (Garrison, 2016). For example, in the context of teaching a subject that requires learners to revise their understanding through inventing ways to solve problems, achieving higher-level inquiry stages is necessary because thinking critically about one's understanding as well as the others' is needed when doing such activities (e.g., synthesizing and defending arguments). Failing to promote higher-order thinking in an online discussion activity may be a detriment to students' learning (Koszalka et al., 2021). In addition, it is also important for such an inquiry to begin with understanding what the problem is at the very beginning of the discussion. Spending sufficient time to confirm what the problem is and how such a problem could be solved is necessary before moving into a deeper discussion regarding the proposed solutions (Garrison, 2016; Vaughan & Garrison, 2005).

Despite the popularity of online asynchronous forums as an OCL environment for conducting these activities, the forum itself does not necessarily foster effective and productive

discussion characterized by high occurrences of cognitive presence (Moore & Miller, 2022; Sadaf & Olesova, 2017). Prior studies reported that, in some cases, learners showed inactivity or less productive discussion in the form of “serial” or sequential monologues (Fung, 2004; Garrison & Cleveland-Innes, 2005; Pawan et al., 2003). Sequential monologues indicate that the learners are only responding to the triggering question posed by the teacher by posting their opinions without responding to the others; thus, collaboration does not happen and the learners do not gain deeper understanding (Garrison & Cleveland-Innes, 2005). Some studies also reported that learners tend to remain at lower-level inquiry stages, like exploration (Bradley et al., 2008; Rourke & Kanuka, 2009). A study also showed very few messages indicating higher-level inquiry stages compared to the former (Garrison et al., 2001). In addition, relatively few triggering event messages were exhibited by the learners in other studies, which may indicate that learners tend to “jump” to stating the solution without confirming what the problem is or showing fewer cues indicating their sense of puzzlement (McKlin et al., 2001; Vaughan & Garrison, 2005).

To address these issues, prior studies have proposed various strategies. It has been suggested that changing the instructional design and providing facilitation could change the pattern of cognitive presence in online discussion. For example, peer and instructor facilitation have been proposed in some prior studies to foster cognitive presence and achieve effective online discussion (An et al., 2009; Chen et al., 2019; Oyarzun & Martin, 2023). However, a study suggested that such facilitations are still inconclusive (Moore & Miller, 2022). Moreover, in the case of peer facilitation, learners who are novice discussion participants may not function effectively as facilitators (Weinberger et al., 2005). On the other hand, too much instructor presence may not necessarily lead to more interaction among students (An et al., 2009). Insignificant instructor presence, although it may lead to freer discussion, may not lead to effective problem-solving, e.g., most of the discussion content is free-talking and unrelated to the problem, with misconceptions being ignored. Additionally, intensive instructor facilitation may become impractical in large classes due to the overwhelming number of messages (Lee et al., 2022).

Another study proposed that providing training before the discussion to prepare the participants could enhance their readiness to engage in productive discussion with high cognitive presence (Junus et al., 2019). However, the mentioned study did not address the issue of whether such training could lead to a discussion with a higher rate of higher-level inquiry stages. Therefore, it is still inconclusive that training alone could significantly foster a higher rate of such occurrences.

Another alternative is providing activities that could increase engagement with the learning content that is related to the discussion topic (Saadatmand et al., 2017). It is also necessary to enable deep personal reflection, which is one of the factors that affect cognitive presence (Maranna et al., 2022). An example that could cater to this need is providing a preparatory activity prior to the discussion in which the learners are instructed to organize and deepen their understanding of the basic knowledge necessary for engaging in the discussion, which they previously received from attending lecture sessions, reading books, etc. Such activity could be done by making summaries or concept maps that represent the knowledge related to the discussion topic.

Concept mapping is an activity of organizing information that could enable learners to process complex problems, have a common vocabulary, and allow information to be easily transmitted by referring to a concept map (Colosimo & Fitzgibbons, 2012; Novak & Cañas, 2006). A concept map visually represents the information included in learning materials as a web of interconnected concepts, thus making underlying connections between concepts explicit for learners.

However, in the context of supporting a deep inquiry involving abstract concepts (e.g., discussion about mathematics), instructing learners only to read through the map is not sufficient for making them aware of underlying connections between several concepts. Learners are expected to be aware of the relationship between the concepts in such a situation. By only reading the map, the learners may skip important connections between concepts. Moreover, making a concept map from scratch risks the possibility of creating meaningless or false propositions due to difficulties in making the propositions (Nurmaya et al., 2023b).

A type of concept mapping that could help learners become aware of connections between concepts and has been adopted in the context of OCL is kit-build concept mapping (KBCM). KBCM is an activity of organizing knowledge in which the learners reconstruct a teacher-created concept map from given components (nodes and links) while receiving immediate feedback during the attempt (Yamasaki et al., 2010). Such nodes and links represent propositions included in the learning materials related to the discussion topic. When reconstructing the map, learners could achieve awareness of the connections between concepts by actively connecting the given component and reflecting their understanding. KBCM could help learners, including lower to middle achievers, to achieve such awareness due to being provided with components as a scaffold, i.e., the learners are not required to extract and express the structure of the domain knowledge by themselves. Thus, KBCM is a promising alternative for engaging learners with discussion-related materials as preparation before online discussion.

Reconstructing a teacher-created concept map (KBCM) could lead to a higher rate of cognitive presence-related messages compared to writing a structured summary (Hasani et al., 2023). Prior studies also presented evidence of a high number of problem-focused messages among learners who used KBCM in OCL (Nurmaya et al., 2023a; Pinandito et al., 2021). An increased awareness of common concepts and terms from recognizing the keywords and propositions in the concept map reconstruction activity is one factor that could potentially lead to a productive discussion with a higher rate of cognitive presence (Hasani et al., 2023).

A productive discussion does not necessarily mean deeper inquiry for solving problems, which is indicated by a high number of messages showing higher-level inquiry stages. Thus, there is a need for an alternative way to prepare the learners to engage in a meaningful and productive discussion and achieve higher-level inquiry stages. A meaningful and deep inquiry is characterized by a sustained transaction of ideas that enables learners to gain a deep understanding (Garrison, 2016). Higher occurrences of higher-level inquiry stages in the discussion (integration & resolution) as well as fostering problem confirmation at the beginning of the inquiry (triggering event) indicate such an inquiry. To address this issue, this study is aimed at comparing the effect of providing knowledge organizing activities in the form of

summary writing and KBCM on the occurrences of triggering event, exploration, integration, and resolution, which make up the cognitive presence within the discussion. Moreover, the pattern of each inquiry stage across the discussion period is analyzed. By comparing the discussion of the KBCM and summary writing groups, the following research questions (RQs) are addressed:

RQ1: To what extent did the number of messages categorized as triggering event, exploration, integration, and resolution differ among the groups?

RQ2: To what extent did the pattern of occurrences of triggering event, exploration, integration, and resolution across the discussion period differ among the groups?

This study aims to contribute to the improvement of CoI-based online discussion implementation. As a case study, an online discussion about linear algebra was conducted and involved both the learners who used KBCM as well as summary writing. RQ1 is addressed in this study to evaluate the extent of learners' engagement throughout inquiry stages in the discussion (i.e., higher-level thinking in online discussion). Whether both groups showed significantly different rates of messages for each inquiry stage is addressed in RQ1. Moreover, RQ2 is addressed to investigate the dynamics of how learners engage the problem in each inquiry stage across the discussion period. Whether both groups showed a pattern of occurrence for each inquiry stage across the discussion period that resembles a deep inquiry is addressed in RQ2.

## **Theoretical Framework**

### ***The Community of Inquiry (CoI) Framework and Practical Inquiry***

The CoI framework provides a theoretical basis for the elements of learning experience in an inquiry-based learning activity. Such a type of collaborative learning is based on the notion of “transaction of ideas” conducted in a text-based asynchronous online medium, in which learners co-construct knowledge through a sustained and meaningful discourse (Garrison, 2016). The framework was developed based on social constructivist theory (Garrison et al., 1999). In the context of OCL, the CoI framework defines three elements that make up the whole learning experience:

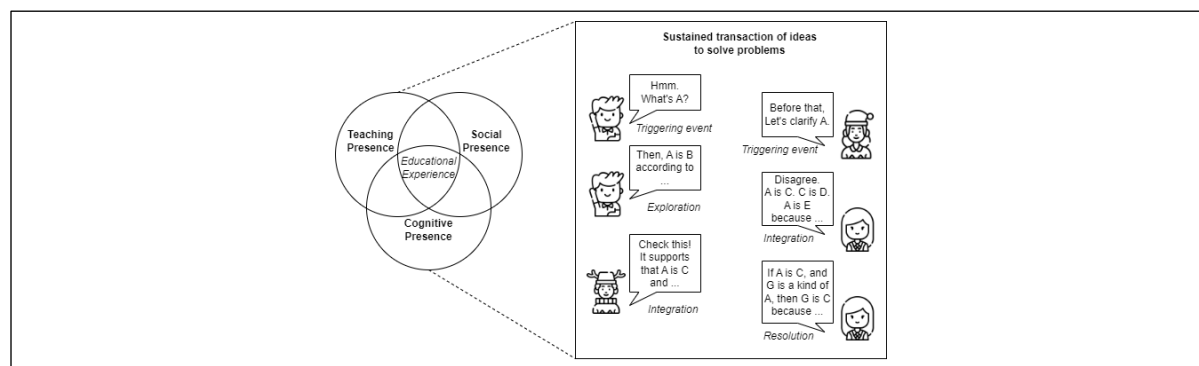
- (a) social presence—bringing authentic self into the online settings to develop interpersonal relationships and enable the transaction of ideas
- (b) cognitive presence—conducting problem-solving through critical thinking in a sustained and meaningful discourse
- (c) teaching presence—designing and facilitating the activity for achieving goals.

Figure 1 illustrates an OCL activity based on this framework

The inquiry activities that occurred in a CoI are further described in the practical inquiry model, which illustrates the operationalization of the cognitive presence (Garrison, 2016). At first, learners are expected to collaboratively address the triggering question by confirming their understanding of the problem as well as the expected solutions, i.e., triggering event. After agreeing on the nature of the problem and the expected solutions, the learners are expected to



discuss further by sharing relevant resources and agreeing or disagreeing on particular ideas, i.e., exploration. They could also elaborate on more than one idea, make logical inferences, and conclude discourse, i.e., integration. If they are able to conduct much higher-order thinking, they may apply solutions in various contexts and defend them, i.e., resolution.

**Figure 1***The CoI Framework*

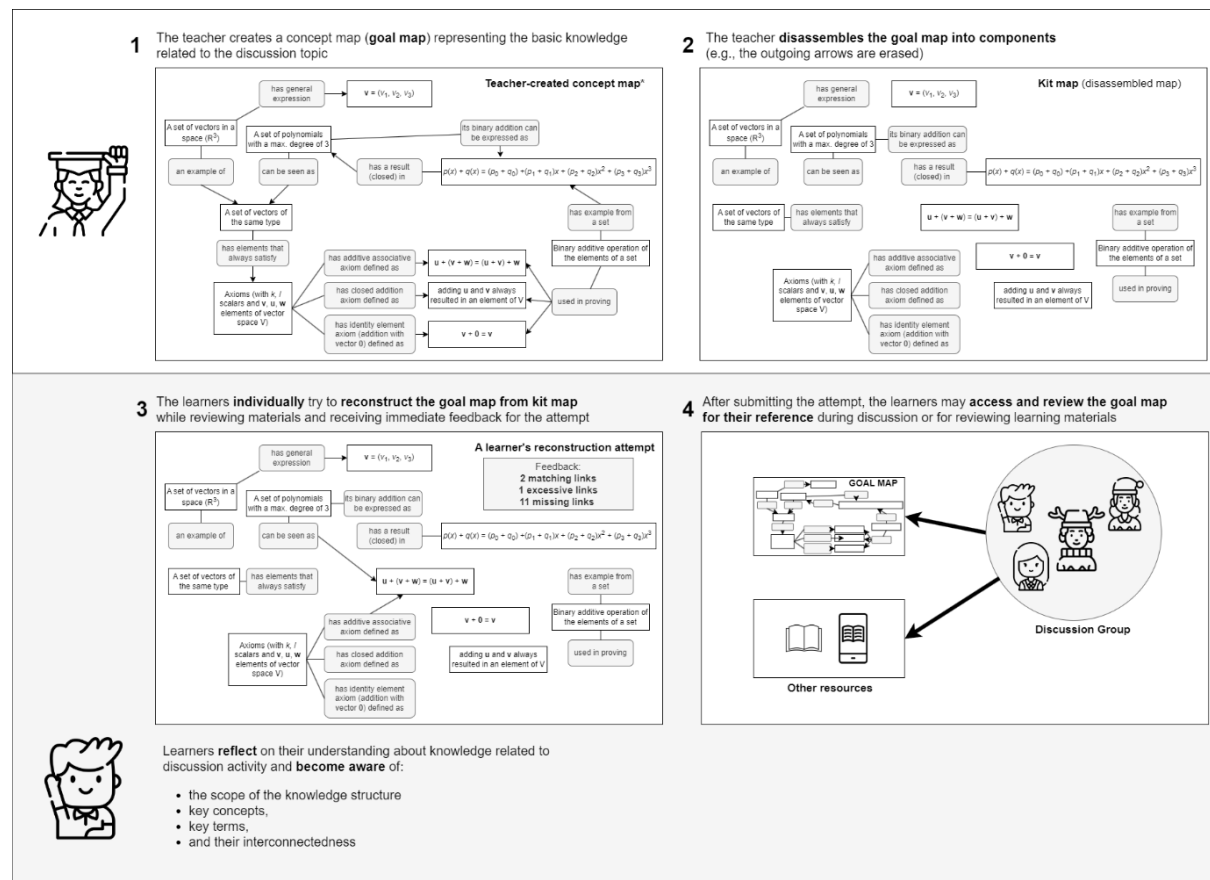
*Note.* Parts of the illustration were adapted from “About the Framework: An Introduction to the Community of Inquiry,” by Centre for Distance Education at Athabasca University, 2021 (<http://thecommunityofinquiry.org/coi>). CC BY-SA 4.0. This figure has been designed using images from Flaticon.com.

**KBCM**

Concept mapping is one of the knowledge-organizing activities that has gained popularity in various educational contexts. As a form of knowledge representation, a concept map visually represents knowledge contents (propositions) as links and nodes (Novak & Cañas, 2006). A type of concept mapping activity that has been proven to be effective for supporting learning in several contexts is KBCM. In KBCM, learners reconstruct a teacher-created concept map from given components (links and nodes) and receive immediate feedback for their attempts (Hirashima et al., 2011; Yamasaki et al., 2010). A KBCM activity usually includes the following steps: (a) a teacher prepares a goal map that represents the knowledge structure of a learning material; (b) the goal map is disassembled into a kit (parts consisting of links and nodes); (c) the learners try to reassemble the goal map from the kit and receive feedback in the process (Yamasaki et al., 2010). Such an activity enables learners to reflect on their understanding while reviewing learning materials. Figure 2 illustrates an excerpt of the teacher-created map (goal map), the disassembled goal map (kit map), and how they can be used to support an OCL activity such as online discussion.

Figure 2

### The Use of KBCM as a Preparatory Activity for Online Discussion



Note. This figure has been designed using images from Flaticon.com.

KBCM activities have been included to complement OCL in some prior studies and have shown the potential to support the inquiry process. In this context, the use of KBCM includes: (a) KBCM as a preparatory activity for online discussion based on the CoI framework (Hasani et al., 2023); and (b) KBCM for collaborative concept-mapping (Nurmaya et al., 2023a; Pinandito et al., 2021). A prior study by Hasani et al. (2023) presented evidence of the potential of KBCM compared to summary writing as a preparatory activity for online discussion. In the case of KBCM, an increased awareness of key terms and concepts related to discussion, as well as their interconnectedness, is shown to be a potential enabler of a productive discussion. In contrast, the learners who used summary writing might have experienced difficulties recognizing the common terms despite being given feedback after the attempt because they could freely use any terms they wanted when writing the summary. Recognizing common terms and using them during the discussion might help learners discuss more productively; thus, it may result in a higher rate of messages containing cognitive presence.

## Methods

This study consists of a follow-up analysis of the data gathered in a related prior study by Hasani et al. (2023), which implemented a quasi-experimental approach involving an experiment conducted in real-classroom settings. The following subsections describe the learning context, the procedures, and the data analysis method used in this study.

### *Learning Context*

The experiment involved 61 students from two linear algebra classes (Class A and Class B) offered by computer science and information systems programs at a public university. Class A and Class B were assigned as the experimental group (KBCM group) and the control group (summary writing group), respectively. Both classes had a different number of enrolled students due to the university's policy of allowing students to choose any available classes based on their convenience. This affected the difference in the sample size between the experimental group and the control group (Class A: 48 students; Class B: 13 students). The participants' informed consent was obtained prior to the experiment.

In addition, ethical clearance and approval from the teaching team were obtained. Table 1 shows the demographics of the participants.

**Table 1**

### *Demographics of the Participants*

|               | Class A (KBCM; $n = 48$ ) | Class B (summary writing; $n = 13$ ) |
|---------------|---------------------------|--------------------------------------|
| <b>Gender</b> |                           |                                      |
| Male          | 39                        | 8                                    |
| Female        | 9                         | 5                                    |
| <b>Batch</b>  |                           |                                      |
| 2019          | 0                         | 1                                    |
| 2020          | 0                         | 1                                    |
| 2021          | 0                         | 1                                    |
| 2022          | 48                        | 10                                   |

Two different lecturers who had more than four years of experience in teaching linear algebra and had prior experience in delivering online collaborative learning based on the CoI framework taught the two classes. In this experiment, they closely worked together in designing and delivering the class to ensure that both classes received the same learning materials, teaching styles, workload, and learning environment. An online forum provided by Moodle (<https://moodle.org>) was used as the online collaborative environment in both classes.

The learning topic that was addressed during the experiment was general vector space. The learning goals for this topic were as follows: The students are able to provide a valid mathematical proof for whether a given mathematical object could be seen as a vector. To be able to attain this goal, the students are expected to

- (a) understand the principles of arithmetics related to vectors in Euclidean spaces ( $\mathbb{R}^2$  and  $\mathbb{R}^3$ )
- (b) be able to use binary set operations for defining arithmetic operations involving vectors
- (c) be able to generalize such principles to vectors in  $n$ -space ( $\mathbb{R}^n$ )
- (d) be able to recognize whether a set of mathematical objects has a similar algebraic structure to the aforementioned set of vectors
- (e) be able to provide a valid mathematical proof using binary set operations to show whether a given set of mathematical objects has such a structure by referring to the 10 axioms of vector space

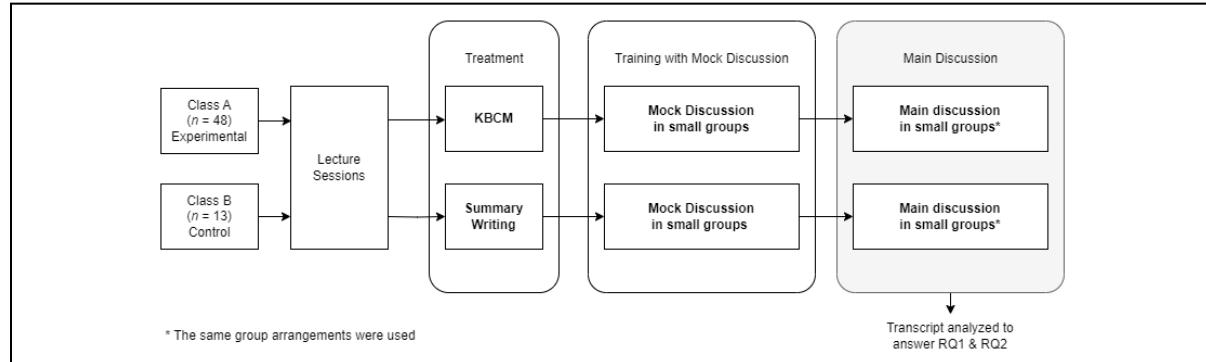
Points (a) and (b) describe the basic knowledge necessary to perform points (c) through (e), which are the expected acquired knowledge after participating in the discussion. The following subsection describes the discussion and other related activities.

### Procedures

The following Figure 3 illustrates the steps taken in this study, as specified in Hasani et al. (2023). At first, both the KBCM group and the summary writing group were provided with identical but separate lecture sessions that introduced them to the basic knowledge about vectors and binary set operations, which will be used in the discussion.

**Figure 3**

#### Steps Undertaken in This Study



After attending the lecture session, both groups received the treatment as illustrated in Figure 3. A pretest measuring both the basic knowledge and the expected acquired knowledge was administered to both groups. The test consists of 20 multiple-choice questions covering points (a) through (e). This test served as the baseline to measure whether both groups started at the same level of understanding about the necessary knowledge related to the discussion topic.

After completing the pretest, the students of both groups participated in a CoI training provided in the form of orientation with mock discussion to familiarize them with the know-how of interacting effectively in a CoI-based discussion. The topic of the mock discussion is proving whether a given vector in  $\mathbb{R}^n$  could also be seen as a vector in a similar way with those in the Euclidean spaces, e.g., a case involving a constant  $k$  and an entity expressed as  $(1, 5, 12, \frac{x}{27})$  with  $k, x \in \mathbb{R}$ .

During the training, the students in both groups were further divided into smaller discussion groups (six or seven students per group) and were given a triggering question as well as guidance. After completing the training, both groups were administered the first post-test to measure their basic knowledge improvement. Furthermore, both groups participated in the main discussion with the same discussion group arrangement and general instructions (e.g., on using the resources, on how to interact, etc.). The triggering questions given were different from the ones given in the training, e.g., a case involving a constant  $k$  and a  $m \times n$  matrix, a polynomial with  $n$ -degrees, or any objects with vector-like algebraic structure. At the end of the activity, both groups received a second post-test measuring the expected acquired knowledge. The detailed results of the pretest and the post-tests could be accessed in Hasani et al. (2023). The analysis conducted in this study focused on the discussion transcript retrieved from the main discussion. The data used for further analysis are the data that were retrieved from students who completed all activities. The data analysis method is described in the following subsection.

### **Data Analysis**

The discussion transcripts from the main discussion were coded using a coding scheme developed by Junus (2023) for use in a linear algebra online learning context, which is based on a coding scheme by Shea et al. (2010). The codes consist of the stages included in the practical inquiry model: triggering event, exploration, integration, and resolution.

To establish the reliability of the coding result, procedures suggested by Campbell et al. (2013) were conducted. At first, the first coder coded all messages included in the transcripts. Then, the second coder independently coded a randomized sample of messages (30% of all messages), whose labels were omitted. The reliability of the coding results based on the sampled segments of the transcript was measured. The measurement of Brennan and Prediger's Kappa statistic showed a value of 0.82, which indicated almost perfect agreement according to a benchmark by Landis and Koch (1977). After that, the two coders discussed and achieved agreement regarding the differences, which in turn produced an agreed-upon coding scheme (criteria for labeling messages). Finally, the agreed-upon coding scheme is applied to all messages in the transcripts.

The resulting coding results were used for further analysis involving statistical tests of significance on the average number of messages per participant for each practical inquiry process (answering RQ1). Furthermore, the pattern in the occurrence of the messages across the discussion period is presented to contrast the occurrences of differently-coded messages (answering RQ2). The results are discussed in the following section.

## **Results**

As reported in Hasani et al. (2023), both KBCM and summary writing groups started from the same level of understanding about both the basic knowledge and the acquired knowledge. Insignificant differences were observed in the average pretest score of both groups. However, both groups showed different discussion patterns. There are 237 and 19 messages retrieved from the KBCM group and summary writing group, respectively.

***Occurrences of Triggering Event, Exploration, Integration, and Resolution***

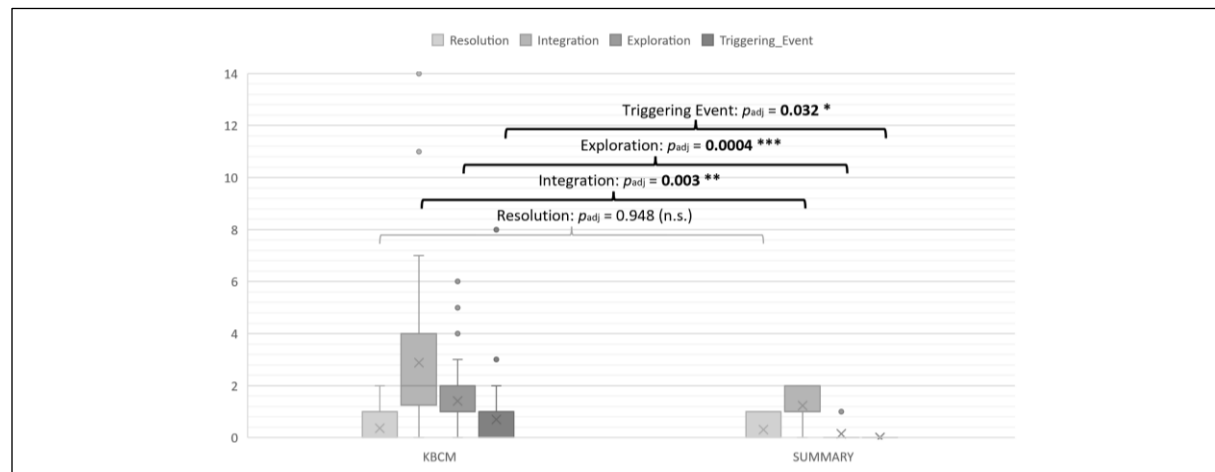
The retrieved messages were coded as triggering event, exploration, integration, and resolution. A message may indicate more than one practical inquiry stage. The following Table 2 shows the descriptive statistics of the messages classified as triggering event, exploration, integration, and resolution in both the KBCM group and the summary writing group.

**Table 2***Descriptive Statistics of Triggering Event, Exploration, Integration, and Resolution Messages*

|                | Triggering Event |       | Exploration |       | Integration |       | Resolution |       |
|----------------|------------------|-------|-------------|-------|-------------|-------|------------|-------|
|                | KBCM             | SW    | KBCM        | SW    | KBCM        | SW    | KBCM       | SW    |
| Total messages | 34               | 0     | 68          | 2     | 138         | 16    | 17         | 4     |
| Average        | 0.708            | 0.000 | 1.417       | 0.154 | 2.875       | 1.231 | 0.354      | 0.307 |
| Median         | 0                | 0     | 1           | 0     | 2           | 1     | 0          | 0     |
| Max.           | 8                | 0     | 6           | 1     | 14          | 2     | 2          | 1     |
| Min.           | 0                | 0     | 0           | 0     | 0           | 0     | 0          | 0     |

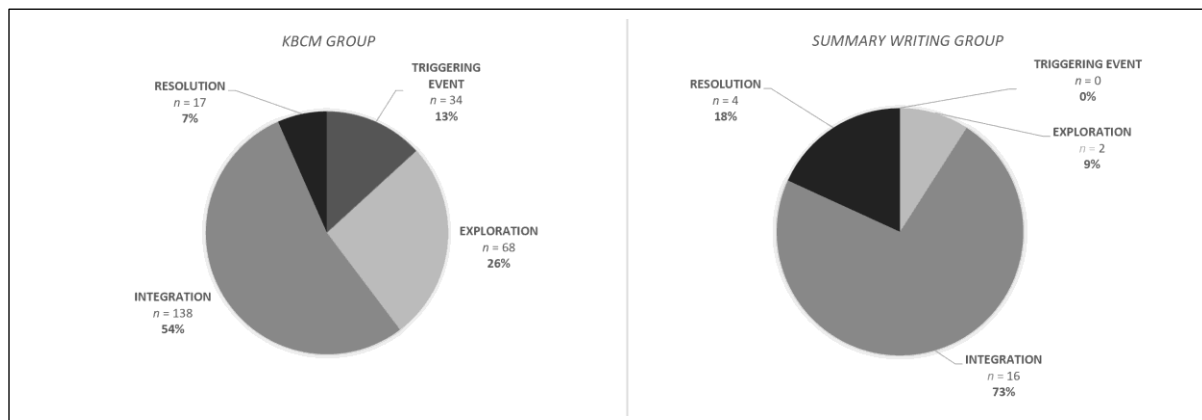
Note. KBCM group ( $n = 48$ ); SW: Summary writing group ( $n = 13$ ).

The median number of messages classified as triggering event, exploration, and integration is compared using a statistical non-parametric test (Mann-Whitney test). For the comparison, the  $p$ -values were adjusted using Holm's method. The results are shown in Figure 4.

**Figure 4***Number of Messages Classified with Practical Inquiry Processes per Participant*

As shown in Figure 4, the test results after  $p$ -value adjustment show that KBCM group exhibited significantly higher amount of messages per person classified as triggering event, exploration, and integration compared to summary writing group ( $p_{adj} < 0.05$ ). However, there is no significant difference in the number of resolution-classified messages in both groups. The KBCM group also showed different proportions of messages classified with each practical inquiry processes (see Figure 5).



**Figure 5***Proportions of Practical Inquiry Stages*

Note. *n* indicates the number of messages.

***Patterns of Overall Occurrence of Inquiry Stages Across Discussion Period***

One important sign of effective inquiry is the high number of triggering event-related activities at the beginning of the discussion (Garrison, 2016). Such activities enable learners to spend sufficient time at the beginning of the discussion reflecting on their understanding of what the problem is and how to solve it before moving into a more rigorous transaction of ideas in the exploration and integration stages. Based on the coding results, the KBCM group and the summary writing group showed different patterns regarding the daily occurrences of each practical inquiry stage (see Table 3).

**Table 3***Daily Occurrence of Triggering Event, Exploration, Integration, and Resolution*

|       | Triggering Event |   | Exploration |   | Integration |    | Resolution |   |
|-------|------------------|---|-------------|---|-------------|----|------------|---|
|       | KBCM             | S | KBCM        | S | KBCM        | S  | KBCM       | S |
| Day 1 | 1                | 0 | 2           | 2 | 1           | 10 | 0          | 1 |
| Day 2 | 15               | 0 | 41          | 0 | 24          | 1  | 0          | 0 |
| Day 3 | 3                | 0 | 5           | 0 | 8           | 0  | 1          | 0 |
| Day 4 | 0                | 0 | 0           | 0 | 0           | 0  | 0          | 0 |
| Day 5 | 0                | 0 | 0           | 0 | 0           | 1  | 0          | 1 |
| Day 6 | 0                | 0 | 1           | 0 | 0           | 0  | 0          | 0 |
| Day 7 | 15               | 0 | 18          | 0 | 73          | 1  | 5          | 0 |
| Day 8 | 0                | 0 | 1           | 0 | 24          | 3  | 6          | 2 |
| Day 9 | 0                | 0 | 0           | 0 | 8           | 0  | 5          | 0 |

Inactivity in the discussion threads of both groups was observed on the fourth and fifth days. During this period, participation attrition might have happened due to learners being distracted to complete assignments from other courses. During the last three days of the

discussion period, both groups received a reminder from the instructors to complete the discussion by the ninth day, thus increasing the number of messages.

## Discussion

***RQ1: To what extent did the number of messages categorized as triggering event, exploration, integration, and resolution differ among the groups?***

To answer RQ1, the KBCM group had a higher rate of messages for triggering event, exploration, and integration (see Figure 4). This finding suggests that, under certain conditions, KBCM as a preparatory activity has the potential to foster all lower-level inquiry stages and the higher-level inquiry stage of integration. In addition, the data revealed that (a) the majority of the messages in both the KBCM group and the summary writing group are classified as integration; and (b) there was a lack of triggering event messages in the summary writing group.

Finding (a) stood in contrast with some other studies that reported exploration as the dominant stage (McKlin et al., 2001; Vaughan & Garrison, 2005). This variation in achievement may be caused by several factors, such as the complexity of the problem, learners' inquiry preparedness, as well as the intensity of teaching presence and social presence as enabling aspects of the progression throughout the inquiry stages (Garrison, 2016). In this study, learners in both groups put more focus on integrating ideas to answer the triggering event, albeit with a different pattern and productivity. Furthermore, the finding suggests that the KBCM group significantly showed more productive integration compared to the summary writing group.

Finding (b) indicates that the learners in the summary writing group did not spend time to understand what the given problem is and what the expected solutions are. There was a tendency to jump to a final conclusion regarding the given problem without even reflecting and confirming first what the question was about. This phenomenon is detrimental to the knowledge-building in the CoI because it risks unresolved misconceptions during the discussion if they do not show considerable effort in debating the proposed solutions later during the discussion. Some prior studies also reported a relatively low frequency of triggering event messages in online discussions (McKlin et al., 2001; Vaughan & Garrison, 2005).

In contrast to the summary writing group, the KBCM group showed some triggering event messages. This is an indication that they spent some time trying to understand the triggering question, confirm it, and show their sense of puzzlement. This may indicate an effective inquiry process, which always begins with questioning a problem, confirming what the problem is about, and how to solve it (see discussion on RQ2).

The significantly higher rate of triggering event, exploration, and integration messages per participant in the KBCM group indicated the potential of KBCM as a preparatory activity to enable more productive discussion in the mentioned practical inquiry stages better than summary writing. However, both the KBCM group and the summary writing group showed the same number of occurrences of resolution-related messages per participant. Thus, both are identically

effective in fostering resolution to some degree. There is an indication that fostering more resolution requires more than providing content-engaging preparatory activity. As suggested in some works of literature, resolution requires higher-order thinking and creative thinking because the learners are expected to be able to apply solutions in different contexts and defend them (Garrison, 2016; Garrison et al., 2001). Some prior studies also showed that resolution was less exhibited during the inquiry (Garrison et al., 2001; McKlin et al., 2001; Pawan et al., 2003; Vaughan & Garrison, 2005).

***RQ2: To what extent did the pattern of occurrences of triggering event, exploration, integration, and resolution across the discussion period differ among the groups?***

To answer RQ2, both groups showed a different pattern of occurrences of the inquiry stages (see Table 3). The KBCM group showed more lower-level inquiry stages during the early phase of discussion (the first three days of the discussion period) and more higher-level inquiry stages during the latter phase (the last three days of the discussion period). In contrast, the summary writing group tended to jump into higher-level inquiry stages from the beginning of the discussion, especially integration, which indicates that the learners tended to present final answers and skipped clarifying the triggering question (see [b] in the previous subsection).

During the collaboration, it is necessary for the learners to focus on understanding what the problem is at the beginning of the inquiry before integrating ideas (Garrison, 2016; Vaughan & Garrison, 2005). This pattern resembles Dewey's reflective thinking, which served as the basis of the CoI framework. In reflective thinking, learners start by recognizing the problems, analyzing the problems, and finally proposing solutions (Meyer, 2019). Additionally, the sequential processes of gathering information and reaching a consensus were also suggested as the foundation of a successful problem-solving collaboration (Bridges, 1979). As shown in Table 3, the pattern that resembles reflective thinking appeared in the KBCM group, in which the learners showed a tendency to clarify the problem first (triggering event and exploration), then proceed to the analysis, and finally reach consensus (integration and resolution). Nevertheless, further analysis of the transition between the inquiry stages may be needed to uncover what kind of transitions (e.g., from integration to resolution, etc.) happened during the activity.

***The Potential Influence of KBCM and Summary Writing on Learners' Discussion***

Some characteristics of both KBCM and summary writing could contribute to the mentioned findings. In the case of KBCM, the learners have the opportunity to review learning materials aided by keywords presented as links and nodes, recognize key concepts, and reflect on their understanding when receiving immediate feedback during concept map reconstruction.

As suggested in a related prior work, such an activity could increase learners' awareness of common terms and concepts that were used throughout the discussion (Hasani et al., 2023). Due to the nature of the concept map as a pedagogical tool that represents knowledge structure as a web of interconnected concepts, it is possible to provide the commonly used terms or vocabulary to the learners (Colosimo & Fitzgibbons, 2012; Novak & Cañas, 2006). Examining a completed concept map could also prompt dialogue and debate (Baroody & Bartels, 2000). Thus, it could potentially lead to a productive discussion because using the same terms when referring to a specific object gives learners opportunities to discuss more deeply about such an object,

including whether there is a difference in how the object is perceived. For example, if a difference happened, it might have triggered further inquiries.

In this study, this characteristic may have contributed to the higher amount of triggering event, exploration, and integration that was observed in the KBCM group. Moreover, this may also indicate sustained transactions of ideas. An example of this phenomenon is shown in Figure 6. A translated excerpt (originally written in Bahasa Indonesia) of a related conversation from a KBCM group and a summary writing group shows a part of a discussion on the given trigger question (TQ)—whether a  $3 \times 3$  matrix could be seen as a vector (see Figure 6). The key concepts discussed in this excerpt include vectors, matrices, rows, columns, and the characteristics of a vector.

### **Figure 6**

*An Excerpt From the First Two Days of Discussion Period*

| KBCM Group                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Summary Writing Group                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Student A</b> Reply to: Triggering Question</p> <p>"... let me explain my response... 🙄 🙄 In my opinion, vector A (3 x 3) could be seen as a <u>vector</u> in the form of row vectors and column vectors..."</p> <p>March 13, 6:06 PM ID:KB1</p>                                                                                                                                                                                                                                                                                                                         | <p><b>Student 1</b> Reply to: Triggering Question</p> $A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$ <p>from that <u>matrix</u>, we can change it into a <u>vector with components</u> as follows:<br/> <math>v = (1, 2, 3, 4, 5, 6, 7, 8, 9)</math><br/>         For proving it we can use <u>10 axioms</u>.<br/> <math>a + b = ((1 + b_1), (2 + b_2), (3 + b_3), (4 + b_4), (5 + b_5), (6 + b_6), (7 + b_7), (8 + b_8), (9 + b_9))</math> With element <math>a + b \in R</math>. It is proven..."</p> <p>March 13, 11:19 AM ID:S1</p>                                |
| <p><b>Student B</b> Reply to: KB1</p> <p>"...Maybe if we want to discuss whether it is a <u>vector</u> or not, it's better to define what a <u>vector</u> is. Maybe the title of the forum, GVS (general vector space), gives us a clue? From my understanding, GVS is a kind of set of vectors that satisfy certain <u>characteristics</u>, such as closed (addition/scalar multiplication). Just like what was discussed in the class and also during concept mapping, there are some <u>characteristics</u>, such as identity elements"</p> <p>March 13, 8:51 PM ID:KB2</p> | <p><b>Student 2</b> Reply to: Triggering Question</p> <p><u>Vector addition</u> has an associative <u>characteristic</u>.</p> $a + (b + c) = (a + b) + c$ $a + (b + c) = ((1, b_1 + c_1), (2, b_2 + c_2), (3, b_3 + c_3), (4, b_4 + c_4), (5, b_5 + c_5), (6, b_6 + c_6), (7, b_7 + c_7), (8, b_8 + c_8), (9, b_9 + c_9))$ $a + (b + c) = ((1, b_1 + c_1), (2, b_2 + c_2), (3, b_3 + c_3), (4, b_4 + c_4), (5, b_5 + c_5), (6, b_6 + c_6), (7, b_7 + c_7), (8, b_8 + c_8), (9, b_9 + c_9))$ <p>Thereby, <math>a + (b + c) = (a + b) + c</math> is proven..."</p> <p>March 13, 2:10 PM ID:S2</p> |
| <p><b>Student B</b> Reply to: Triggering Question</p> <p>"...Before we make a conclusion, it's better to clarify what a <u>matrix</u> is and how to define it. Then what is a vector? After that, we can identify the <u>connections</u>..."</p> <p>March 14, 10:39 AM ID:KB3</p>                                                                                                                                                                                                                                                                                              | <p><b>Student 3</b> Reply to: Triggering Question</p> <p>"I will try to prove the ninth <u>axiom</u> and the tenth <u>axiom</u></p> <p>9.<br/> <math>1u = u</math><br/> <math>1v = v</math><br/> <math>1(1, 2, 3, 4, 5, 6, 7, 8, 9) = (1, 2, 3, 4, 5, 6, 7, 8, 9)</math><br/>         ...."</p> <p>March 14, 1:26 PM ID:S3</p>                                                                                                                                                                                                                                                                  |
| <p><b>Student C</b> Reply to: Triggering Question</p> <p>"...A <u>matrix</u> is an arrangement of numbers in rows and columns, while a vector is a <u>matrix</u> with only one row or column..."</p> <p>March 14, 10:47 AM ID:KB4</p>                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><b>Student B</b> Reply to: Triggering Question</p> <p>"...Vector is a special form of <u>matrix</u> with only one row or column..."</p> <p>March 14, 10:48 AM ID:KB5</p>                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><b>Student D</b> Reply to: Triggering Question</p> <p>"...The <u>relationship between vectors and matrices</u> is that a matrix is a <u>collection of vectors</u>."</p> <p>March 14, 11:08 AM ID:KB6</p>                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><b>Student B</b> Reply to: KB4</p> <p>"... (this view) may invites a question: Is a <u>matrix</u> a set of row or column vectors?"</p> <p>March 14, 11:17 AM ID:KB7</p>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <p><b>Student B</b> Reply to: KB6</p> <p>"... I agree..., but is it possible that a <u>matrix</u> has a structure consisting of only one row or column?... I think it is important to define <u>vectors</u> and matrices in a deeper way to prevent this kind of confusion... How should we define a vector?..."</p> <p>March 14, 11:24 AM ID:KB8</p>                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

*Note.* This excerpt only shows a part of the discussion from the first two days of the discussion period. Some emphasis in the form of underlined words to show key concepts is added by the authors. The mathematical notations are presented as originally posted.

An excerpt from a KBCM group shows an example of how a group of learners who were aware of the aforementioned key concepts and the existence of relationships between them (e.g., vectors and matrices) tried to reach agreement regarding how to respond to the TQ—i.e., whether a 3 x 3 matrix is a vector—as well as agree on how a vector and a matrix could be defined, including their relationship. In the process, they were responding to each other's ideas and sharing relevant resources (including the goal map), thus increasing the occurrence of exploration and integration. In addition, the behavior of trying to understand relationships between concepts (see messages from Students A, B, C, and D in Figure 6) could also be

encouraged by the use of KBCM prior to the discussion as well as reviewing the goal map during the discussion.

Regarding the possible role of KBCM in influencing the discussion, a study suggested that a well-designed concept map is an effective external representation of knowledge structure that could encourage certain cognitive behaviors more than a mere memory aid (Zhang, 1997). Thus, a concept map is worth sharing during the discussion, especially during the exploration stage. In addition, KBCM provided an advantage in the form of immediate feedback that enabled deeper reflection as well as greater awareness of the existence of relationships between key terms and concepts used in the discussion. This might have contributed to a productive inquiry, e.g., confirming understanding about such relationships when exploring possible solutions (for example, see Student B's messages in Figure 6).

As a result of this productive inquiry, the learners could have more opportunity to reflect on their understanding as well as the others' (e.g., by revisiting posts and the concept map), thus learning more deeply about the topic. Such a personal reflection is an activity that affects cognitive presence and critical thinking (Koehler et al., 2020; Maranna et al., 2022); thus, it may explain the finding of a higher number of cognitive presence messages in the KBCM group, especially the rate of messages indicating integration. In addition, they may also detect their own misconceptions in the process, which is one of the requirements of the context of learning in this case—revising misconceptions about vectors.

In the case of the summary writing group, writing a summary was shown to have less effectiveness for increasing discussion productivity due to some possible factors. Firstly, learners might have written summaries with different content and scope, even though they were provided with the same learning materials and guided with subtopics; thus, they may have difficulties recognizing relationships between key concepts. Secondly, without receiving immediate feedback when writing a propositional sentence, they may have used different words for describing key concepts (e.g., vectors and matrices) and retained misconceptions throughout the whole activity, even though they were provided with the teacher-created summary as the feedback that is accessible during the discussion. These factors might have caused them to be less aware of the key concepts and encouraged a “jumping to solutions” kind of discussion in the summary writing group. An example of this case is shown in the excerpt from a summary writing group—note that the responses tend to directly answer the TQ or add to prior messages to directly present the solution. This phenomenon showed some similarity to the one reported in prior works on asynchronous discussion that showed some learners' tendency to scratch only the surface of the problems and do the bare minimums, e.g., respond only for the sake of being there, in order to satisfy the course's requirements (Hara et al., 2000; Koehler et al., 2020).

In this case, the students tend to present the final answer to the proof even at the beginning of the discussion, albeit in an invalid way. Two errors remained unresolved in the discussion, which include insufficient proof by example (see messages from Students 1, 2 and 3 in Figure 6) and a howler for transforming elements of a  $3 \times 3$  matrix into a 9-dimensional vector (see Student 1's message in Figure 6). This phenomenon may indicate the tendency of novice learners of mathematics to rely on mere memorization of formulas or principles without trying to

understand the connection between the concepts that have been taught and the problems they encounter (Hafiz et al., 2017).

These cases are examples of how the difference in the form of preparatory activity and knowledge representation used as the reference for the discussion could lead to a different pattern of discussion. Nevertheless, these cases cannot be generalized yet and require further investigation due to the possibility of influences from other factors existing in real-classroom settings, such as motivations, attitudes towards OCL, etc.

### ***Practical Implications and Recommendations***

In the case of achieving deeper learning as the learning goal in online collaborative learning, learners are expected to create knowledge and reflect on their understanding through performing collaborative tasks (e.g., asynchronous online discussion) and achieve higher-level inquiry stages for effective learning (Koszalka et al., 2021; Villanueva et al., 2022). In the general context of improving online collaborative learning delivery, the following measures may help learners succeed in achieving the mentioned expectations:

- (a) providing an activity of organizing information as a complementary activity during the pre-discussion training to prepare the learners to productively contribute to the discourse
- (b) KBCM or similar activities may be provided
- (c) a teacher-created concept map may be provided throughout the discussion as a reference for the learners to discuss

Providing an online asynchronous forum as a mere learning environment does not necessarily lead to a productive discussion with high-level inquiry (Moore & Miller, 2022; Sadaf & Olesova, 2017). Moreover, a productive discussion does not necessarily include higher-level critical thinking because of the possibility for the learners to show surface-level thinking and exhibit a bare minimum, such as echoing responses in the discussion, as reported in some studies (Essa et al., 2023; Hara et al., 2000; Hsiao et al., 2013; Koehler et al., 2020). As a result, some strategies are needed, such as providing facilitation (An et al., 2009; Chen et al., 2019) and providing learning analytics to monitor discussion (Alwafi, 2022)—each of which comes with some advantages and limitations. Alternatively, a content-engaging preparatory activity may be provided as a complement to the existing strategies to prepare the learners before the discussion. As suggested by Saadatmand et al. (2017), providing a content-engaging activity may foster learners' cognitive presence and critical thinking through personal reflection (Maranna et al., 2022). This study provides evidence of the potential of KBCM as a better alternative to summary writing for preparing learners to achieve higher-level inquiry in an asynchronous discussion based on the CoI framework.

In particular, this study also contributed to addressing the question of how to improve the collaborative learning of mathematics in a higher-education context. In such a context, critical thinking in the sense of evaluating personal understanding as well as others' ability to make informed decisions is one of the important aspects that is expected to be acquired by learners (Ernest, 2010; Sachdeva & Eggen, 2021). Achieving higher-level thinking through performing the higher-level inquiry stages (integration and resolution) is necessary to move from surface learning to deeper learning about the concepts in a mathematics subject. Doing the bare minimum or addressing only the surface of the problems, as reported in some OCL

implementations in the past (Hara et al., 2000; Koehler et al., 2020), is insufficient for gaining a correct and complete understanding of a topic in a mathematics subject, e.g., linear algebra. The results suggested that KBCM followed by a CoI-based online asynchronous discussion has the potential to be an alternative for helping learners achieve the expected higher-level thinking about a topic in mathematics.

Several issues could be explored further, such as finding effective ways for encouraging learners to achieve resolution; comparing KBCM with other forms of OCL preparatory activities; and applying the proposed activity in different educational contexts. Regarding achieving resolution, it remains a challenging part due to the complexity of preparing the learners to conduct higher-order thinking during the discussion as well as creative thinking to enable “out of the box” ideas to appear when trying to apply the proposed solution in other contexts.

## Conclusion

In some learning contexts, ensuring the achievement of higher-level inquiry stages is difficult using facilitation and preparatory activities involving discussion training and reviews of learning materials through writing a summary. Concept mapping is a promising way to help learners become aware of important concepts and terms related to the discussion and could be used in a preparatory activity before a discussion. However, using traditional scratch concept mapping may be unfit for all types of learners (e.g., low achievers), as they may have difficulties in making correct propositions. Kit-build concept mapping (KBCM) could be a solution that is fit for all types of learners due to providing components to be used for reconstructing a teacher-created map, which could help all types of learners become aware of the concepts. This study presents evidence regarding the potential of using KBCM as a better preparatory activity to support cognitive presence in an online discussion up to the integration stage, compared to summary writing.

RQ1: To what extent did the number of messages categorized as triggering event, exploration, integration, and resolution differ among the groups? The results show that learners in the KBCM group exhibited a significantly higher rate of message occurrences for triggering event, exploration, and integration compared to the summary writing group.

RQ2: To what extent did the pattern of occurrences of triggering event, exploration, integration, and resolution across the discussion period differ among the groups? The KBCM group tended to focus on triggering event and exploration at the beginning, followed by integration and resolution at the end, while the summary writing group tended to focus only on integration throughout the discussion.

In addition, there is evidence that indicates opportunities for more transactions of ideas necessary for deeper learning and revising misconceptions. Some possible influential factors resulting from KBCM activity include increased awareness of key concepts, terms, and the relationship between concepts included in the basic knowledge related to the discussion topic, which may be harder to achieve by writing a summary. Nevertheless, such an effect needs to be confirmed in future studies due to the limitations of implementing the treatments in linear algebra classes as a case study. Thus, the results cannot be generalized yet. This study



contributes to the state-of-the-art of OCL by providing an alternative preparatory method for fostering higher-level inquiry stages in online discussion. Future studies need to investigate whether such treatments are effective for different topics or subjects. Additionally, future studies involving a larger number of participants and a better controlled sample are needed to investigate whether the results could be replicated.

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### **Declarations**

This study has received ethical clearance and has been approved by the teaching team of the involved classes. Due to the fact that the institutional board had not yet been formed when this study was being conducted, the university has provided a formal assertion that the authors of this study had obtained participants' informed consent prior to the experiment (Reference Letter No. S- 3 /UN2.F11.D1.5/PPM.00.00/2024). The authors declare no conflict of interest in this study.

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# The Effectiveness of the Good Behavior Game on Students' Academic Engagement in Online-Based Learning

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## Abstract

Online learning has become a popular form of education, particularly accelerated by the COVID-19 pandemic, providing flexibility but posing challenges like reduced collaboration, limited student-faculty interactions, and decreased engagement. Therefore, there is a pressing need to implement effective instructional modalities, designs, and strategies to enhance online engagement. This study investigated the effectiveness of the Good Behavior Game (GBG), rooted in applied behavioral analysis, in promoting academically relevant behavior among nursing students engaged in online learning. Using a quasi-experimental pre-test, post-test design, 95 nursing students from a public university in Jordan were divided into groups exposed to different GBG conditions. Data on participation were collected over 11 weeks, and statistical analyses revealed a significant positive impact of the GBG on student engagement. When the GBG initially targeted the quantity of participation, there was a significant improvement in students' participation quality, but not the quantity. On the contrary, when only the quality was targeted, the improvement was significant in the participation quality but not quantity. Combining quality and quantity contingencies in one condition produced the most significant improvement, suggesting the GBG's adaptability and potential as a comprehensive engagement strategy in online learning. The study result suggests that many drawbacks associated with online learning can be addressed through designing effective educational strategy. This research highlights the GBG's potential for enhancing online education, addressing its limitations by fostering students engagement. Further exploration of its applicability in diverse educational settings is recommended, solidifying its place as an effective strategy in the evolving education landscape.

**Keywords:** Good Behavior Game, academic engagement, nursing students, online learning, COVID-19

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Online teaching is gaining ground in higher education. In 2018 in the United States of America, the National Center for Education Statistics reported that more than half of the students reported enrollment in online learning, with around 73% from private institutions and 34.1% from public institutions as cited by Aldhafeeri & Alotaibi (2022). Since the COVID-19 pandemic, online education has taken unprecedented status in higher education institutions adopting online learning and forced almost all higher educational institutions in developed and developing countries to adopt online learning, including Jordan (Al-Okaily et al., 2024; Salas-Pilco et al., 2022). All higher education institutions adopted online learning to meet the pandemic, regardless of their teaching-learning philosophy (Natarajan & Joseph, 2022). Thus, online learning becomes essential to any educational institution's educational system. This trend continued after the pandemic's end as the institution saw it as a means to deal with similar potential crises. However, one major issue associated with the most commonly used online instructional modalities and designs is student engagement due to poorly designed online courses (Natarajan & Joseph, 2022). Student engagement has been essential in promoting students' performance and satisfaction (Graham et al., 2023). Thus, the research, up to this point, examines ways to promote student engagement in online learning (Aldhafeeri & Alotaibi, 2022). A well designed online course is expected to enhance the learning experience, promote accessibility, and provide a convenient learning modality, while sustaining learning outcomes in a way similar to face-to-face learning (Saiyad et al., 202). Poorly instructional designs have several drawbacks, such as the reduced likelihood of participating in collaborative learning, limited student-faculty interactions, and fewer opportunities for discussions with diverse peers (Dumford & Miller, 2018; Thamri et al., 2022). These drawbacks can lead to decreased exposure to effective teaching practices and a lower quality of interactions, often resulting in student dissatisfaction and frustration (Dumford & Miller, 2018; Thamri et al., 2022). Thus, special attention must be paid to the online instructional modality to ensure it is well-designed and directed toward promoting educational outcomes.

Nursing education has a unique nature that includes practical, problem-based, and project-based learning to promote students' communication skills (Salmani et al., 2022; Wolf & Wolf, 2023). Such skills are considered the core of holistic and comprehensive care for nurses. For example, communication skills and teamwork are essential to the quality of care being received, even from the perspective of the care recipient (Al-Hammouri et al., 2020; Milton et al., 2023). Many studies recommended exploring strategies to foster student engagement across different modes of instruction, primarily when online learning is being used to compensate for skills ordinarily learned through face-to-face learning (Dumford & Miller, 2018; Thamri et al., 2022).

One technique that the authors think can overcome some of the drawbacks associated with using online learning is the Good Behavior Game (GBG). The use of gamification in online environments promotes student engagement and motivation that help overcoming drawbacks associated with poorly designed online learning (Al-Hammouri, 2024; Zakaria et al., 2024). The GBG is an educational strategy that is deeply rooted in the field of applied behavioral analysis (Joslyn et al., 2019). The GBG manages classroom behavior and incentivizes individuals to demonstrate academically appropriate skills and knowledge (Joslyn et al., 2019). With certain behaviors or skills in mind, the class is divided into teams. These teams then compete to meet



certain academic behaviors and skills according to pre-specified rules. The winning team members are rewarded at the end of the time window specified for the game.

Since it was first tested in 1969, the evidence of GBG effectiveness across various populations, age groups, behaviors, and settings has been supported (Joslyn et al., 2019). The seminal work of Barrish and colleagues in this area first developed and introduced GBG as a way to control individual student performance by setting group contingencies (Barrish et al., 1969). In their work, Barrish and colleagues targeted student behavior such as “out of seat” and “talking out” in a fourth-grade class. The class was divided into two teams while the contingencies were based on available privileges on day-to-day school settings. The GBG was an efficient intervention in reducing targeted behaviors (Barrish et al., 1969). Although the behaviors addressed in the seminal work on GBG are not exhibited by adult learners, including nursing students, they show the efficiency of the GBG in making the classroom more conducive to learning.

Since then, GBG has been used to target various academic and classroom behaviors. For example, the GBG was used with children to reduce disruptive behaviors in the classroom (Harris, & Sherman, 1973). It has also been used with schoolchildren to promote student engagement (Hier et al., 2023). However, the use of the GBG with university students was not reported. Thus, to the best of our knowledge, this paper will be the first to address the use of GBG with nursing students. Thus, the study aims to examine the effectiveness of GBG in promoting academically relevant behavior (namely, participation quality and participation quantity as indicators of student engagement) in a sample of nursing students.

## **Literature Review**

### ***Good Behavior Game***

In this section, we review the studies that have implemented GBG in classroom settings, noting that the behaviors addressed in these studies are not similar to those faced with adult learner. Limited studies have examined the effectiveness of the GBG with adult learners and show the potential of the GBG in promoting conducive educational environments. The Good Behavior Game was first tested to reduce disruptive behaviors in school-age children (Cooper et al., 2019). Under the GBG, students are ideally divided into teams competing on specific winning criteria associated with targeted behaviors. This approach relies on group-based rewards, where the entire team benefits if members meet the set behavior expectations (Cooper et al., 2019). In other words, each team is required to meet specific criteria associated with the team’s performance, which is directly associated with an individual’s performance. For example, a team may be asked to collectively score lower than a certain number regarding disruptive behaviors to win (Cooper et al., 2019). Early research in this area showed great potential for the GBG’s application in academic settings in controlling student behaviors, including various disruptive behaviors (Barrish et al., 1969).

Since then, the GBG has been applied in various populations, settings, and behaviors. For example, the GBG applications were reviewed and found effective in promoting behavioral vaccines, which refer to behaviors aimed at protecting against health issues (Embry, 2002). The GBG was named as the best practice to promote behavioral vaccines, including antiseptic hand

washing, substance abuse, and violent behavior (Embry, 2002). On the other hand, the GBG has been shown to effectively reduce teacher stress and increase academic engagement in elementary school children (Radley et al., 2023). A strength of the GBG is that it can be adapted to fit various settings and populations. For example, the GBG targeted off-task behaviors in special education classrooms (Groves et al., 2022). The results supported the effectiveness of the GBG in academic settings with different groups of participants in particular settings. However, the applications of the GBG across various settings and populations are still limited. Our literature search showed that the GBG was not examined in the university setting. However, the GBG was recommended as a universal intervention that can be used in different classroom settings and age groups (Kellam et al., 2011).

The mechanism by which the GBG enhances student performance and engagement in any learning setting and context is essentially based on promoting students competition to perform better (Al-Hammouri, 2024; Cooper et al., 2019). Such competition can occur at three levels (Al-Hammouri et al., 2024; Cooper et al., 2019). First, competition can occur within teams where the students must perform better than the other team members to gain the award or reinforcer. Second, competition across teams, where students compete to outperform other teams to gain the award or the reinforcer. Finally, individual learners and teams compete to meet certain criteria to gain the award or the reinforcer (Al-Hammouri et al., 2024; Cooper et al., 2019).

### ***The Good Behavior Game and Student Engagement in Online Courses***

The evidence concerning the GBG's effect on student engagement in online courses is minimal. Our search returned no results for studies that examined the effect of the GBG on student engagement in online courses among university students. Although there were no studies that have examined GBG in online courses among university students, we found a single study that examined the effect of the GBG on student engagement in three third- through fifth-grade classrooms in online courses (Hier et al., 2023). The authors of this study reported that the GBG was not previously implemented in the online learning context (Hier et al., 2023). This study showed that applying the GBG was associated with moderate to strong improvement in student engagement. In addition, the study supported the GBG usability and acceptability by teachers and students, respectively (Hier et al., 2023). Since learner engagement in online education needs more attention, even in higher education (Al Okla et al., 2023), studying the impact of the GBG on student engagement can provide valuable insights. While there is strong evidence supporting the benefits of the GBG, its use in higher education remains limited. This study addresses one research question:

Does the use of the GBG affect student engagement (quantity and quality) in a sample of nursing students in a university setting?

## **Method**

### ***Research Design***

This study employed a quasi-experimental pre-test, post-test research design conducted at a major public university in Jordan. Under this design, the authors first assigned different

interventions to already existing groups of students. After collecting baseline data, each group was exposed to different conditions to examine the effect of the GBG on different dimensions of student engagement behaviors. For example, Group 1 followed a sequence of baseline phase, quality improvement phase, and quality and quantity improvement phase. For Group 2, the sequences were the baseline phase, followed by the quantity improvement phase, followed by the quality and quantity improvement phase.

### ***Participants***

A total of 105 students were registered for the Communication and Health Education course, where the GBG activity was applied. Among the students, 95 participated in the GBG as a class bonus activity. The grades students were awarded—based on the GBG activity—were not a part of the course's final score; instead, they were added as bonus grades to the final grade at the end of the course. The minimum required sample size was calculated using G\*Power. To perform a repeated measure, Multivariate Analysis of Variance (MANOVA) on two groups with a power of 0.8, a large effect size, three measurement time points, and an alpha level of 0.05, a minimum sample of 82 was required. The participants were nursing students from the Communication and Health Education class. The class consisted of two groups; each was assigned to different conditions (as described below) to achieve the study goal. The sole inclusion criterion was that they must be nursing students currently enrolled in an online Communication and Health Education course.

### ***GBG and Measures***

The GBG activity was applied to two groups of the above-mentioned online course. Students in each group were randomly divided into teams of 10-11 students. Each group participated in a game concerning specific dimensions of students' academic engagement (participation quantity and participation quality, see below). Each group had a separate online discussion forum. The lecture was a 2-hour weekly lecture. Thus, a weekly analytical question was posted in the forum at the end of the lecture. Students were given three days to answer the question and respond to each other's responses. After the end of the three days, the discussion was closed, and students' participation quantity and quality were evaluated. The time was selected based on practical reasons. The evaluators of the students' responses needed enough time to review scores of the students' participation quality and quantity before posting next week's question. Students' participation quality and quantity were measured for both groups at all times to compare students' performance under different GBG activity conditions (i.e., Quality Condition, Quantity Condition, Quality-Quantity Condition; see below).

#### **Participation Quantity**

In the GBG activity planned in the course, the participation quantity referred to the team's average number of posts. To calculate participation quantity, the total number of posts by each member was counted. Then, the number of posts made by all team members was added and divided by the number of students in the team. The average scores and the individual student's performance were then used to determine the winning team.

#### **Participation Quality**

The quality was determined using a rubric designed to assess the quality of student participation. The rubric evaluated students participating in four domains: reflective, originality,

clarity, and provocative. The reflective domain focused on student ability to analyze and synthesize course ideas in answering the question. Originality focused on the student ability to generate new ideas and perspectives while answering the question and avoiding paraphrasing others' ideas. Clarity focused on the student ability to express ideas clearly, understandably, and logically. Finally, the provocative domain focused on the students' responses' ability to initiate a discussion concerning the topics of the questions. These domains were scored for each comment using a scale from 1 to 5. The scores were averaged for each student, then the team scores were calculated by averaging the team members' scores. Thus, individual and team scores ranged between 1 and 5. The team and individual students' scores were then used to determine the winner among the competing teams.

The GBG activity in the class consisted of three conditions for each group. Group 1 was exposed to the baseline condition, Quality Condition, and Quality-Quantity Condition, while Group 2 was exposed to the baseline condition, Quantity Condition, and Quality-Quantity Condition. The order of implementing different conditions for the different groups was planned to help make multiple comparisons between groups across different conditions. For example, when Quality Condition targeted participation quality for Group 1, Group 2 had Quantity Condition, which targeted participation quantity but not quality. Thus, this assembly enabled the authors to compare the impact of different conditions on different aspects of students' engagement. Finally, superimposing the contingencies applied to the other group over the existing one in Quality-Quantity Condition, helped the authors examine the effect of the rule change on the targeted aspect of student engagement. Such assembly is usually used in single-subject research design and is called multiple baseline design (Cooper et al., 2019). In what follows, we will explain all of these conditions.

### Baseline

Both groups were initially exposed to this condition. As the name suggests, the goal of this condition was to establish baseline data to compare student engagement indicators (participation quality and quantity) to subsequent conditions. Under this condition, the instructor posted a weekly analytical question into the discussion forum, with no specific contingencies applied. The only instruction was that "weekly discussion questions will be posted about the course material on the discussion board. You can post your answers to the discussion and respond to others' answers." This condition was applied for three weeks, during which the student could participate in three analytical questions.

### Quality Condition

Under this condition, the teams in Group 1 competed to win over other teams based on the quality of participation. Although the students' participation quantity was not targeted under this condition, it was measured and assessed for analysis purposes to compare both groups under different conditions. After the end of the baseline condition, the students were given recorded instructional material describing the rules and contingencies of the GBG. Two types of contingencies were applied. The first contingency was applied to the teams meeting the GBG minimal criteria: achieving a team average participation quality score of 2.5 out of 5, with the lowest team member participation quality score of 2 or above (Table 1). If the team met these conditions, each student was awarded a +1 (for that week) grade toward the course final grade.

The second contingency applied was the winner team contingency (Table 1). Based on this contingency, each team member with the highest average participation quality score among all teams was awarded a +1 grade toward the course's final grade. Thus, if the winning team met the minimal criteria, each student would be awarded +2 grades toward their final course grade. However, one last contingency was added to ensure minimal team performance deterioration. This contingency was called response cost. If the team scored 0.5 lower on average teams' participation quality score compared to the previous week, a -1 grade would be implemented on the bonus grades the teams awarded to their course bonus grades (Table 1).

**Table 1**

| <i>Quality Condition Contingencies</i> |                                                                                                                                                       |               |                    |
|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|
| <b>Performance criteria</b>            | <b>Description</b>                                                                                                                                    | <b>Status</b> | <b>Contingency</b> |
| <b>Minimal criteria</b>                | <ul style="list-style-type: none"> <li>The team scored at least 2.5 in the average participation quality score.</li> </ul>                            | Met           | +1                 |
|                                        | <ul style="list-style-type: none"> <li>The lowest participating student achieved a 2 or more in participation quality score.</li> </ul>               | NOT Met       | 0                  |
| <b>Winner</b>                          | <ul style="list-style-type: none"> <li>The team with the highest average participation quality score.</li> </ul>                                      | Met           | +1                 |
| <b>Response cost</b>                   | <ul style="list-style-type: none"> <li>The team scored .5 lower in average participation quality score compared to the previous week score</li> </ul> | Met           | -1                 |

### Quantity Condition

Under this condition, the teams in Group 2 competed to win over other teams based on the participation quantity. Although the students' participation quality was not targeted under this condition, it was measured and assessed for analysis purposes to compare both groups under different conditions. After the students had completed the baseline condition, the students were provided with recorded instructional material describing the rules and contingencies of the GBG under this condition. Similar to Quality Condition, two types of contingencies were applied. The first contingency was applied upon the teams meeting the GBG minimal criteria, which were achieving an average team's participation quantity equal to or above 50% of the highest participating team, with the lowest participating team member achieving at least 5% of the team's total participations (Table 2). If the team met these conditions, each student was awarded a +1 grade (for that week ) toward the course's final grade.

The second contingency applied was the winner team contingency (Table 2). Based on this contingency, each team member in the winning team, which had the highest average participation quantity score, was awarded a +1 grade toward the course's final grade. Thus, if the winning team met the minimal criteria, each student would be awarded +2 grades toward their final course grade. Similar to Quality Condition, one last contingency was added to ensure minimal team performance deterioration. This contingency was called response cost. If the team scored 10% lower on the total number of participations than the previous week's score, a -1 grade would be implemented on the bonus grades the teams awarded to their course bonus grades (Table 2).

Table 2

*Quantity Condition Contingencies*

| Performance criteria    | Description                                                                                                          | Status  | Contingency |
|-------------------------|----------------------------------------------------------------------------------------------------------------------|---------|-------------|
| <b>Minimal criteria</b> | • The team scored at least 50% of the highest participating group in the teams' average participation score.         | Met     | +1          |
|                         | • The lowest participating student achieved 5% of his team's total participation                                     | NOT Met | 0           |
| <b>Winner</b>           | • The team with the highest average participation quantity score                                                     | Met     | +1          |
| <b>Response cost</b>    | • The team had 10% or more reduction in the average team participation quantity score compared to the previous score | Met     | -1          |

Quality-Quantity Condition

This condition is technically a combination of the conditions 1 and 2 in that Quality-Quantity Condition targeted participation quality and quantity (Table 3). Again, two types of contingencies were applied under this condition. First contingency was applied upon the teams meeting the GBG minimal criteria, which were achieving 50% of the highest participation quantity team, the lowest participating student achieving at least 5% of the teams' participation, the team meet at a score of 2.5 on the average participation quality, and the lowest team member score of 2 or above in participation quality. If the team met these conditions, each student was awarded a +1 grade toward the course final grade (Table 3).

The second contingency applied was the winner team contingency (Table 3). We took one step further to determine the winning team beyond conditions 1 and 2. Under Quality-Quantity Condition, we calculated another number by multiplying the average participation quality score for the teams by the average number of teams' participation quantity. The team that achieved the highest number is considered the winning team. Similarly, based on this contingency, each team member was awarded a +1 grade toward the course's final grade. Thus, all winning team members were awarded +2 grades toward their final course grade, achieving both contingencies. Finally, two additional contingencies were added to ensure minimal team performance deterioration. This contingency was called response cost contingencies. If the team scored 10% lower on the total number of participations than the previous week's score, a -0.5 grade would be implemented on the bonus grades the teams awarded to their course bonus grades (Table 3). Additionally, if the team scored 0.5 lower on average teams' participation quality score than the previous week's score, a -0.5 grade would be implemented on the bonus grades the teams awarded to their course bonus grades (Table 3).

Table 3

*Quality-Quantity Condition Contingencies*


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| Performance criteria    | Description                                                                                                                                                                                             | Status  | Contingency |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------|
| <b>Minimal criteria</b> | <ul style="list-style-type: none"> <li>The team scored at least 50% of the highest participating group in the teams' average participation score.</li> </ul>                                            | Met     | +1          |
|                         | <ul style="list-style-type: none"> <li>The team scored at least 2.5 in the average participation quality score.</li> </ul>                                                                              |         |             |
|                         | <ul style="list-style-type: none"> <li>The lowest participating student achieved 5% of his team's total participation</li> </ul>                                                                        |         |             |
|                         | <ul style="list-style-type: none"> <li>The lowest participating student achieved a 2 or more in participation quality score.</li> </ul>                                                                 | NOT Met | 0           |
| <b>Winner</b>           | <ul style="list-style-type: none"> <li>The group scored the highest number of multiplying the team's average participation quality score by the team's average participation quantity score.</li> </ul> | Met     | +1          |
| <b>Response cost</b>    | <ul style="list-style-type: none"> <li>The team had 10% or more reduction in the average team participation quantity score compared to the previous score</li> </ul>                                    | Met     | -.5         |
| <b>Response cost</b>    | <ul style="list-style-type: none"> <li>The team scored .5 lower in average participation quality score compared to the previous score</li> </ul>                                                        | Met     | -.5         |

### ***Procedure***

To achieve the study goal, Group 1 has received baseline condition, followed by Quality Condition, and then Quality-Quantity Condition. Group 2 received baseline condition, Quantity Condition, and finally, Quality-Quantity Condition. Under all conditions for both groups, the participation quality and quantity data were collected on a weekly basis to compare and contrast to achieve the study goal.

After the online class time, an analytical question was posted on the discussion forum. The students were given three days to answer the discussion forum question, starting from the time of posting the question, beyond which no further participation was accepted. The time left between ending the participation and the next class was reserved for scoring the participation quality and quantity and announcing the results for the groups to provide feedback concerning their performance in the previous week.

At the beginning of the class, the first three questions were posted without providing any specific instructions, except that these questions will be part of a bonus activity later in the class. The participation quality and quantity were scored to form the baseline for subsequent conditions. After the first three weeks, Group 1 was provided with the condition details and how the contingencies would work. Group 2 simultaneously received the same type of information about Quantity Condition. After five weeks of implementing Quality Condition and Quantity Condition, Quality-Quantity Condition was implemented for both groups simultaneously. The initial plan was to implement conditions 1 and 2 for five weeks, followed by Quality-Quantity Condition for five weeks. Due to technical issues with the discussion forum platform, the data

collection was stopped after three weeks of implementing Quality-Quantity Condition. Thus, the entire GBG activity, including the baseline, and the three conditions continued for 11 weeks.

### ***Inter-rater Reliability***

Two raters evaluated the participation quality and quantity. Although the evaluation for the participation quantity was straightforward, counting the number of participations done by each student and then combining them into teams' averages and totals, the case was more complicated for participation quality. First, two research assistants were recruited for this purpose, and they have nothing to do with other class- or grading-related activities. The two research assistants were only responsible for scoring the GBG activities (i.e., participation quality and quantity). The research assistants received training on using the participation quality rubric using data from previous semesters.

During research assistants training, the goal was to achieve a 100% interrater agreement. Both research assistants were required to score the participation quality separately during the course. After they finished scoring, the research assistant met to discuss the scoring results. In case of any discrepancy in the scoring results, the research assistants discussed the scoring until they reached a 100% inter-rater agreement. Then, the research assistants calculated the required parameters to award the bonus for meeting minimal criteria, award the winning team a bonus, and implement a response cost when applied. Then, they prepared the final announcement for the feedback to be posted before the next class. The announcement involved the teams' names, the number of grades awarded, and the reason for the grades awarded (i.e., their performance according to the contingencies/conditions in effect). To promote confidentiality, individual students' names and the rubrics were not shared. The announcement was made available 24 hours before the next class, to allow the students to ask any questions concerning the results so they can improve their performance in the subsequent week.

### ***Data Analysis***

The data collected during the GBG activity included participants' gender, participation quality, and participation quantity. A repeated measures MANOVA was used to analyze data from three-time points, comparing Groups 1 and 2 on participation quality and quantity. The analysis used the final data points recorded under each condition: week 3 (final baseline data), week 8 (final data for the Quality and Quantity Conditions), and week 11 (final data for the Quality-Quantity Condition).

In addition, to provide additional information regarding the data trend concerning the condition in effect, the individual week data points were depicted in two different graphs. One graph was for participation quality, and one was for participation quantity. Separate lines were used to depict different groups (Group 1 and Group 2) (See results section below).

### ***Ethical Consideration***

During the course, no identifiable data were collected. Only the gender of the students was collected. The participation of the GBG as a bonus activity was totally voluntary, while the students could withdraw from the study without any consequences. Each participating student signed a written informed consent before starting the study. The confidentiality of the students



was maintained by ensuring that students' answers and comments were made only available to the research assistants for scoring purposes.

## Results

A total of 95 students participated in this study, with 71.6% of them being females. The number of students in Group 1 and Group 2 was 55 and 40, respectively.

### **MANOVA: Repeated measures**

The results of repeated measures MANOVA showed that there was a statistically significant effect of the GBG activity on the linear combination of the dependent variables (i.e., the quantity and quality of participation at weeks 3, 8, and 11): Pillai's Trace ( $V$ ) = .85,  $F(2, 92) = 249.8$ ,  $p < .001$ . Likewise, there was a statistically significant effect of the time factor ( $V$  = .98,  $F(4, 90) = 1323.4$ ,  $p < .001$ ) and time X GBG activity ( $V$  = .92,  $F(4, 90) = 252.9$ ,  $p < .001$ ). Table 4 presents the results of repeated measures MANOVA.

**Table 4**

#### *Results of Repeated Measures MANOVA*

| <u>Factor</u> | <u>V</u> | <u>F</u> | <u>H. DF</u> | <u>E. DF</u> | <u>P</u> | <u>ES<sup>†</sup></u> | <u>Power</u> |
|---------------|----------|----------|--------------|--------------|----------|-----------------------|--------------|
| Group         | .85      | 249.8    | 2            | 92           | <.001    | 2.29                  | 1.0          |
| Time          | .98      | 1323.4   | 4            | 90           | <.001    | 7.0                   | 1.0          |
| Group X Time  | .92      | 252.9    | 4            | 90           | <.001    | 3.39                  | 1.0          |

V: Pillai's Trace; F: F statistic; H. DF: hypothesis degrees of freedom; E. DF: error degrees of freedom; ES: effect size.

<sup>†</sup> Values of the effect size were calculated using post-hoc function in G\*Power 3.1

### **Univariate and Follow-Up Analyses**

The ANOVA output showed that the GBG activity's effect on the quality of students' participation was statistically significant:  $F(1, 93) = 481.69$ ,  $p < .001$ . The effect on students quantity of participation was also significant  $F(1, 93) = 25.53$ ,  $p < .001$ . The effects of time on participation quantity  $F(1, 93) = 1974.87$ ,  $p < .001$  and participation quality  $F(1, 93) = 3058.90$ ,  $p < .001$  were statistically significant. Similarly, significant effects of time by group on participation quantity  $F(1, 93) = 54.39$ ,  $p < .001$  and participation quality  $F(1, 93) = 38.13$ ,  $p < .001$  were found.

A follow-up analysis, using Bonferroni adjustment, revealed that the mean difference in the quantity and quality of participation was insignificant at the end of week 3 (i.e., at baseline). By the end of week 8, students in Group 2 had a statistically significant higher mean score of participation quantity. However, the mean score of participation quantity was significantly lower in Group 2 by the end of week 11. Regarding participation quality, the pairwise comparison showed that the mean difference was significantly lower in gGroup 2 compared to Ggroup 1 at the end of weeks 8 and 11 (Table 5).

**Table 5**

#### **Pairwise Comparison of the Quality and Quantity of Participation Mean Scores**

|            | Quantity              |                       |                        | Quality               |                       |                        |
|------------|-----------------------|-----------------------|------------------------|-----------------------|-----------------------|------------------------|
| Data point | <u>3<sup>ed</sup></u> | <u>8<sup>th</sup></u> | <u>11<sup>th</sup></u> | <u>3<sup>ed</sup></u> | <u>8<sup>th</sup></u> | <u>11<sup>th</sup></u> |
| Group 2    | .23                   | 5.88                  | 4.40                   | 1.24                  | 1.32                  | 2.85                   |
| Group 1    | .40                   | 2.20                  | 6.24                   | 1.21                  | 3.30                  | 3.23                   |
| Difference | -.17                  | 3.68**                | -1.84**                | .03                   | -1.97**               | -.38**                 |
| 95% CI     | -.38, .03             | 3.18, 4.17            | -2.21, -1.46           | -.05, .11             | -2.11, -1.8           | -.48, -.28             |

\*\* the mean difference is statistically significant at p value of <.001

Figure 1 shows teams' weekly participation quality data points. As seen in the figure when applying conditions 1 and 2, Group 1 showed a steady increase in participation quality (Figure 1), contrary to Group 2. This seemed logical as the Quality Condition contingencies targeted participation quality. Looking at Figure 2, Group 2 showed a steady increase in participation quantity compared to Group 1 (Figure 2). Again, this seemed logical since Quantity Condition targeted participation quantity.

**Figure 1**

*Teams' Participation Quality Weekly Data Points*

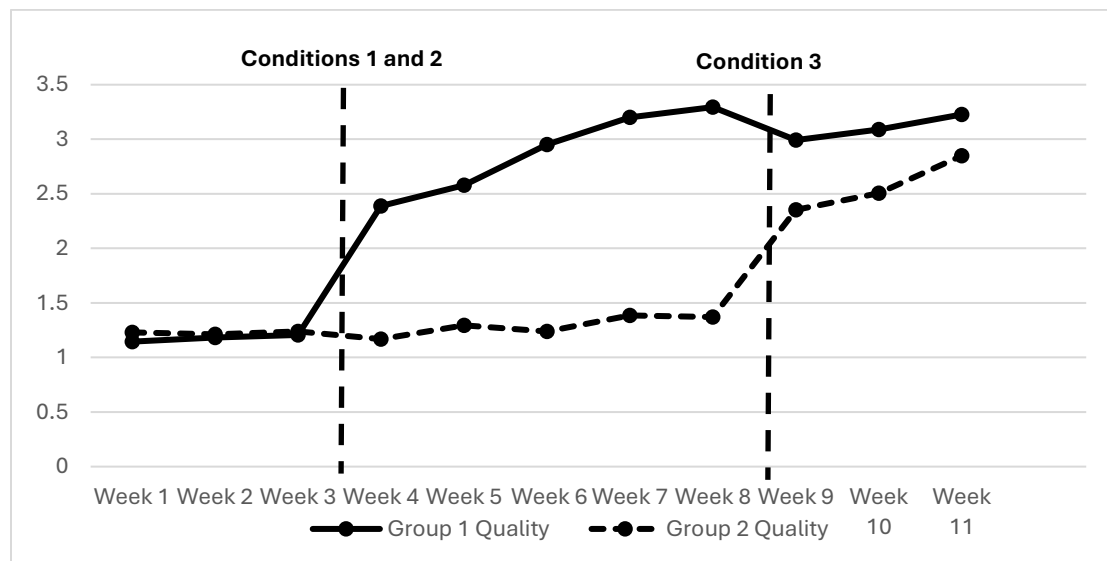
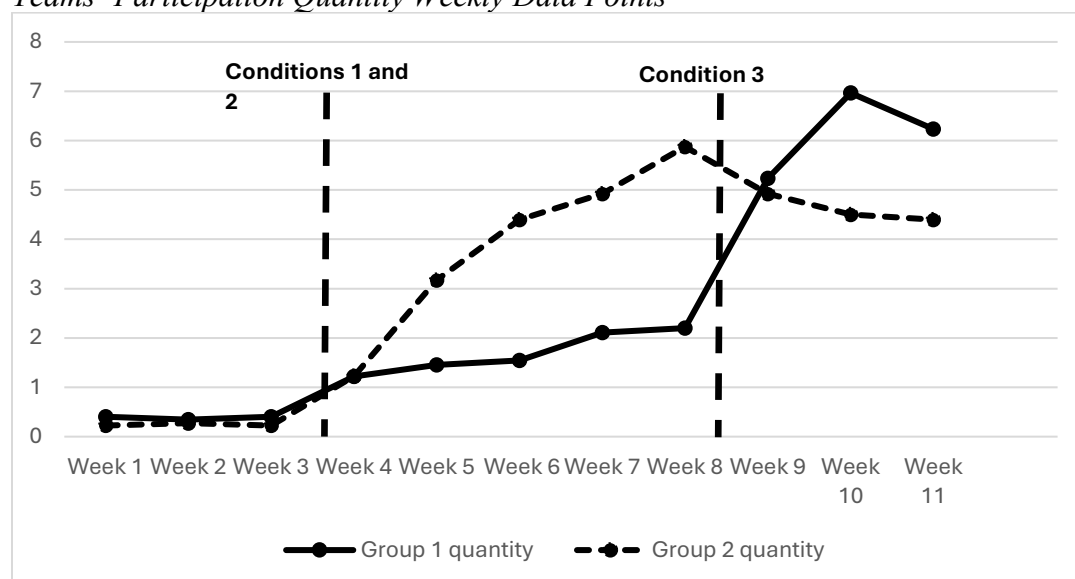


**Figure 2***Teams' Participation Quantity Weekly Data Points*

Looking at Figures 1 and 2, we can see that after the application of Quality-Quantity Condition in Groups 1 and 2, there was a steady increase in the engagement indicator that was not targeted earlier. For example, in Group 1 which was initially targeted by participation quality contingencies, the participation quantity steadily increased after implementing Quality-Quantity Condition, which represented superimposing participation quantity contingencies over the already existing participation quality contingencies. For Group 2, which was initially targeted by participation quantity contingencies, the participation quality steadily increased after implementing Quality-Quantity Condition. This represented superimposing participation quality contingencies over the already existing participation quantity contingencies.

## Discussion

In an era marked by the profound transformation of education, accelerated by the COVID-19 pandemic, the importance of online learning is paramount. This study has explored the potential of the GBG as a novel strategy to enhance online learning, specifically focusing on nursing students—a group with unique learning needs and a curriculum demanding practical skills and effective communication. The current study aligns with the calls in the literature to provide empirical evidence on the use of gamification in educational settings in general, and in online learning in specific (Antonaci et al., 2019). This is considered of utmost importance for an online learning environment where the students' engagement is problematic with limited interaction of the students with institution, teachers, and peers, compared to in-person learning (Vermeulen & Volman, 2024)

The repeated measure MANOVA analysis showed that implementing the GBG activity and associated contingencies significantly promotes the targeted academic behavior. Although

no previous studies have examined the effectiveness of GBG in university students in general or nursing students specifically, the current study's results align with similar previous studies. For example, GBG was implemented with school-age children whose outcome behaviors were writing speed and accuracy (Klaft & Coddington, 2022). Another study with school-aged children showed the positive impact of the GBG on students' engagement during online classes (Hier et al., 2023). However, these results are consistent with the few available studies on the use of gamification in online environments to promote student engagement and motivation (Zakaria et al., 2024). The study revealed intriguing trends in the data. Students initially exposed to participation quality contingencies demonstrated a steady improvement in this aspect, while those exposed to participation quantity contingencies demonstrated an increase in their quantity of participation. However, the most significant finding emerged when both contingencies were combined under Quality-Quantity Condition, resulting in a synergistic effect. In this phase, students from both groups exhibited improved engagement in areas that were not initially targeted. This suggests that the GBG has the potential to enhance holistic engagement by addressing multiple aspects of student participation simultaneously. Thus, generally, the current study supports the previous studies' results, suggesting that the implementation of active learning modalities in online education has had a favorable impact on students' attitudes toward learning, leading to a reduction in their reluctance to engage in the learning process (Al-Hammouri, 2024).

Contrary to what the authors were expecting, there is a significant difference between groups at week 11 regarding participation quality and quantity. We expected these differences to disappear as the same contingencies were in effect for both groups. One explanation for this finding is that more sessions/weeks were needed under similar research conditions before the data stabilized (Carneiro et al., 2021; Costa & Cançado, 2012). If the study had been completed as planned, the participation quality and quantity differences might have disappeared. Another explanation would be fluctuation in student performance as other course requirements near the end of the semester started to interfere and resulted in some noise in the data. Although these might be valid explanations, further future replication is required to support which one could be the valid explanation. This contradiction with some of the authors' expectations does not discount the noticeable impact of GBG on student engagement as indicated by their participation quality and quantity, especially when we look at the large values of post hoc effect sizes (Table 4).

Results from this study demonstrate that the GBG can be a valuable tool for promoting engagement in online learning environments. Through a systematic approach combining contingencies for participation quality and quantity, the GBG was able to bridge the gaps created by the limitations of online education. Notably, the GBG succeeded in fostering higher levels of student participation and improved the quality and quantity of their engagement, especially when used in conjunction with traditional online discussion forums. One explanation regarding the effectiveness of the GBG could be that GBG has impacted students' motivation to learn, which in turn impacted student engagement (Akram & Li, 2024).

The implications of this research extend beyond nursing education. The GBG's adaptability to various disciplines and its potential as a holistic engagement strategy in online learning environments open new avenues for educators and institutions seeking effective ways to

design activities in online educational courses. Specifically, the GBG offers a promising approach to address the challenges posed by the reduced collaborative learning opportunities and limited student-faculty interactions.

### ***Limitations and Recommendations***

This study has several limitations that warrant consideration. First, the generalizability of the results may be restricted due to the study's specific context—a major public university in Jordan—and the participant pool consisting of nursing students in a Communication and Health Education course. Second, a larger and more diverse sample would enhance the generalizability of the results. Third, technical issues with the online discussion forum platform led to the premature termination of data collection, impacting data completeness and the ability to draw more conclusions. It has been suggested that there are usually several sessions before the trend in any changing behavior stabilizes (Carneiro et al., 2021; Costa & Cançado, 2012). Thus, having more time to complete the data collection would have given us a complete picture of when and how the targeted behaviors would stabilize and stop the increasing trend. These limitations should be considered when interpreting the study's results and designing future research endeavors in online education.

### ***Conclusion***

In conclusion, this study underscores the importance of innovative approaches in adapting to the changing education landscape. The GBG, initially implemented in different contexts, has proven its efficacy in enhancing student engagement in online learning, particularly in fields like nursing, where practical skills and communication are essential. Further research can explore the nuances of the GBG's application in diverse educational settings, assess its long-term impact on student outcomes, and investigate its potential as a comprehensive engagement strategy. Integrating such strategies can help ensure that online learning remains a robust and effective platform for education in the years to come.

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### ***Ethical approval***

The institutional review board committee at Jordan University of Science and Technology approved this study.

### ***Conflicts of interest***

The authors have no conflicts of interest.

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