



ONLINE LEARNING

THE OFFICIAL JOURNAL OF OLC



ONLINE LEARNING™
CONSORTIUM

Online Learning

OLJ • THE OFFICIAL JOURNAL OF OLC

OLJ Volume 30 Issue 1 March 2026

Introduction

In Memoriam: A. Frank Mayadas

Faculty, Professional Development, and Online Teaching

Inclusive Design as a Predictor of Pass/Fail Rates in Online Courses

Investigating Factors Influencing Student Academic Outcomes in Online Higher Education: A Cross-Sectional Observational Study

Challenges and Benefits of Collaborative Work in Online Courses

Teaching Engineering Online: Examining Instructor Practices Through the Community of Inquiry Framework

Online versus Classroom teaching: Differences and specificities in teacher-student interaction processes

Determinants of Job Satisfaction and Online Learning Continuation: A Study of Kazakhstani Educators during COVID-19

Hot-fit Model on E-Learning Success: Innovation and Quality Consciousness

Empirical Studies

Collaborative Online International Learning: Scale Validation and Reliability

Exploring Preservice Teachers' Design Thinking Mindset in a Technology-Enhanced Active Learning Environment for STEM Courses

Mixed Reality System for Automotive Vocational School: Academic Performance and Experience Assessment

Tracking Self-Regulated Learning Strategies in Blended Learning: A Digital Trace Approach

Motivations matter: Predicting online entrepreneurship education course completion with a Decision Tree approach

Epistemic Network Models of Students' Cognitive Engagement and Teachers' Feedback in Online Research Writing Courses

Online or Face to Face? The Modality of a Learning Strategies Course and Impacts on Grades, GPA, Retention and Persistence for Developmental Students

Students, Community, and Online Learning

Going Online: Decision Processes of Students Enrolling in Online Degree Programs

Learner Support Practices in Open and Distance Learning Institutions in Gaborone, Botswana

Blended New Student Orientations are Making a Difference

Online and Blended Learning in the Age of Generative AI

Exploring Social sciences and humanities Student Perspectives on AI in Higher Education: A Comprehensive Study of Usage, Ethics, and Future Intentions

Enhancing Oral Language Skills with Pi AI: A Study on Speaking and Pronunciation Gains

Generative AI in Project-Based 3D Modelling: Effects on Creativity, Critical Thinking, and Workflow

In Memoriam: Dr. A. Frank Mayadas

Peter Shea
Editor-in-Chief, *Online Learning*
Professor, School of Education, University at Albany

Eric Fredericksen,
Associate Vice President for Online Learning &
Professor of Educational Leadership, University of Rochester

Anthony Picciano
Professor, Hunter College and CUNY Graduate Center, School of Education

The world of online learning suffered a significant loss recently with the passing of Dr. A. Frank Mayadas, former Chair of the Board of Directors of the Online Learning Consortium. An early pioneer and a visionary behind what were then known as asynchronous learning networks (the “ALN” in the former name of the *Online Learning Journal*, JALN). Prior to his role with the OLC, Frank (to those who had the privilege to know him), was the program officer for the Alfred P. Sloan Foundation’s *Anytime, Anyplace Learning Program* (AALP), which began under the tenure of his colleague Dr. Ralph Gomery, President of the Foundation.

Under Franks thoughtful guidance, the AALP program provided more than \$70M in start-up funding for the early asynchronous online programs for many of the country’s largest public systems of higher education: The State University of New York, The City University of New York, The University of Massachusetts System, The University of Illinois System, The University of Central Florida, The University of Maryland University College, Penn State World Campus, and many other institutions that would go on to serve tens of millions of students.

Beyond his stewardship of the financial resources from the Sloan Foundation, Frank’s role as an advisor proved valuable. He was a kind and supportive colleague and friend; he welcomed visits to the Sloan Foundation offices in Manhattan. We treasured his encouragement, which was forceful and had no end. We appreciated his insight and his abundant sense of humor. Many of us are truly grateful that the relationship with Frank continued after the grants. For some of us, this good fortune lasted more than three decades.

It is no exaggeration to say that Frank reshaped higher education as we have come to know it. Through Frank’s efforts, we saw a transformation from a centuries-old form of physical distance education to the birth of a new interactive medium, a new pedagogy, and a new system called “online learning.” The system led to the development of new theories of teaching and learning, (including, e.g. the Community of Inquiry model), which became possible only through the implementation of asynchronous learning networks in which student-to-student interaction was feasible at increasing scale. The now ubiquitous learning management system (LMS) itself was an outgrowth of earlier models of asynchronous learning networks and the homegrown systems that were made possible through funding from AALP.

Organizationally, online learning required the development of new administrative structures and roles and an explosive growth in instructional design and faculty professional development. In the 90s, Frank had the foresight to bring together the early Sloan grantees to confer about what

he dubbed the five pillars: faculty experience, student experience, learning effectiveness, access, and scale.

Frank's view of "network" was not always related to technology. The meaningful definition for him was a network of people—students and professors. As the *Anytime, Anyplace Learning Program* grew, the definition of "network" expanded to include a connection among colleges and universities. Frank sponsored meetings for grantees to get together and share their experiences. He reveled in our updates on progress and growth. Our first sessions were possible around a single conference room table. These early meetings grew into larger and larger conferences organized under the Sloan Consortium (and later, the Online Learning Consortium).

The entire notion of blended learning was launched through these early conferences and supported through Frank's "localness" initiative with the assistance of luminaries such as Mary Niemiec and Tanya Joosten. For decades, the Sloan Consortium became the "go to" place to learn and share what has arguably become the most popular mode of learning throughout the world.

Frank was a champion for research. He was a very early advocate for collecting data on the faculty and student experience, especially in institutions scaling up. He urged us to publish, present, and share our work to benefit others who were just getting started. He sponsored research workshops and retreats that yielded some of the field's first books. He took great pride in the research community for online education. As the *Online Learning Journal* kicks off its 30th year of publication (and its 12th as OLJ) we must offer a word of thanks to Frank who provided the backing and vision for the earlier iteration of the journal (known as the *Journal of Asynchronous Learning Networks*). Frank's recognition of the tremendous opportunity to develop a scholarship of online teaching and learning encouraged many early scholars (including Randy Garrison, Terry Anderson, Karen Swan, Chuck Dziuban, Starr Roxanne Hiltz, and Murray Turroff) first published in *JALN*.

You might argue that Frank's contributions may not have been the LMS, or that online and blended learning might have happened without him, that the growth in new roles and in the scholarship of online teaching and learning might have occurred anyway. Nonetheless, Frank's greatest gift may have been his quiet but confident leadership. We don't believe that the technologies, roles, pedagogies, organizations, and scholarship would exist in their current configurations if Frank had not taken the initiative to direct the process. Certainly, we would not have had them so quickly.

Was Frank's contribution consequential? Ask the tens of millions of learners who were able to access higher education who otherwise would have been left on the sidelines. Without Frank's agenda, foresight, and commitment, we might have had to imagine the pandemic period without online learning. In the final analysis, we believe that Frank's leadership led to the higher education ecosystem we see today, one in which the only area of growth in US college enrollments has been via online learning, and one in which anyone, anywhere, has the opportunity to improve their station in life through higher education.

This was the original mission of Frank Mayadas, one that met with wild success. His passing marks the end of an era.

Inclusive Design as a Predictor of Pass/Fail Rates in Online Courses

Amanda Blakewood Pascale
University of North Florida

Suzanne Ehrlich
University of North Florida

Amanda Lovins
University of Florida

Abstract

As the prevalence of online learning continues to increase in institutions of higher education, research devoted to understanding how these classrooms can be designed to best promote student success is warranted. For this study, online course Canvas shells at one large public four-year university were examined and scored for inclusive design. Findings indicate that inclusive design in online courses was significantly related to course pass rates. Implications and recommendations for campus administrators and faculty interested in designing and implementing online classes that promote student success are discussed.

Keywords: Online learning, inclusive design, online teaching, student success

Pascale, A.B., Ehrlich, S., & Lovins, A. (2026) Inclusive design as a predictor of pass/fail rates in online courses. *Online Learning*, 30(1), pp. 1-13.
<https://doi.org.10.24059/olj.v30i1.4759>

Online instruction is increasingly prevalent in institutions of higher education (Mishra et al., 2020). The 2020 pandemic pushed universities that were in various stages of online learning programming to rapidly transition to online teaching (Barlett et al., 2021). As a result, both faculty who previously had, or had not, taught online were challenged with creating connections with their students in addition to designing and delivering course content. The continued prevalence of virtual course offerings post-pandemic suggests that online learning will remain an option for most institutions of higher education. Many contemporary online course offerings still reflect pandemic-residual course designs or are currently undergoing redesign. However, post-pandemic, more research is needed to inform redesign of online courses that are effective in promoting student success. Further research to better understand factors that affect positive student outcomes in online settings is warranted. For this study, a course equity and inclusion rubric (Ko, 2021) was utilized to examine online course Canvas shells from one large public 4-year university to determine if there was a relationship between inclusive online course designs and course pass rates. This study can help inform faculty, instructional design staff, and administrators who are involved in design and delivery of online courses that are conducive to student academic success.

Literature Review

The literature contextualizing this study is arranged into three areas, (a) studies relating to online learning and student success, (b) research on effective online pedagogies, and (c) literature relating to inclusivity in online higher education environments. Taken together, this body of work informs the present study and provides the basis for the research design and the study's implications for practice.

Online Learning and Positive Student Outcomes

It is well-established that unless students are able to successfully academically integrate into their university they are at high risk for attrition (Tinto, 1993). In their seminal book titled *How College Affects Students Volume 3: 21st Century Evidence That Higher Education Works*, Mayhew et al. (2016) declare “academic achievement [to be] the strongest within-college predictor of educational attainment,” (p. 379). Contemporary students need to be able to academically integrate across modalities, as the rise in online course offerings may necessitate enrolling in one or several online courses on the path to degree attainment (Bartlett et al., 2021). Several studies have identified factors that contribute to success in online learning (Kauffman, 2015; Greene et al., 2015; Wladis, 2017). These factors include individual learner characteristics and satisfaction (Kauffman, 2015), as well as course level variables (Greene et al., 2015; Wladis, 2017). Historically, however, online courses were notorious for having higher dropout rates, and/or higher percentages of students earning non-passing grades than traditional courses. For instance, Frankola (2001) indicated that dropout rates for online courses could be up to 20% higher than face-to-face offerings of the same course. A follow-up study by Patterson and McFadden (2009) confirmed eight years later that the online learner attrition trend had not changed. Some studies investigated factors to explain the difference in attrition patterns for face-to-face and online learnings suggesting that online student departure decisions could be predicted by certain institutional support and learning environment variables as well as learner characteristics (Lee & Choi, 2013). Further research confirmed that the online learner experience was dependent on the quality of course design (Means et al., 2014). In the spring of 2020, the

COVID-19 pandemic brought new dimensions to the online learning discussion, namely, emergency remote teaching (EMT) characterized by the necessitated and sudden switch from face-to-face to online course delivery that left little time for measured course design and quality control aspects typically present in intentional online course delivery (Hodges et al., 2020). The pandemic-caused pivot to large numbers of online learning modalities has led to an increased interest and need to examine effective online pedagogies.

Effective Online Pedagogies

Research suggests that too heavy a focus on provision of teaching materials without regard to how students receive information and stay motivated to learn, may help explain observed student retention issues in distance learning institutions (Simpson, 2013). Creating effective pedagogical spaces requires both student and instructor connection and buy-in. To better understand perceptions of helpfulness of strategies for designing online spaces that are conducive to learning for diverse students, Martin et al., (2023) created a 45-item instrument and surveyed 478 online instructors regarding their use of these strategies. They found differences among instructor group characteristics (e.g., those who taught synchronous vs. asynchronous, graduate or undergraduate, and those who had attended a teacher training vs. not) and their perception of helpfulness of strategies to create equitable and inclusive online learning environments for diverse learners. In another study of faculty adaptation and performance of various roles (e.g., course facilitator, advisor/mentor, technology expert), Martin and colleagues (2021) found that effective instructors embraced all roles, and those who worked with instructional designers and/or took a training more frequently demonstrated these competencies within the course. Studying students' perception of specific online design elements, Chen et al., (2018) found that higher student ratings of online course design efficacy correlated to higher satisfaction and perception of learning. More recent research suggests that for effective learning to occur, course designs should center relationships among instructors, students, and learning communities to underscore the importance of the learner-to-content connection (Archambault et al., 2022). Pancansky-Brock and colleagues (2020) referred to this process as the humanization of the online learning space and asserted that particularly in the wake of the pandemic-forced pivot online, humanizing virtual courses is essential to ensuring students connect and engage in their online learning. Ample research has long supported the value of community in online learning environments (e.g., Saderia et al., 2009; Sun & Chen, 2016)—an understanding predicated on the idea that learning is a social process (Csibra & Gergely, 2006). These perspectives are grounded in theoretical underpinnings posited through learning-centered approaches and constructivism, and emphasize both the instructor and learners' humanity and individuality (McCombs, 2015).

Inclusivity in Online Spaces

Fostering connection to the online learning community is critical to support students' sense of belonging (Archard, 2014), an important component of social integration that contributes to student retention (Tinto, 1993). A growing emphasis on inclusivity in higher education has garnered attention for the need to design inclusive spaces in online as well as face-to-face environments (Hockings et al., 2012). Many universities have begun adopting operating frameworks such as Universal Design for Learning (UDL), which focuses on accessibility, inclusivity, and equity to reduce barriers for all learners (Rao, 2021). UDL and inclusive design share a common goal to make online spaces accessible to diverse learners, although they differ in

that UDL focuses on design of a single product's accessibility without the need of adaptation (CAST, 2018). On the other hand, inclusive design focuses on understanding learner needs and designing spaces to best support their experience (Persson et al., 2015). Reduction of barriers for all learners and the provision of online spaces that promote belonging and inclusivity have been shown to have positive effects on important student learning outcomes such as engagement and retention (Bawa, 2016). Along this line of thinking, the purpose of this study was to investigate the relationship between a humanized course design and delivery (inclusive design), and course pass rates in online courses.

Methods

This study was designed to investigate the relationship between inclusive design (ID) and course pass rates in online courses. The setting for the study was one large public, four-year institution, in the southeastern region of the United States. This study was the initial stage of a larger project designed to better understand how to support students enrolled in online courses. The following question guided our analysis:

Is the extent to which a course is inclusively designed predictive of course pass rate in online courses, when controlling for course-level variables identified here:

- (a) percentage of students with cumulative GPAs 3.5 or higher
- (b) percentage of students previously having earned a grade of a "D" "F" or "W" in the course
- (c) whether or not faculty had completed an online teaching training
- (d) total course enrollment

Data Collection and Instrumentation

After obtaining IRB permission, the researchers solicited participation from all faculty at the institution who taught an online course during the Summer 2020 to Summer 2021 terms. The terms were intentionally selected as the University had moved all courses online to continue learning during the COVID-19 pandemic timeframe. At the time of this research, most faculty were not utilizing online course templates in their course design. Rather, they were engaging in the design of their own Canvas shells. In total, 261 Canvas course shells were shared with the research team. After removing duplicates (i.e., same faculty member who taught multiple sections of a course), remaining courses were sorted based on pass rate and grouped into three categories: (a) high pass rate, (b) medium pass rate, and (c) low pass rate. A stratified random sample was taken from these three groups resulting in a total analytic sample of 71 courses. Of these 71 courses, approximately 60% were upper-level undergraduate courses, 39% were lower-level undergraduate courses, and the remaining 1% were graduate-level courses. As the groups were only stratified by pass rate prior, course levels were randomly assigned across the three groups. Course enrollments ranged from 20 to 218. Course disciplines were diverse in nature and areas across campus including the sciences, arts, engineering, computing, mathematics, humanities, and education were represented in the analytic sample. The university enrolls approximately 16,000 students, approximately 14,000 of which are undergraduate and 2,000 are graduate students. Approximately 58% of the student body identifies as White, and 36% as first-generation college students.

A group of undergraduate and graduate students were recruited to be a part of the research team, specifically to aid in course reviews and scoring. The *Course Design Equity and Inclusion Rubric* (Ko, 2021), was utilized to aid in scoring Canvas course shells for inclusive design. The rubric consists of 5 content areas and a number of respective indicators (a) content, (8 indicators), (b) community (7), (c) instructor (7) (d) assessment (6), and (e) in-class policies, (6). For example, one rubric item under the community content area was “relation of the course to the student.” Another rubric item under the instructor content area was “teaching presence and availability.” The full instrument is accessible via Stanford University’s Teaching Commons website.

The team of student researchers participated in three, three-hour training sessions led by one of the lead researchers with expertise in training and development and Universal Design for Learning (UDL). Each course was assigned two reviewers who were not expected to need to take the course for their degree completion. Review of the courses took place over five months. The average time per course review was three hours and each reviewer was assigned between 29 and 37 courses to review. For each item within the five content areas, (as identified in Ko’s rubric), reviewers had an option to select the most appropriate response: (a) absent/needs improvement, (b) developing, (c) present, or (d) exemplary. All courses were scored and transposed into corresponding numbers ranging from zero to three. The rubric scores ranged between zero and 27 points per content area (five content areas total). Scores were calculated for each content area and summed to create an overall inclusive design (ID) composite score. In our sample, ID composite scores ranged between 45 and 115 ($m = 88.35$; $sd = 13.44$). To mitigate potential variability in the reviewer scores, the individualized scores from each of the two reviewers were averaged.

Variables

The dependent variable for the analysis was course pass rate (CPR), operationalized as the percentage of students who passed the course earning a grade of “C” or higher. Several control variables, derived from the literature on predictors of CPRs, were included in the analysis. These were (a) percentage of students with cumulative GPAs 3.5 or higher, (b) percentage of students having earned a previous grade of a “D” “F” or “W” in the course, (c) whether or not faculty had completed an online teaching training, and (d) total course enrollment. The composite ID score served as the independent variable of interest.

Analysis and Findings

Analysis began with descriptive statistics on all variables (see Table 1).

Table 1

Descriptive Statistics

Variable	<i>M</i>	<i>SD</i>	<i>n</i>	<i>SE_M</i>	Min	Max	Skewness	Kurtosis
Course Pass Rate	0.82	0.13	71	0.02	0.39	1.00	-0.86	0.41
Enrollment	37.92	29.69	71	3.52	20.0	218.0	3.97	18.68

Prior_DFW_Grades	0.07	0.11	71	0.01	0.00	0.65	3.18	11.69
High_GPA	0.28	0.18	71	0.02	0.00	1.00	1.76	4.16
Teacher Training	0.42	0.50	71	0.06	0.00	1.00	0.31	-1.90
Inclusive Design Score	88.35	13.44	71	1.60	45.50	115.50	-0.57	0.81

Next data were checked to ensure assumptions had been met. Normality was assessed using Q-Q scatterplots, where data points formed relatively straight lines. Additionally, data were checked that neither homoscedasticity nor multicollinearity assumptions were violated. To ascertain if inclusive design of an online course matters to course pass rates, a two-step hierarchical multiple linear regression analysis was conducted. In step 1 variables that were literature-derived predictors of student success in online courses that described the course were entered into the null model. These variables were (a) total course enrollment, (b) percentage of students who had earned GPAs of 3.5 or higher, and (c) percentage of students who had previously earned a grade of a D, F, or W and (d) instructor training prior to teaching. In step 2 ID score was added, and the models were compared and interpreted to answer our research question:

Is the extent to which a course is inclusively designed predictive of student pass rate in online courses, when controlling for course-level variables, such as

- (a) percentage of students with cumulative GPAs 3.5 or higher,
- (b) percentage of students previously having earned a grade of a D, F, or W in the course,
- (c) whether or not faculty had completed an online teaching training, and
- (d) total course enrollment.

Model Comparison and Interpretation

Comparing the F-tests of each model to each other in Step 1 and Step 2, we found both to be statistically significant at an alpha value or .05 or below. Specifically, the linear combination of factors in Step 1 yielded a significant F-test value $F(4, 66) = 5.98, p < .001, R^2 = .27$. A combination of course level variables including (a) percentage of students with cumulative GPAs 3.5 or higher, (b) percentage of students previously having earned a grade of a D, F, or W in the course, (c) whether or not faculty had completed an online teaching training, and (d) total course enrollment explains ~27% of the variance in course pass rate. In Step 2 we added our variable of interest, ID. The F-test for Step 2 was significant, $F(1, 65) = 4.01, p = .050, \Delta R^2 = .04$. Adding ID to the predictive model contributed an additional 4% in the amount of variance explained by other predictor factors in CPR. Table 2 shows model comparisons.

Table 2

Model Comparisons for Variables Predicting CPR

Model	R^2	df_{mod}	df_{res}	F	p	ΔR^2
Step 1	.27	4	66	5.98	< .001	.27

Step 2	.31	1	65	4.01	.050	.04

Note. Each Step was compared to the previous model in the hierarchical regression analysis.

Individual interpretation of model inputs shows that three factors in the null model were not significant predictors of CPR at the .05 level. Enrollment ($B = 0.0005$, $t(65) = 1.07$, $p = .287$), teacher training ($B = 0.04$, $t(65) = 1.25$, $p = .215$), and percentage of students with cumulative GPAs 3.5 or higher ($B = 0.13$, $t(65) = 1.66$, $p = .102$.) were non-significant factors. Percentage of previous DFW students in the course significantly predicted CPR ($B = -0.42$, $t(65) = -3.23$, $p = .002$). A one-unit increase of percentage of students earning a grade of D, F, or W in the course will decrease the value of CPR by 0.42 units. The addition of ID ($B = 0.002$, $t(65) = 2.00$, $p = .050$.) in Step 2 yielded another significant predictor of CPR. On average, a one-point increase in ID score will increase the CPR by 0.002 units. Table 3 shows a summary of the hierarchical regression analysis.

Table 3

Summary of Hierarchical Regression Analysis for Variables Predicting CPR

Variable	B	SE	95% CI	β	t	p
Step 1						
(Intercept)	0.76	0.04	[0.69, 0.84]	0	19.84	< .001
Enrollment	0.0005	0.0005	[-0.0004, 0.002]	0.12	1.1	0.277
Previous DFW	-0.44	0.13	[-0.71, -0.18]	-0.37	-3.34	0.001
High GPA	0.14	0.08	[-0.02, 0.31]	0.2	1.79	0.079
Teacher Training	0.05	0.03	[-0.005, 0.11]	0.2	1.82	0.073
Step 2						
(Intercept)	0.58	0.1	[0.39, 0.78]	0	5.94	< .001
Enrollment	0.0005	0.0005	[-0.0004, 0.001]	0.11	1.07	0.287
Previous DFW	-0.42	0.13	[-0.68, -0.16]	-0.35	-3.23	0.002
High GPA	0.13	0.08	[-0.03, 0.29]	0.18	1.66	0.102

Teacher Training	0.04	0.03	[-0.02, 0.10]	0.14	1.25	0.215
ID Score	0.002	0.001	[0.0005, 0.004]	0.22	2	0.05

Discussion and Conclusions

Identifying and understanding factors that influence student success in online courses is critically important as the number of courses offered virtually continues to increase. Though the results from this study are limited by study of courses at one university and perhaps also by the timeframe in which the study was conducted, the demonstration of a positive association between inclusive design in online course offerings and course pass rates after controlling for factors known to impact course pass rates is an important contribution to the understanding of college student success in online learning environments. Our models explained ~30% of the variance in course pass rate. Two statistically significant predictors of CPR were identified, percentage of previous D, F, and W students in the course and ID score. With this information we address our research question: *Is the extent to which a course is inclusively designed predictive of course pass rates in online courses, when controlling for several course-level variables?* Based on our research, we conclude that the answer is *yes, inclusive design in online course matters*. This finding has statistical as well as practical significance, as unlike several other factors that influence course pass rates, such as the percentage of students in the class who earned prior grades of D, F, or W, this research suggests that increasing inclusive design in online courses is a feasible and controllable way to increase student pass rates. This finding is supported via previous literature regarding the importance of student sense of belonging in online classes (Archard, 2014). Further, our findings add to the growing body of literature indicating the importance of student-faculty connection and interaction in helping students create a sense of belonging and encourage student success (e.g., Guzzardo et. al, 2020). Additionally, this research underscores the need to further explore and support humanization in online courses (Pakansky-Brock et al., 2020).

Results from this study confirm that the largest amount of variance in course pass rates can be explained by the percentage of students who received grades of D, F, or W in the course. This result is not surprising, however, it is plausible that creating more inclusively designed online courses may aid in reducing the percentage of repeat students in courses, which may in turn further increase student success and reduce negative outcomes (e.g., financial burden for repeat courses and increased time to degree) for students. The results of this research indicate that intentionally designing inclusive online courses is one viable strategy to increase the numbers of students receiving passing grades in their online courses.

Limitations and Delimitations

There are some limitations of the study that should be acknowledged. Notably, the dataset included only course-level variables. That is, no individual student-level variable was accounted for within the model. It is certainly plausible that inclusion of student-level data would have enhanced the explanatory power of the statistical model. Also, there are certain characteristics of the course delivery that could have explained course pass rate outside of

inclusive design. For instance, some courses in the sample were delivered in shortened six- or eight-week summer sessions as compared to full sixteen-week semesters. Furthermore, aside from inclusion of the control variable, whether the instructor attended an online course training or not, our study did not account for courses that were originally intended to be delivered online with an instructor who had extensive online teaching experience as compared to those who were required to deliver their classes online due to the pandemic. Despite these limitations, we maintain that the results of this study have important implications from which impactful recommendations are generated.

Implications and Recommendations

This study produced important findings that may be beneficial for campus administrators, faculty, and students alike. It is necessary, however, to situate the applicability of these findings within the context relative to the time that the research was conducted. Specifically, the courses examined for this study were taught in 2020 and 2021, a unique period of study, as much of online education was characterized by emergency remote teaching (ERT), as compared to standard online education. The COVID-19 pandemic drove rapid deployment of the ERT out of necessity. To that end, many online courses lacked sound design and intentional pedagogical approaches that are typically characteristic of standard online education. Our study found that inclusive design matters to course pass rate. Interpreted in light of the context, we hypothesize that the heightened duress of the pandemic served to amplify the importance of inclusive design in online course delivery. In other words, inclusive design may be most necessary in situations where learners are experiencing stress and instability. This interpretation is consistent with research that suggests that faculty empathy contributes to students' sense of belonging and overall experience, which encourages student success (Hoffman et al., 2002). Further, we conclude that while the pandemic introduced some previously never experienced stressors that may have subsided since, post-pandemic fallout may be contributing to the steady increase in mental health issues among contemporary college-going students (Dave et al., 2024). Effectively facilitating student success will continue to require a focus on the learners' experiences and backgrounds with intentional design of online spaces and humanized learning environments (Pancasky-Brock et al., 2020).

Campus administrators are likely to benefit from the findings of this study as this research suggests a specific and feasible way to improve student academic success. For many institutions of higher education (IHE), resources are limited; this may be especially true for institutions where course pass rates are particularly problematic. Based on this research, it is recommended that campus administrators invest in faculty training designed to help faculty facilitate community in their online courses. Department chairs and deans might also consider incentivising faculty who engage in online pedagogy professional development that explores inclusive design and delivery. Communities of practice or inquiry centered around designing and implementing inclusive design in online courses may prove to be a particularly promising strategy towards improving online student success.

Faculty are also implicated through this work. Many faculty may benefit personally (e.g., improved student evaluations, increased job satisfaction) by a positive change in their course pass rates. This research suggests that even very small changes to online course delivery may positively impact course pass rate. It is recommended that instructional designers and faculty

work together to identify small changes to their courses that allow for more inclusive design and delivery. The idea that a major course overhaul is not necessary to impact student outcomes is helpful to faculty who may wish to improve their student experience, but may feel overwhelmed or time-restricted, and for those for whom full course redesign may not be an immediate option.

Finally, students are implicated through this research as these findings point to strategies for improving the overall student experience. This research emphasizes the connection between community and academic success. As retention theory suggests (Tinto, 1993) academic integration is an essential component to student retention. This research provides insight into one feasible mechanism to help improve student pass rates, which relates to both student academic integration and retention. It is recommended that to aid in college student development, that opportunities to create community through inclusive design and delivery are pervasive across campus and inclusive of online learning environments. Further, given that post-pandemic online modalities are common in many IHEs, this research contributes to the literature around the needs of the contemporary higher education student.

Future Research

Based on the findings of this research, it is recommended that future studies investigate the effectiveness of inclusive course designs in different types of institutions to determine the generalizability of these findings across course and institution types. Future studies might also focus on student experience in online classrooms, to understand if inclusive design contributes to increased levels of student self-efficacy, or classroom community, for example.

Conclusion

This study investigates how inclusive design is related to online student course pass rates. The findings indicate that inclusive design is predictive of online student pass rate after controlling for other known indicators of student academic success. This information provides a feasible strategy that can be utilized by university administrators and faculty to encourage thoughtful design of online courses that can positively elevate the online learning experience and contribute to higher levels of college student success.

Declarations

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

References

- Archambault L., Leary, H., & Rice, K. (2022) Pillars of online pedagogy: A framework for teaching in online learning environments. *Educational Psychologist*, 57(3), 178-191. <https://doi.10.1080/00461520.2022.2051513>
- Archard, S. J. (2014). Feeling connected: A sense of belonging and social presence in an online community of learners. *International Journal of Cyber Ethics in Education*, 3(2), 13-26. <https://doi.10.4018/ijcee.2014040102>
- Bartlett, M. E., Warren, C. L., & Chapman, D. D. (2021). Supporting postsecondary faculty transition to rapid online teaching and learning. *Impacting Education: Journal on Transforming Professional Practice*, 6(2), 43-47. <http://doi.10.5195/ie.2021.158>
- Bawa, P. (2016). Retention in online courses: Exploring issues and solutions—A literature review. *Sage Open*, 6(1), 21-58. CAST (2018). Universal design for learning guide- lines version 2.2 <http://udlguidelines.cast.org>
- Chen, B., Bastedo, K., & Howard, W. (2018). Exploring design elements for online stem courses: active learning, engagement & assessment design. *Online Learning*, 22(2), 59-75. <https://files.eric.ed.gov/fulltext/EJ1181419.pdf>
- Csibra, G., & Gergely, G. (2006). Social learning and social cognition: The case for pedagogy. In Y. Munakata & M. H. Johnson (Eds.), *Processes of change in brain and cognitive development* (pp. 249-274). Oxford University Press.
- Dave, S., Jaffe, M., & O'Shea, D. (2024). Navigating college campuses: the impact of stress on mental health and substance use in the post COVID-19 era. *Current Problems in Pediatric and Adolescent Health Care*, 101585.
- Frankola, K. (2001). Why online learners drop out. *Workforce*, 80(10), 53-58.
- Greene, J. A., Oswald, C. A., & Pomerantz, J. (2015). Predictors of retention and achievement in a massive open online course. *American Educational Research Journal*, 52(5), 925-955.
- Guzzardo, M. T., Khosla, N., Adams, A. L., Bussmann, J. D., Engelman, A., Ingraham, N., & Taylor, S. (2021). “The ones that care make all the difference”: Perspectives on student-faculty relationships. *Innovative Higher Education*, 46(1), 41-58. <https://doi.org/10.1007/s10755-020-09522-w>
- Hockings, C., Brett, P., & Terentjevs, M. (2012). Making a difference—inclusive learning and teaching in higher education through open educational resources. *Distance Education*, 33(2), 237–252. <https://doi.org/10.1080/01587919.2012.692066>
- Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020, March 27). The difference between emergency remote teaching and online teaching. *Educause Review*.

<https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning>

- Hoffman, M., Richmond, J., Morrow, J., & Salomone, K. (2002). Investigating “sense of belonging” in first-year college students. *Journal of College Student Retention: Research, Theory & Practice*, 4(3), 227-256. <https://doi.org/10.2190/DRYC-CXQ9-JQ8V-HT4V>
- Kauffman, H. (2015). A review of predictive factors of student success in and satisfaction with online learning. *Research in Learning Technology*, 23. <https://doi.org/10.3402/rlt.v23.26507>
- Ko, M. (2021). *Course design equity and inclusion rubric*. Teaching Commons. <https://teachingcommons.stanford.edu/news/course-design-equity-and-inclusion-rubric>.
- Lee, Y., & Choi, J. (2013). A structural equation model of predictors of online learning retention. *The internet and higher education*, 16, 36-42. <https://doi.org/10.1016/j.iheduc.2012.01.005>
- Martin, F., Kumar, S., & She, L. (2021). Examining higher education instructor perceptions of roles and competencies in online teaching. *Online Learning*, 25(4), 267-295.
- Martin, F., Oyarzun, B., & Sadaf, A. (2023). Higher Education Instructor Perception of Helpfulness of Inclusive and Equitable Online Teaching Strategies. *Online Learning*, 27(4), 144-170. <https://doi.10.24059/olj.v25i4.2570>
- Mayhew M. J., Rockenbach A. N., Bowman N. A., Seifert T. A., Wolniak G. C., Pascarella E. T., Terenzini P. T. (2016). *How college affects students Volume 3: 21st century evidence that higher education works*. Jossey-Bass.
- McCombs, B. (2015). Learner-centered online instruction. *New Directions for Teaching and Learning*, 2015(144), 57-71. <https://doi.org/10.1002>
- Means, B., Bakia, M., & Murphy, R. (2014). *Learning online: What research tells us about whether, when and how*. Routledge.
- Mishra, L., Gupta, T., & Shree, A. (2020). Online teaching-learning in higher education during the lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open*, 1, 100-112. <https://doi.org/10.1016/j.ijedro.2020.100012>
- Pacansky-Brock, M., Smedshammer, M., & Vincent-Layton, K. (2020). Humanizing online teaching to equitize higher education. *Current Issues in Education*, 21(2 (Sp Iss)).
- Patterson, B. & McFadden, C. (2009) Attrition in online and campus degree programs *Online Journal of Distance Learning Administration*, 12(2) 24-36.
- Persson, H., Åhman, H., Yngling, A. A., & Gulliksen, J. (2015). Universal design, inclusive

design, accessible design, design for all: different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects. Universal access in the information society, *14*, 505-526. <https://doi.org/10.1007/s10209-014-0358-z>

Rao, K. (2021). Inclusive instructional design: Applying UDL to online learning. *The Journal of Applied Instructional Design*, *10*(1), 83-97.

Sadera, W. A., Robertson, J., Song, L., & Midon, M. N. (2009). The role of community in online learning success. *Journal of Online Learning and Teaching*, *5*(2), 277-284

Simpson, O (2013). Student retention in distance education: Are we failing our students? *Open Learning: The Journal of Open, Distance, and e-Learning*, *28*(2), 105-119.
doi.org/10.1080/02680513.2013.847363

Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. *Journal of Information Technology Education: Research*, *15*, 157-190.

Tinto, V. (1993). Leaving college: Rethinking the causes and cures of student attrition (2nd ed.). Chicago: The University of Chicago Press.

Wladis, C., Conway, K., & Hachey, A. C. (2017). Using course-level factors as predictors of online course outcomes: A multi-level analysis at a US urban community college. *Studies in Higher Education*, *42*(1), 184-200. <https://doi.org/10.1080/03075079.2015.1045478>

Investigating Factors Influencing Student Academic Outcomes in Online Higher Education: A Cross-Sectional Observational Study

Carl Beitsayadeh

College of Doctoral Studies, University of Phoenix, USA

College of General Studies, University of Phoenix, USA

Pamayla E. Darbyshire

College of Doctoral Studies, University of Phoenix, USA

Gergana Velkova

College of Doctoral Studies, University of Phoenix, USA

Abstract

Evolving student demands and technological advancements have facilitated the rise of online learning in higher education, fostering greater access to online educational opportunities. The purpose of this research was to investigate the impact of self-directed learning, collaborative learning, and isolation (independent variables) on academic achievement and academic resilience (dependent variables) among online undergraduate university students, using self-determination theory as the foundation for the research. This study employed a quantitative cross-sectional observational design for population-based surveys and captured a single data collection point from the participants, based on study criteria. Multiple regression analysis revealed self-directed learning and collaborative learning positively correlated with academic achievement and academic resilience, while student isolation showed a negative relationship. Although the study provides valuable insights for online education practitioners, it acknowledges potential limitations due to context-specificity and unexplored factors. This research contributes empirical evidence to inform the design of supportive virtual educational environments in higher education.

Keywords: Academic achievement, academic resilience, collaborative learning, loneliness, self-determination theory, self-directed learning, student isolation, quantitative research

Beitsayadeh, C., Darbyshire, P.E., & Velkova, G. (2026). Investigating factors influencing student academic outcomes in online higher education: A cross-sectional observational study. *Online Learning*, 30(1), pp. 14-46.
<https://doi.org/10.24059/olj.v30i1.5004>

The contemporary higher education landscape has witnessed a dramatic shift towards online learning platforms, driven by flexibility and accessibility for students (Salama & Hinton, 2023). While this trend offers undeniable advantages, it simultaneously presents distinct challenges. Research suggests that online environments can foster student isolation, potentially hindering academic achievement and resilience compared to traditional face-to-face settings (Garivaldis et al., 2022). This necessitates a move away from a singular model for online learners, prompting educators to explore alternative approaches that cater to their specific needs. While previous studies have explored the independent effects of self-directed learning, collaborative learning, and student isolation on academic achievement and academic resilience in online higher education, a critical research gap exists regarding their combined influence (Asif et al., 2022; Lenny et al., 2019; Morris, 2019; Permatasari et al., 2021; Rudd et al., 2021; Santaoja, 2024).

This study aimed to investigate the specific influence of self-directed learning, collaborative learning, and student isolation (independent variables) on academic achievement and academic resilience (dependent variables) among undergraduate online degree program university students. Utilizing a quantitative research approach, the study analyzed the relationship between the variables and contributed a more refined understanding of how to foster student success in online higher education environments. By outlining the measurable outcomes of each variable and its impact on student performance, the investigation illuminated the intricate web of factors influencing online student success. The findings hold the potential to inform the development of targeted support structures and pedagogical approaches that mitigate isolation, enhance self-directed and collaborative learning skills, and empower students to thrive in online learning environments.

Literature Review

How can educators optimize online learning to achieve the best student outcomes while minimizing challenges? Research shows that online courses have drawbacks, such as higher dropout and lower completion rates than traditional in-person classes (Charokar & Dulloo, 2022). To succeed in online courses, students must be strong independent learners and develop self-directed learning skills (Sun et al., 2023). These skills involve taking ownership of their learning process, setting goals, and independently managing their time and resources (Sun et al., 2023). Recent work in Massive Open Online Courses (MOOCs) confirms that SDL is central to motivation, learning strategies, and instructional outcomes in online contexts (Zhu et al., 2022). Charokar and Dulloo found a positive correlation between self-directed learning, academic self-efficacy, and achievement motivation in undergraduate students. The results suggest that fostering students' independence and study skills can improve their self-belief and learning motivation.

While self-directed learning is crucial, collaborative online learning (COL) also plays a significant role in student success. Blau et al. (2020) investigated student perceptions of COL activities in a Management Information System course, finding that well-structured activities with strong peer interaction led to increased perceived learning and satisfaction. Heilporn et al. (2021) examined strategies for fostering communication and interaction in online learning environments and proposed a framework to aid instructors and instructional designers in creating well-structured, interactive online courses for higher education, promoting collaboration among educators, and improving student learning outcomes.

However, the solitary nature of online learning can make it difficult for students to develop these skills independently (Sarkar, 2020). Olugbara et al. (2023) examined factors influencing student support in open and distance learning (ODL) environments, aiming to guide institutions in developing effective support services. Their review suggested that student support is crucial for ODL success, particularly in addressing isolation and dropout rates.

While online programs offer flexibility and accessibility, they may lead to student isolation (ISO) and a lack of engagement (Garivaldis et al., 2022). Research during remote online classes further shows that loneliness and belonging are central concerns for online learners (Hansen-Brown et al., 2022). Studies suggest that ISO in online learning environments can negatively impact academic achievement (AA) and hinder the development of academic resilience (AR), especially when compared to traditional face-to-face learning. This highlights the need for educators to consider alternative approaches beyond a one-size-fits-all model for online learners (Lamon et al., 2020; Sarkar, 2020).

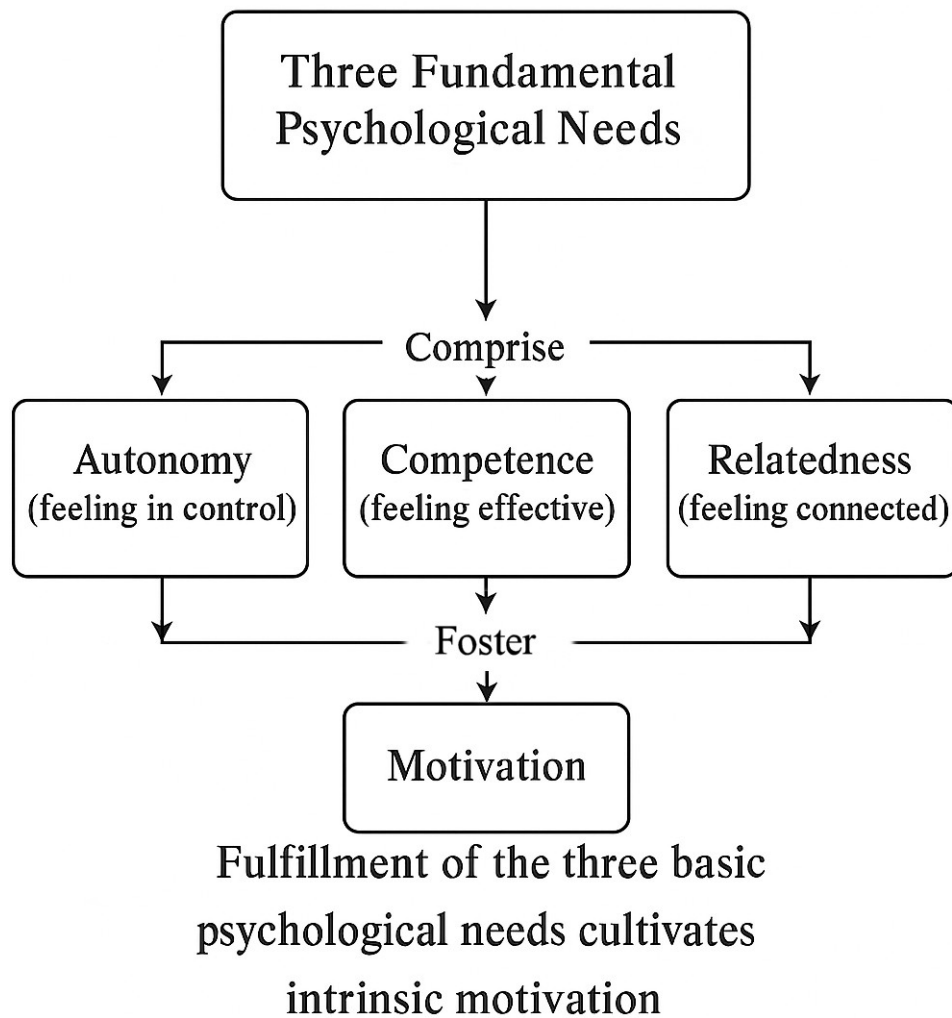
Academic achievement is a student's performance outcome, indicating their met educational goals within an instructional environment (Kassaw & Demareva, 2023). These goals can be cognitive (i.e., critical thinking) or domain-specific (i.e., knowledge acquisition, science, history). Torun (2020) investigated the link between e-learning readiness and AA in an online higher education course and found that motivation emerged as a significant predictor of academic achievement. These findings suggest that fostering students' autonomy and motivation is crucial for success in online environments.

Online learning success also depends on students' academic resilience (AR), which is their ability to bounce back from challenges (Polat, 2024). AR refers to a student's capacity to overcome acute or chronic adversities seen as major assaults on educational processes (Zarrinabadi et al., 2022). Online learning challenges require strong resilience in students as universities work to equip them with coping skills unique to the stressors of the online learning format (Nuryana et al., 2023). The notion of resilience explains why some people respond adaptively to extreme stress while others do not (Avci, 2022; IJntema et al., 2023).

Theoretical Framework

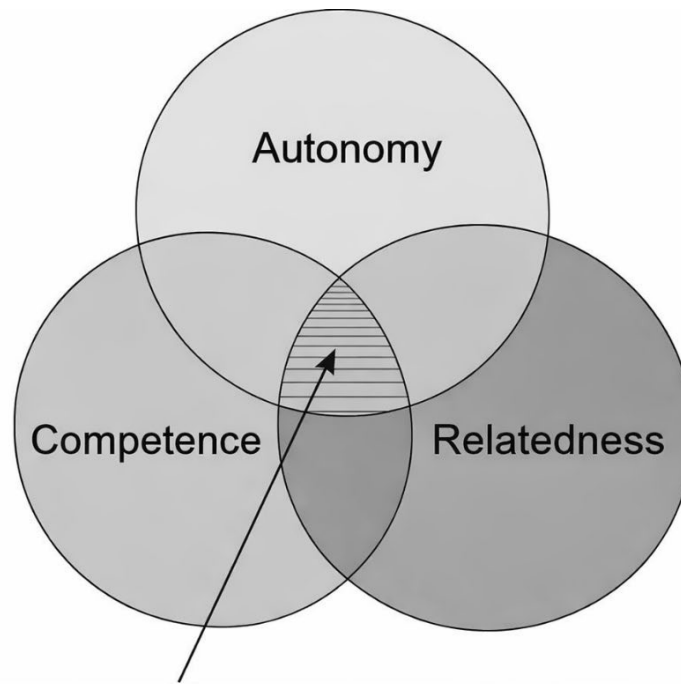
The self-determination theory (SDT), with its focus on the three basic psychological needs of autonomy, competence, and relatedness, provides a valuable theoretical framework for understanding the dynamics of SDL, COL, and ISO in online learning environments (Ryan & Deci, 2020). SDL aligns closely with the need for autonomy, COL supports the need for relatedness, while ISO may hinder the fulfillment of these needs, potentially affecting both AA and AR (Liu & Huang, 2021). These three basic psychological needs are defined as: (1) autonomy, the need to feel a sense of volition and choice in one's actions, (2) competence, the need to feel effective and capable in one's interactions with the environment, (3) relatedness, the need to feel connected and have meaningful relationships with others (Ryan & Deci, 2000).

Figure 1 *Self-Determination Theory (SDT), Fundamental Psychological Needs, Intrinsic Motivation (created by the authors based on Vansteenkiste et al., 2020).*



Note. Figure 1 illustrates the foundational role of the three fundamental psychological needs—autonomy, competence, and relatedness—in fostering intrinsic motivation. Autonomy highlights the sense of self-direction; competence represents perceived effectiveness in interaction with one’s environment; and relatedness underscores the importance of meaningful social connection.

Figure 2 *Intersection of Self-Determination Theory and Basic Psychological Needs (created by the authors based on Vansteenkiste et al., 2020).*



The intersection of autonomy, competence, and relatedness, as proposed by Self-Determination Theory, creates optimal conditions for fostering intrinsic motivation.

Note. Figure 2 illustrates the intersection of autonomy, competence, and relatedness as conceptualized in Self-Determination Theory. The overlap of autonomy and competence reflects a sense of self-directed mastery and confidence. The overlap of autonomy and relatedness reflects support and connection while maintaining individuality, whereas the intersection of competence and relatedness promotes belonging accompanied by effectiveness. The central intersection of all three needs represents the optimal psychological state in which individuals experience empowerment, intrinsic motivation, engagement, and overall well-being.

In the application to educational contextual settings, SDT provides a valuable framework for understanding how structured learning environments promote student motivation and academic success. The theory suggests that how students experience a sense of autonomy, feel competent in their abilities, and have positive relationships with peers and teachers, are likely to exhibit higher levels of intrinsic motivation (Lopez-Garrido & McLeod, 2023). Environments supportive of the three basic psychological needs enhance performance, engagement, and well-being.

Study Variables

This study operationalized key constructs within the framework of self-determination theory (SDT) to investigate the influence of learning contexts and social connection on academic outcomes. The following variables have been identified as central to this inquiry. Each variable is defined and contextualized within the SDT framework, providing a theoretically grounded basis for the subsequent analyses and interpretations. The following outlines each variable and its relationship with SDT.

Independent Variables.

(1) Self-directed learning (SDL) refers to the process by which individuals take initiative in diagnosing their learning needs, formulating learning goals, identifying resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes (Knowles, 1975). Within the SDT framework, SDL aligns with the need for autonomy, as it empowers learners to take control of their learning process.

(2) Collaborative learning (COL) involves the joint intellectual effort of students, or of students and teachers together, typically in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product (Smith & MacGregor, 1992). In the context of SDT, COL primarily addresses the need for relatedness by fostering social connections and a sense of belonging. Additionally, it may contribute to competence as students learn from and with their peers.

(3) Student isolation (ISO) refers to the perceived lack of meaningful interactions with peers, instructors, or the broader academic community in educational settings (Erichsen & Bolliger, 2011). Within the SDT framework, ISO is hypothesized to primarily hinder the fulfillment of the relatedness need but may also impact autonomy and competence by limiting social support and learning resources. Consequently, ISO is expected to negatively influence intrinsic motivation and academic outcomes.

Dependent Variables.

Academic achievement (AA) encompasses the extent to which a student has achieved their short or long-term educational goals (York et al., 2015). In the context of SDT, AA is hypothesized to be enhanced when the three basic psychological needs are met. SDL and COL are expected to positively influence AA by supporting these needs, while ISO is anticipated to have a negative impact.

Academic resilience (AR) refers to students' capacity to overcome acute or chronic adversities that threaten their educational development (Martin & Marsh, 2009). Through the lens of SDT, AR is expected to bolster students' basic psychological needs, equipping them with the motivation and resources to persevere through academic challenges. SDL and COL are hypothesized to enhance AR by supporting these needs, whereas ISO is expected to diminish AR by impeding need fulfillment.

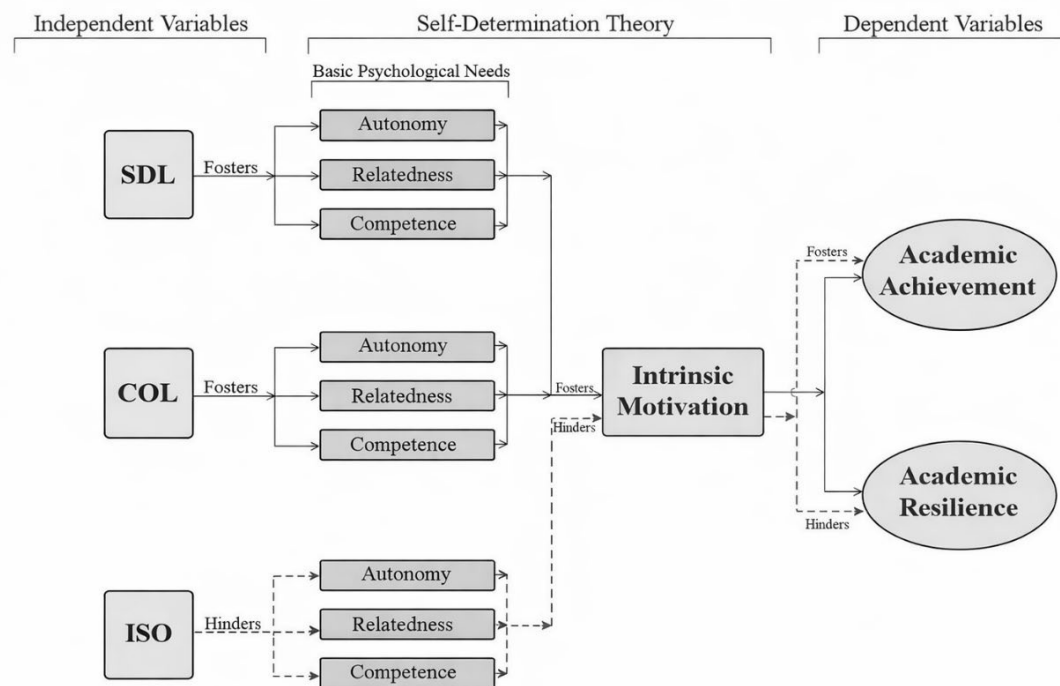
Problem

The literature review highlights the importance of self-directed learning, collaborative learning, and student isolation in higher education online learning environments as they affect student academic achievement and academic resilience. This study investigated the following gaps: (1) Multivariable Analysis (core gap): Extant research within the domain of online higher education learning has primarily focused on the influence of a limited number of independent variables, measured by dependent variables (Fernández-Batanero et al., 2022; Uilah et al., 2023). This study addressed the gap by separately investigating the effect of the independent variables on each dependent variable, utilizing a multivariable multiple regression analysis. (2) Context-Specific Analysis (secondary gap): Current research examined online learners in general and as a broad population, potentially overlooking the influence of specific institutional contexts.

Purpose

This study investigated the relationships between three independent and two dependent variables, providing insights into how educational practices aligned with SDT principles.

Figure 3 *Conceptual Framework of Hypothesized Relationships (created by the authors)*



Note. Figure 3 illustrates the hypothesized relationships between the study variables and SDT psychological components.

Addressing this methodological gap is critical because inadequate handling of heterogeneous scales and psychosocial variables risk obscuring valid predictors of student success in online higher education.

Research Questions and Hypotheses

This study aimed to determine the independent variables' influence on each dependent variable. The primary objective of this research was to analyze the variables and test formulated hypotheses.

Research Question 1: Do self-directed learning, collaborative learning, and student isolation influence academic achievement of undergraduate online degree program university students?

Research Question 1: Hypothesis

H_{01} : Self-directed learning, collaborative learning, and student isolation do not influence academic achievement of undergraduate online degree program university students.

H_{A1} : Self-directed learning, collaborative learning, and student isolation influence academic achievement of undergraduate online degree program university students.

Research Question 2: Do self-directed learning, collaborative learning, and student isolation influence academic resilience of undergraduate online degree program university students?

Research Question 2: Hypothesis

H_{02} : Self-directed learning, collaborative learning, and student isolation do not influence academic resilience of undergraduate online degree program university students.

H_{A2} : Self-directed learning, collaborative learning, and student isolation influence academic resilience of undergraduate online degree program university students.

Methods

Research Design

This study employed a quantitative cross-sectional observational design. The cross-sectional approach captured a single data collection point from the participants, based on inclusion or exclusion criteria (Cuschieri, 2019; Setia, 2016; STROBE, 2025). Cross-sectional designs are used for population-based surveys in conjunction with the study's objectives to investigate the influence of various factors on academic achievement and academic resilience. The study was grounded in self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000), which proposes that three basic psychological needs—autonomy, competence, and relatedness are essential for fostering intrinsic motivation and optimal functioning. This theoretical framework provided the lens to examine the factors influencing academic achievement and academic resilience, particularly in the context of higher education.

Operational Definitions and Measuring Instruments or Study Variables

This section described the operational definitions and corresponding measurement instruments for the principal variables in this study. The selected instruments have demonstrated good psychometric properties in previous research, supporting their validity and reliability for use in this study.

Self-Directed Learning

SDL is the extent to which students demonstrate initiative in their learning process, including goal setting, progress monitoring, and independent knowledge acquisition (Knowles, 1975; Lounsbury et al., 2009).

Measurement Instrument. Self-directed learning scale (SDLS), developed by Lounsbury et al. is a 10-item unidimensional scale that evaluated an individual's capacity to independently seek and acquire knowledge, establish personal learning objectives, and actively engage in the learning process without exclusive reliance on external guidance or instruction. Responses were recorded on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The SDLS demonstrated good internal consistency with a Cronbach's α of 0.87 in previous studies. Participant data was collected using the "Self-Directed Learning Scale" developed by Lounsbury et al. with prior authorization to use the instrument.

Collaborative Learning

COL is defined as the frequency and quality of peer and instructor interactions within online learning environments (Ng et al., 2022). This construct encompassed various aspects of collaborative engagement, including group discussions, peer feedback mechanisms, and collaborative project work.

Measurement Instrument. The Online collaborative learning scale (OCLS), a multidimensional instrument developed by Ng et al. (2022) was employed to assess collaborative learning. The scale utilized a seven-point Likert scale, ranging from "1 = strongly disagree" to "7 = strongly agree" for all items in the survey. Seven dimensions were evaluated: (1) online collaborative tools; (2) collaboration with peers; (3) student engagement; (4) idea generation; (5) idea organization; (6) intellectual convergence; and (7) student learning outcomes. The OCLS demonstrated high reliability with Cronbach's α values ranging from 0.87 to 0.96. Participant data was collected using the "Online Collaborative Learning Scale" developed by Ng et al. with prior authorization to use the instrument.

Student Isolation

ISO is the degree to which students experience a perceived disconnect from peers and instructors, specifically within the context of online learning environments (Hays & DiMatteo, 1987). This construct encompassed social disconnection, loneliness, and the perceived absence of close relationships within the academic setting.

Measurement Instrument. The UCLA Loneliness Scale, ULS-8 (alternative short-form version of the UCLA Loneliness Scale ULS-20) by Hays and DiMatteo (1987) consisted of an 8-item instrument that measured subjective feelings of loneliness and social isolation, including perceived social disconnection, lack of companionship, and feelings of being left out or isolated. Participants respond on a 4-point Likert scale from 1 (never) to 4 (often). ULS-8 demonstrated good internal consistency with a Cronbach's α of 0.84 in previous studies. Participant data was collected using the "ULS-8" developed by Hays and DiMatteo with prior authorization to use the instrument.

Academic Achievement.

AA is a student's self-perceived academic success, such as personal goal attainment, effort expenditure, and relative performance compared to peers. This construct goes beyond traditional objective measures to capture a more holistic view of academic accomplishment (Stadler et al., 2021).

Measurement Instrument. The subjective academic achievement scale (SAAS), developed by Stadler et al. (2021) is a 5-item unidimensional instrument that assessed various aspects of perceived academic success, including grade satisfaction, overall study success, perceived grade-effort appropriateness, study progress, and comparative peer performance. Responses were recorded on a 5-point Likert scale from 1 (low satisfaction) to 5 (high satisfaction). The SAAS has shown good internal consistency with a Cronbach's α of 0.82 in pilot studies (Stadler et al., 2021). Participant data was collected using the "Subjective Academic Achievement Scale" developed by Stadler et al. with prior authorization to use the instrument.

Academic Resilience

AR is defined as the capacity to recover from academic setbacks and challenges while maintaining motivation and perseverance (Cassidy, 2016). This construct encompassed various dimensions of resilience specific to academic contexts, including adaptive coping strategies and positive responses to educational adversities.

Measurement Instrument. The academic resilience scale (ARS-30), developed by Cassidy (2016) is a 30-item instrument. Responses were recorded on a 5-point Likert scale from 1 (strongly agree) to 5 (strongly disagree). The ARS-30 demonstrated high internal consistency with a Cronbach's α of 0.90. Participant data was collected using the "Academic Resilience Scale" developed by Cassidy with prior authorization to use the instrument.

A consolidated summary of reliability and validity statistics, including Cronbach's α , McDonald's ω , factor structures, and fit indices for all study instruments, is provided in Supplemental Materials A1 (Psychometric Properties of Instruments). Team assignment participation data were collected through self-report measures. These reports were not independently verified against course records, which should be considered when interpreting collaborative learning findings.

Power Analysis

A priori power analysis was conducted using G*Power (version 3.1.9.7) to determine the required sample size for the regression models. Based on Cohen et al. (2017), and Kang (2021), guidelines, a medium effect size ($f^2 = 0.15$) was chosen, as it represented a moderate relationship between predictors and outcomes, which is common in educational research. The analysis assumed $\alpha = 0.05$, power $(1 - \beta) = 0.85$, and three predictors. A power of 0.85 was selected, which represented a midpoint between the conventional standard of 0.80 in educational research and a more stringent 0.90 level (Cohen et al., 2017; Faul et al., 2007; Faul et al., 2009; Kang 2021). This choice struck a balance between enhancing the probability of detecting true effects and minimizing the risk of Type II errors (false negatives) while accounting for practical resource limitations. At this power level, the study had an 85% chance of identifying a genuine effect (if one existed) in the population, thereby increasing the robustness of the findings (compared to a standard 0.80 power) without incurring the substantial increase in required sample size associated with a power of 0.90. The resulting minimum required sample size was 87 participants. The study target population of 268 exceeded this requirement, ensuring adequate statistical power to detect medium-sized effects. This sample size also allowed for the detection of smaller effects and provided more precise parameter estimates, enhancing the robustness of the findings.

Sensitivity Analyses

Using G*Power revealed the sample size of 268, $\alpha = 0.05$, and power = 0.85, effect sizes as small as $f^2 = 0.0466$ could be detected. The regression analyses yielded effect sizes of $f^2 = 0.212$ for academic achievement ($R^2 = 0.175$) and $f^2 = 0.198$ for academic resilience ($R^2 = 0.165$), both falling within the medium effect size range guidelines (Cohen et al., 2017; Faul et al., 2007; Faul et al., 2009; Kang, 2021). These results indicated that the sample size of 268 participants provided robust statistical power.

Study Participants and Sample Criteria

Study participants were recruited through eligibility criteria. This method aligns with the cross-sectional observational study design (Cuschieri, 2019; STROBE, 2025). The inclusion criteria was a target population of online college students ≥ 18 years old, enrolled in online bachelor's degree programs from five colleges incorporated within a university campus in Southwestern United States within 60 days preceding the receipt of the survey, and had participated in class team assignments. Exclusion criteria were students < 18 years old and not currently enrolled in online bachelor's degree programs at the university. This carefully structured inclusion-exclusion framework ensured that the study sample accurately

represented the target population, thereby enhancing the validity and generalizability of the research findings within the context of online higher education (Cuschieri, 2019; STROBE, 2025).

Recruitment Process

Recruitment was conducted through the university's marketing department. A total of 25,450 survey invitations were emailed to students meeting the inclusion criteria. Invitations were sent in five batches on consecutive Mondays over a 30-day data collection period from July 22, 2024, to August 20, 2024. To prevent duplicate responses, subsequent batches excluded recipients who had already accessed the survey link.

Data Collection

Data collection, through Google Forms, a secure online survey platform, ensured participant anonymity, and efficiency in data gathering (Creswell & Creswell, 2022). The survey captured essential participant demographic information and allowed for a more detailed understanding of the sample population (Hakimi et al., 2024; Kayyali, 2024). No incentives were offered to participants to ensure unbiased responses.

Survey Response

The survey yielded 561 responses during the 30-day data collection period, resulting in a gross response rate of 2.2% (561/25,450). On average, online survey response rates are 11% below mail and phone surveys, and rates as low as 2% have been reported (Monroe & Adams, 2012; Petchenik & Watermolen, 2011). Several contributing factors to the low response rate were: (1) Monday distributions; (2) 94-item questionnaire and personal time investment; (3) demographics of the target population (age) may have influenced response rates; (4) survey fatigue and (5) a lack of personal interest or perceived relevance in the research topic. Despite the low overall response rate, the study achieved a more than sufficient sample size for robust statistical analysis.

Data Cleaning

A systematic approach was initiated to ensure the quality and relevance of the collected responses:

Removal of responses lacking informed consent	(<i>n</i> = 3)
Exclusion of participants with associate degrees	(<i>n</i> = 7)
Exclusion of participants with certifications	(<i>n</i> = 1)
Elimination of incomplete responses	(<i>n</i> = 180)
Exclusion of responses from the College of Business & IT	(<i>n</i> = 19)
Removal of suspicious responses exhibiting repetitive, conflicting and extreme answer patterns	(<i>n</i> = 83)

The last criterion involved a meticulous examination of response patterns to identify suspicious or potentially non-genuine participation. This included responses with identical answers across multiple constructs, uniform selection of extreme values, or consistent selection of the same response option throughout the survey. Additionally, responses were deemed conflicting if they indicated no engagement in teamwork assignments while providing answers to collaborative learning experience questions. This rigorous data cleaning process aimed to enhance the overall quality and reliability of the study's dataset by excluding responses (293) that did not meet predefined criteria for completeness, relevance,

and authenticity. The resulting sample of 268 responses was utilized for subsequent analyses, ensuring a more robust and valid dataset for the study.

Sample Distribution

Table 1

Demographic Characteristics of Participants (n = 268) Compared with Raw Data (N = 561)

College	Analyzed (n = 268)	%	Raw Data (N = 561)	%
Social-Behavioral Sciences	115	43	220	39
Health Professions	65	24	118	21
Education	54	20	125	22
General Studies	30	11	64	11
Nursing	4	1	12	2

Note. The demographic distribution of the analyzed sample closely mirrors that of the original sample, with the percentages from each college remaining consistent. This indicates that the data cleaning process did not introduce significant bias.

Data Transformation

The presence of heterogeneous Likert scales, coupled with non-normal data distributions and the identification of outliers, necessitated a rigorous data preprocessing approach prior to subsequent analyses. Accordingly, all variables were standardized using a rank-based inverse normal z-score transformation (Chien, 2020; Solomon & Sawilowsky, 2009), which ensured comparability across instruments and improved residual properties. Full transformation steps are detailed in Supplemental Materials A2.1, with sensitivity analyses reported in A2.2.

Data Analysis

Data analyses were accomplished using JASP (Version 19.1), a statistical analysis open-source software package suitable for this study's analytical requirements. Data were categorized in Microsoft Excel prior to JASP analyses and data standardization.

Ethical Considerations

Informed consent was obtained from participants, clearly describing the study's purpose, potential risks and benefits, and the voluntary nature of participation. Participants were assured of their right to withdraw without consequence and skip any uncomfortable questions, respecting their autonomy. Anonymity was maintained by not collecting any personal identifying information (PII) from the participants. To minimize potential biases, the study employed strategies such as rigorous participant selection based on established eligibility criteria, standardized data collection procedures, and systematic analysis methods. All raw data and digital files were slated for permanent deletion upon completion of the study, and no physical copies were generated or retained throughout the research process. This collective approach ensured the protection of participants' rights, enhanced research validity, and supported scientific integrity while balancing research objectives with ethical considerations (Ravitch & Riggan, 2016).

Results

This section represents the empirical findings of the effects of self-directed learning, collaborative learning, and student isolation on academic achievement and academic resilience among undergraduate online degree program university students. Statistical analyses revealed significant relationships between SDL, COL, and ISO and academic outcomes, providing a deeper understanding of the factors that contribute to student success in the online learning environment.

Demographic Descriptive Statistics

Table 2

Demographic Characteristics of Participants (n = 268)

Characteristic	n = 268	%
Gender	responses	
Female	236	88.06
Male	29	10.82
Other	3	1.12
Age		
18-24	8	2.99
25-34	60	22.39
35-44	90	33.58
45-54	77	28.73
55-64	29	10.82
65 and over	4	1.49
College		
Social and Behavioral Sciences	115	42.91
Health Professions	65	24.26
Education	54	20.15
General Studies	30	11.19
Nursing	4	1.49
1st Generation College Student?		
Yes	170	63.43
No	98	36.57
Employment Status		
Full-time employed (35+ hours/week)	158	58.96
Part-time employed (less than 35 hours/week)	38	14.18
Not currently employed	65	24.25
Prefer not to answer	7	2.61

The majority of participants identified as female (88.06%, $n = 236$), with a small proportion identifying as male (10.82%, $n = 29$) and other gender identities (1.12%, $n = 3$). Age distribution was between 25-54 years, with 33.58% ($n = 90$) in the 35-44 age range, followed by 28.73% ($n = 77$) in the 45-54 range, and 22.39% ($n = 60$) in the 25-34 range. Regarding college affiliation, 42.91% ($n = 115$) were from the college of social and behavioral sciences, with the remaining distributed across other colleges. Notably, 63.43% ($n = 170$) of participants identified as first-generation college students. Employment status

varied among participants, with 58.96% ($n = 158$) reporting as full-time employed, 24.25% ($n = 65$) not currently employed, and 14.18% ($n = 38$) employed part-time.

Statistical Analysis

To explore potential associations between demographic factors, several statistical analyses were conducted. A χ^2 test of independence revealed no significant relationship between gender and age ($\chi^2(20) = 27.691, p = 0.117$), first-generation status ($\chi^2(4) = 3.323, p = 0.505$), college affiliation ($\chi^2(16) = 21.900, p = 0.146$), or employment status ($\chi^2(12) = 8.806, p = 0.719$). However, using Kendall's τ_b test, a weak positive correlation was found between gender and age (Kendall's $\tau_b = 0.167, p = 0.003$). The contradictory results between gender and age highlight the importance of using multiple statistical approaches to fully understand the relationships between variables in complex datasets.

Demographics Effects on the Academic Achievement Linear Regression Model

Analysis of demographic variables' effects on academic achievement (AA) revealed that gender significantly influenced AA, with male students showing a notable positive effect ($\beta = 0.180, p = 0.044$). Other demographic factors, including age, college affiliation, employment status, and first-generation student status, did not demonstrate statistically significant associations with AA.

Demographics Effects on the Academic Resilience Linear Regression Model

Analysis of demographic variables' effects on academic resilience revealed no statistically significant influences. While some categories approached marginal significance or exhibited notable trends, the overall impact of demographics on AR was limited.

Descriptive Statistics of Independent and Dependent Variables

The analyses encompassed measures of central tendency, dispersion, and distribution characteristics for each variable, based on standardized data using the rank-based inverse normalized z-score standardization method.

Table 3

Descriptive Statistics for SDL, COL, ISO, AA, and AR (n=268)

Variable	Mean (95% CI)	Median	Mode	SD	Range	Skewness	Kurtosis
SDL	-0.593 (-0.680, 0.505)	-0.344	0.005	0.729	-0.900 to 0.042	-1.085	0.508
COL	-0.517 (-0.600, -0.433)	-0.513	0.061	0.693	-2.900 to 0.722	-1.123	0.755
ISO	-1.392 (-1.604, 1.179)	-2.900	-2.900	1.766	-2.900 to 1.288	0.368	-1.766
AA	-0.677 (-0.752, -0.602)	-0.288	-0.268	0.655	-2.900 to -0.231	-1.349	1.262
AR	-0.779 (-0.843, -0.716)	-0.470	-0.470	0.527	-2.900 to -0.042	-1.790	2.821

Note. CI = Confidence Interval; SD = Standard Deviation

All variables exhibited negative mean scores, with ISO the lowest mean (-1.392) and COL the highest (-0.517). The standard deviations ranged from 0.527 for AR to 1.766 for ISO, indicating differing levels of response variability. SDL, COL, AA, and AR demonstrated negative skewness, suggesting a tendency towards higher scores, whereas ISO displayed positive skewness, indicating a tendency towards lower scores. The kurtosis values revealed leptokurtic distributions for SDL, COL, AA, and AR, while ISO exhibited a platykurtic distribution.

Correlation Among Variables

Spearman's correlation coefficient revealed significant relationships among the variables, indicating that SDL and COL are positively correlated with AA and AR, while ISO is negatively correlated with these outcomes (Table 4). The strongest positive correlation was found between COL and AR ($r = 0.455, p < 0.001$), whereas the strongest negative correlation was observed between ISO and AR ($r = -0.363, p < 0.001$). These findings suggest that both SDL and COL may positively contribute to academic outcomes, while ISO may have detrimental effects.

Table 4

Spearman's Correlation Matrix for SDL, COL, ISO, AA, and AR

Variable	SDL	COL	ISO	AA	AR
SDL	1				
COL	0.237*	1			
ISO	-0.253*	-0.249*	1		
AA	0.297*	0.298*	-0.221*	1	
AR	0.266*	0.455*	-0.363*	0.306*	1

Note. * $p < 0.001$

Instrument Reliability

All instruments demonstrated good to excellent internal consistency, with Cronbach's α ranging from 0.624 (AA) to 0.957 (COL). The SDL and COL instruments showed excellent reliability and validity, while the ISO instrument suggested a potential two-factor structure. The AA instrument demonstrated moderate internal consistency with one weak item, and the AR scale showed excellent internal consistency.

Research Question 1: Influence of Predictors on Academic Achievement

Linear Regression Analysis. A multivariable linear regression model (M_1) was employed to examine the combined effect of SDL, COL, and ISO on AA. This model explained 17.5% of the variance in academic achievement ($R^2 = 0.175$, Adjusted $R^2 = 0.166$), demonstrating significant overall fit ($F(3,264) = 18.703, p < 0.001$). All three predictors (SDL, COL, ISO) significantly contributed to the model (p values < 0.05). SDL ($\beta = 0.228, t = 3.871, p < 0.001$) and COL ($\beta = 0.231, t = 4.019, p < 0.001$) were positively associated with AA, while ISO ($\beta = -0.140, t = -2.403, p = 0.017$) exhibited a negative association. These results confirmed the positive effects of SDL and COL on AA while indicating a negative impact from ISO.

Table 5

Model Summary for Model M_1 – Academic Achievement

M	R	R^2	Adj. R^2	AIC	BIC	F Change	$df1$	$df2$	p	Durbin-Watson		
										Auto correlation	Statistic	p
M_0	0.000	0.000	0.000	357.423	364.605		0	267		0.036	1.926	0.541
M_1	0.419	0.175	0.168	311.776	329.731	18.703	3	264	<0.001	0.058	1.877	0.312

Note. M = model, M_1 includes SDL, COL, ISO

The results of the ANOVA for Model M1 and the regression analysis are summarized in Supplemental Materials A3 (ANOVA Results, Table A3.1) and A4 (Regression Coefficients, Table A4.1). Posterior summaries from the Bayesian Robustness Test are reported in A5 (Table A5.1).

Hypothesis Testing and Error Consideration.

Multivariable linear regression model (M_I) analysis strongly supported the influence of SDL, COL, and ISO on AA. Model M_I explained 17.5% of AA variance, with all predictors significant ($p < 0.001$), showed high inclusion probabilities (SDL and COL > 0.99 , ISO > 0.855). These results reject the null hypothesis, minimizing Type I and Type II error risks.

Research Question 2: Influence of Predictors on Academic Resilience

Linear Regression Analysis

The regression model yielded statistically significant contributions from all three predictors: SDL demonstrated a positive influence ($\beta = 0.167$, $t=2.815$, $p=0.005$), as did COL with a stronger effect ($\beta = 0.226$, $t = 3.896$, $p < 0.001$), while ISO exhibited a negative impact ($\beta = -0.196$, $t = -3.346$, $p < 0.001$) on AR. These results confirmed the positive effects of SDL and COL on AR while indicating a negative impact from ISO.

Table 6

Model Summary for Model M_I – Academic Resilience

M	R	R^2	Adj. R^2	AIC	BIC	F Change	$df1$	$df2$	p	Durbin-Watson		
										Auto correlation	Statistic	p
M_0	0.000	0.000	0.000	266.808	233.990		0	267		0.034	1.930	0.566
M_I	0.406	0.165	0.155	184.513	202.468	17.377	3	264	<0.001	-0.034	2.055	0.652

Note. M = model, M_I includes SDL, COL, ISO

The results of the ANOVA for Model M_I and the regression analysis are summarized in Tables A3.2 and A4.2, respectively. Detailed results of the Bayesian Robustness Test, including posterior summarized in Supplemental Materials A3 (ANOVA Results, Table A3.2) and / (Regression Coefficients, Table A4.2). Posterior summaries from the Bayesian Robustness Test are reported in A3.2 (Table A5.2).

Hypothesis Testing and Error Consideration

The multivariable linear regression model (M_I) strongly supported the influence of SDL, COL, and ISO on AR. Model M_I explained 16.5% of AR variance, with all predictors significant ($p < 0.001$). These results reject the null hypothesis, minimizing Type I and Type II error risks. Robustness checks indicated minimal impact of assumption. COL emerged as the strongest positive predictor, followed by SDL, while ISO consistently showed a negative relationship with AR.

Correlation Between Academic Achievement and Academic Resilience

This analysis revealed a moderate positive correlation between AA and AR (Spearman's $\rho = 0.306$, $p < 0.001$), suggesting that higher AR is associated with improved AA. The use of Spearman's correlation was justified by the non-normal data distribution (Shapiro-Wilk test, $p < 0.001$).

Results Summary

Linear regression analyses revealed significant relationships between the predictors and outcomes. For AA, M_I explained 17.5% of the variance, with SDL and COL showing positive associations, while ISO demonstrated a negative relationship. Similarly, for AR, M_I accounted for 16.5% of the variance with SDL and COL positively influencing AR, and ISO negatively impacting it. Additionally, a moderate positive correlation was observed between AA and AR, further supporting the interrelation of these academic outcomes.

Discussion

This study investigated the influences of self-directed learning, collaborative learning, and isolation on academic achievement and academic resilience among undergraduate college students enrolled in online university degree programs. The findings demonstrated that self-directed learning and collaborative learning exerted a positive influence on academic achievement and academic resilience. Conversely, student isolation represented a significant negative impact on the outcomes. These results not only clarify the roles of self-directed learning, collaborative learning, and isolation but also demonstrate how rigorous data standardization can enhance validity. This contributes to improving the measurement of online student outcomes and strengthens the methodological foundation for future large-scale studies.

Gender Differences in Academic Achievement

The analysis revealed a significant gender difference in AA, with male students exhibiting a notably stronger positive effect. This unexpected finding contrasts with the study by Idriizi et al. (2020), who observed little difference in online learning outcomes based on gender. This discrepancy suggests that the factors influencing gender differences in online learning may be multifaceted.

Effect of SDL on Academic Achievement

Research examining the relationship between SDL and AA have demonstrated that SDL serves as a significant predictor of students' AA (Cazan & Schiopca, 2013); while Khia (2015) revealed that adult students' perceived competence in SDL characteristics, such as goal setting, time management, and stress management, directly and indirectly influenced their academic performance. Lounsbury et al. (2009) suggest that SDL and AA were interconnected and difficult to separate when examining their effects as suggested by the current study results. The positive impact of SDL on AA, supported by Wang et al. (2021), underscores the importance of developing skills that enhance internal motivation. Khalid et al. (2020) revealed a stronger correlation between SDL and academic performance in online students compared to conventional university students. Bacatan et al. (2022) study suggests that while students may be highly self-directed learners, SDL does not directly influence their academic performance. In contrast, Tekkol and Demiral (2018) proved that SDL made a significant change in university students' academic achievements. The results of SDL on AA may influence university leadership in the development of self-directed learning initiatives for online classroom instruction.

Effect of COL on Academic Achievement

Multiple study results, supported by Gat et al. (2021), Knopf et al. (2021), Nazeef and Ali (2024), Warganegara and Gat (2021), found collaborative learning approaches led to a significant and positive improvement in academic achievement; enhanced individual learning

experiences and outcomes; and positively impacts students' academic performance in higher education. The researchers concluded that universities should focus on developing teaching methods that foster collaborative learning environments in online settings, and that encourage student engagement in collaborative learning to improve online teaching and student outcomes.

Effect of ISO on Academic Achievement

The current study revealed a significant negative effect of ISO on AA. This finding was consistent with research by Mizani et al. (2022), who reported that loneliness negatively impacted academic achievement among university students. Hansen-Brown et al. (2022) also highlighted how belonging and loneliness directly shaped student outcomes in remote online classes, reinforcing the importance of addressing isolation in online learning environments. These results emphasize the critical need for online learning environments that foster a sense of community and belonging to mitigate the potential negative impact of isolation on student outcomes. The meta-analysis by Munoz (2024) found a significant negative correlation between loneliness and academic achievement in adolescents. Researchers also believe that loneliness affects students' academic performance (Bek, 2017; Yang & Sweekwi, 2021) and dropout intentions (Alkan, 2014).

Effect of SDL on Academic Resilience

Hasyim et al. (2023) indicated that students with higher levels of self-directed learning tend to exhibit greater academic resilience, suggesting that fostering independence in learning can help students overcome obstacles in their educational journey. Hwang and Kim (2023) suggested that fostering self-directed learning skills can help nursing students cope with academic challenges and stressors, particularly in the context of rapidly changing educational environments, such as those influenced by the COVID-19 pandemic.

Effect of COL on Academic Resilience

Knopf et al. (2021) study found that online collaborative learning can enhance individual learning experiences and outcomes but may also require more time and effort compared to non-collaborative online learning. The research suggests that incorporating collaborative activities in online teaching can help transfer some advantages of traditional classroom settings to the virtual environment.

Effect of ISO on Academic Resilience

Frisby et al. (2024) and Singh et al. (2024) found that students' loneliness negatively impacted their academic resilience. The studies revealed that the COVID-19 pandemic's abrupt shift to online learning and subsequent isolation significantly lowered university students' academic resilience.

Incidental Finding: AA & AR correlation

This study represents a significant positive correlation between AA and AR and aligns with recent research by Khalid et al. (2023), who reported a similar positive relationship between academic performance and academic resilience among university students. The moderate strength of this correlation suggests that while there is a clear relationship between the two, other unaccounted factors play important roles in determining these outcomes.

Strengths

The present study demonstrates several notable strengths that contribute to the understanding of online learning dynamics. Primarily, this research provides an examination

of the complex interplay between predictors and the outcomes. By employing multiple regression analysis grounded in self-determination theory, the study provides empirical insights into the factors influencing academic achievement and academic resilience and adds substantial depth to the existing literature on online education.

The study's methodological approach also presented several strengths. The implementation of multivariable regression analyses enabled a systematic examination of the direct relationships between the predictors and the outcomes, while also investigating the association between the outcomes. This analytical approach provides a more refined understanding of online learning processes compared to simpler correlation studies.

Limitations

Limitations of the study include the use of the cross-sectional design, which restricted the ability to infer causal relationships and provided only a temporal snapshot of student experiences. Additionally, the sample, drawn from a single institution, constrains the extent to which the findings can be applied more broadly. The one-month data collection period, mass email distribution alongside other research studies, and the length of the questionnaire further discouraged participation and contributed to the low gross response rate. The overall response rate of 2.2% also introduces potential nonresponse bias, which may limit the generalizability of the findings.

The reliance on self-reported data introduces potential method bias, as students' perceptions may be influenced by social desirability or recall limitations, despite the common use of such measures in educational research. Furthermore, the study's narrow focus on specific variables limits participant responses. While the broader institutional undergraduate population was female (67% in 2023), the final study sample in 2024 showed an even stronger gender imbalance, with females comprising 88% of respondents. This overrepresentation may reduce applicability of results to underrepresented demographic groups. Beyond gender, the study sample only partially reflects the broader undergraduate population. Age and college distribution aligned with institutional patterns; however, the exclusion of one college in the university and the modest sample size limit full representativeness. The questionnaire length (98 items) may have contributed to survey fatigue, potentially discouraging participation and further reducing response rates.

Implications for Practice

Institutions are encouraged to prioritize initiatives that foster a robust sense of community, promote the adoption of active learning strategies, and deliver targeted support services tailored to the unique challenges faced by online learners. Institutions may consider designing interventions that provide sustained support and are adaptable to the evolving needs of individual learners. The observed positive correlation between AA and AR underscores the importance of online learning environments as a means to enhance academic success. Future research could address the limitations of this study by employing longitudinal research designs, expanding the diversity of participant samples, and investigating the underlying mechanisms that drive the observed relationships. Additionally, examining the moderating effects of individual differences, such as personality traits and learning styles, may offer further insights into the dynamics of academic achievement and academic resilience in online learning contexts.

Future Research

Longitudinal designs would provide more comprehensive insights into the dynamic

nature of academic achievement and academic resilience. A mixed-method approach, combining quantitative analysis with qualitative research could offer deeper understanding of the lived experiences of online learners.

The potential non-linear relationship observed between predictors and academic resilience warrants further exploration. Future studies could employ more sophisticated statistical techniques, such as hierarchical linear modeling, to more precisely map these complex interactions. Additionally, expanding the scope of investigated variables includes examining the roles of self-efficacy, self-regulation, technological self-efficacy, and external support systems in online learning success.

The study's findings also invite development of targeted interventions. Educational institutions could design personalized support programs that recognize the individualized nature of resilience development, offering adaptive strategies that respond to students' unique learning contexts and psychological needs. By prioritizing initiatives that promote active engagement, social connection, and tailored support, educational institutions can enhance student success and ensure equitable access to higher education in an evolving digital landscape. Future research could continue exploring these relationships and investigate additional factors that may influence academic outcomes in higher education online settings. The study may also provide a foundation for future research and the development of targeted interventions to enhance student success.

Conclusion

The findings of this study are likely to prompt reflection among educators and administrators in online learning environments. As the demand for online education continues to rise, it is essential to establish clear connections between learning strategies and student outcomes. This study reveals that while self-directed learning and collaborative learning positively impact academic achievement, their relationship with academic resilience is more complex than initially anticipated; implying that SDL and COL are significant predictors of AA, reinforcing the importance of fostering autonomy and social interaction among students. However, the intricate relationship between these factors and AR suggests that resilience development may require tailored approaches that consider individual student circumstances.

This complexity highlights the need for targeted interventions designed to enhance AR at various stages of students' academic journeys. The significant interaction effect between COL and ISO underscores the use of collaborative activities and student interaction and emphasizes the critical role of community-building in online education, where feelings of isolation can hinder academic achievement and success.

While this study does not provide definitive evidence that specific online learning strategies lead to improved academic outcomes, it reveals the complex interplay of factors influencing student success in online environments. The relationships observed between self-directed learning, collaborative learning, student isolation, and academic outcomes are intricate and may be influenced by confounding factors. These findings underscore the need for further research to fully understand the mechanisms underlying academic achievement and resilience in online learning contexts. This research contributes valuable insights into the dynamics influencing AA and AR in online learning contexts. The study underscores the importance of fostering self-directed and collaborative learning strategies in online education

while addressing issues of student isolation and contributes to understanding the dynamics influencing academic achievement and academic resilience in online learning environments.

Authors Notes**Ethics Statement**

This study adhered to strict ethical research principles outlined in the Declaration of Helsinki, the World Medical Association (WMA, 2023, 2024), and the Belmont Report (Health and Human Services, 2022, 2024) concerning research and human subjects. Prior to data collection, approval was obtained from the university Committee on Research (COR), the Institutional Review Board (IRB # 2187121-1), and the university's legal compliance team. Informed consent was obtained from all participants.

Declaration of Interest/Disclosure/Funding Statement

The authors report there are no competing interests and no financial or non-financial interests.

Conflict of Interest

The authors declare no conflicts of interest related to the research, authorship, or publication of this article.

References

- Alkan, N. (2014). Humor, loneliness and acceptance: Predictors of university drop-out intentions. *Procedia – Social and Behavioral Sciences*, 152, 1079–1086.
<https://doi.org/10.1016/j.sbspro.2014.09.278>
- Asif, M., Khan, M. A., & Habib, S. (2022). Students' perception towards new face of education during this unprecedented phase of COVID –19 outbreak: An empirical study of higher educational institutions in Saudi Arabia. *European Journal of Investigation in Health, Psychology and Education*, 12(7), 835–853.
<https://doi.org/10.3390/ejihpe12070061>
- Avci, S. (2022). Investigation of the individual characteristics that predict academic resilience. *International Journal of Contemporary Educational Research*, 9(3), 543–556. <https://doi.org/10.33200/ijcer.1076091>
- Bacatan, J., Grengia, R. A., Marquez, A., & Mosqueda, R. (2022). Relationship of self-directed learning and academic achievement of second-year teacher education students. *International Journal of Novel Research in Humanity and Social Sciences*, 9(5), 26–36. <https://doi.org/10.5281/zenodo.7221647>
- Bek, H. (2017). Understanding the effect of loneliness on academic participation and success among international university students. *Journal of Education and Practice*, 8(14), 46–50. <https://files.eric.ed.gov/fulltext/EJ1143922.pdf>
- Blau, I., Shamir-Inbal, T., & Avdiel, O. (2020). How does the pedagogical design of a technology – enhanced collaborative academic courses promote digital literacies, self-regulation, and students' perceived learning? *Internet and Higher Education*, 45(100722). <https://doi.org/10.1016/j.iheduc.2019.100722>
- Cassidy, S. (2016). The academic resilience scale (ARS–30): A new multidimensional construct measure. *Frontiers in Psychology*, 7(1787), 1–11.
<https://doi.org/10.3389/fpsyg.2016.01787>
- Cazan, M. & Schiopca, A. (2013). Self-directed learning, personality traits and academic achievement. *Procedia – Social and Behavioral Sciences*, 127, 640–644.
<https://doi.org/10.1016/j.sbspro.2014.03.327>
- Charokar, K., & Dulloo, P. (2022). Self-directed learning theory to practice: A footstep towards becoming a life-long learner. *Journal of Advanced Medical Education Profession*, 10(3), 135–144. <https://doi.org/10.30476/JAMP.2022.94833.1609>
- Chien, L. C. (2020). A rank-based normalization method with the fully adjusted full-stage procedure in genetic association studies. *PloS one*, 15(6), e0233847.
<https://doi.org/10.1371/journal.pone.0233847>
- Cohen, L., Manion, L., & Morrison, K. (2017). *Research methods in education* (8th ed.). Routledge.
- Creswell, J. W., & Creswell, J. D. (2022). *Research design: Qualitative, quantitative, and*

mixed methods approaches (5th ed.). Sage Publications.

- Cuschieri S. (2019). The STROBE guidelines. *Saudi Journal of Anaesthesia*, 13(Suppl 1), S31–S34. https://doi.org/10.4103/sja.SJA_543_18
- Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer.
- Erichsen, E. A., & Bolliger, D. U. (2011). Towards understanding international graduate student isolation in traditional and online environments. *Educational Technology Research and Development*, 59, 309–326. <https://doi.org/10.1007/s11423-010-9161-6>
- Faul, F., Erdfelder, E., Lang, A.–G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191. <https://doi.org/10.3758/BF03193146>
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A.–G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>
- Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & Tadeu, P. (2022). Online education in higher education: Emerging solutions in crisis times. *Heliyon*, 8(8), e10139. <https://doi.org/10.1016/j.heliyon.2022.e10139>
- Frisby, B. N., Sidelinger, R. J., Lawrence, A., & Ribott, M. (2024). Students' peer network quality: Effects on academic resilience and intention to persist. *Review of Communication*, 24(3), 133–145. <https://doi.org/10.1080/15358593.2024.2374913>
- Garivaldis, F. J., Chung, J., Braganza, L., Arulkadacham, L., Sharma, R., Reupert, A., McKenzie, S., Rose, G., Gupta, T., Aziz, Z., Mowbray, T., Ilic, D., & Mundy, M. (2022). Out of sight, but not out of mind: A case study of the collaborative development of a university-wide orientation resource for online students. *Educational Technology Research and Development*, 70(2), 531–558. <https://doi.org/10.1007/s11423-022-10090-3>
- Hakimi, M., Katebzhadah, S., & Fazil, A. W. (2024). Comprehensive insights into e-learning in contemporary education: Analyzing trends, challenges, and best practices. *Journal of Education and Teaching Learning (JETL)*, 6(1), 86–105. <https://doi.org/10.51178/jetl.v6i1.1720>
- Hansen-Brown, A. A., Sullivan, S., Jacobson, B., Holt, B., & Donovan, S. (2022). College students' belonging and loneliness in the context of remote online classes during the COVID –19 pandemic. *Online Learning*, 26(4), 323–346. <https://doi.org/10.24059/olj.v26i4.3123>
- Hasyim, S. P., Oktaviani, M., & Uthor, E. (2023). The effects of self-directed learning on academic resilience in students. In *Proceedings English national seminar: Critical thinking in English education for a just society* (pp. 38–47). English Education Study Program STKIP PGRI PACITAN. <http://repository.stkippacitan.ac.id/id/eprint/1318>

- Hays, R. D., & DiMatteo, M. R. (1987). A short form measure of loneliness. *Journal of Personality Assessment*, 51(1), 69–81. https://doi.org/10.1207/s15327752jpa5101_6
- Heilporn, G., Lakhal, S., & Bélisle, M. (2021). An examination of teachers' strategies to foster student engagement in blended learning in higher education. *International Journal of Educational Technology in Higher Education*, 18(1), 1–25. <https://doi.org/10.1186/s41239-021-00260-3>
- Hwang, E. H., & Kim, K. H. (2023). Relationship between optimism, emotional intelligence, and academic resilience of nursing students: The mediating effect of self-directed learning competency. *Frontiers in Public Health*, 11, 1182689. <https://doi.org/10.3389/fpubh.2023.1182689>
- Idrizi, E., Filiposka, S., & Trajkovik, V. (2020, September). Gender differences in online learning. In *Conference: ICT innovations 2020 web proceedings* [Online conference]. <https://hdl.handle.net/20.500.12188/9485>
- IIntema, R. C., Schaufeli, W. B., & Burger, Y. D. (2023). Resilience mechanisms at work: The psychological immunity – psychological elasticity (PI-PE) model of psychological resilience. *Current Psychology*, 42, 4719–4731. <https://doi.org/10.1007/s12144-021-01813-5>
- Jeffrey's Amazing Statistics Program (JASP). (2024). *JASP (Version 0.19.02)* [Computer software]. <https://jasp-stats.org/>
- Kang, H. (2021). Sample size determination and power analysis using the G*Power software. *Journal of Educational Evaluation for Health Professions*, 18(17), 1–12. <https://doi.org/10.3352/jeehp.2021.18.17>
- Kassaw, C., & Demareva, V. (2023). Determinants of academic achievement among higher education student found in a low resource setting: A systematic review. *PLOS ONE*, 18(11), e0294585. <https://doi.org/10.1371/journal.pone.0294585>
- Kayyali, M. (2024). Career development in higher education: Best practices and innovations. In B. Christiansen & A. M. Even (Eds), *Advancing student employability through higher education* (pp. 1–19). IGI Global. <https://doi.org/10.4018/979-8-3693-0517-1.ch001>
- Khalid, M., Bashir, S., & Amin, H. (2020). Relationship between self-directed learning and academic achievement of university students: A case of online distance learning and traditional universities. *Bulletin of Education and Research*, 42(2), 131–148. <https://files.eric.ed.gov/fulltext/EJ1281053.pdf>
- Khalid, B., Rehman, M. U., Zareen, S. J., Choudary, A., & Sultana, N. (2023). Relationship between academic resilience and academic achievements of students: A case of Government College of Education (Mirpur AJ&K). *Journal of Asian Development Studies*, 12(4), 784–795. <https://doi.org/10.62345/jads.2023.12.4.62>

- Khiat, H. (2015). Academic performance and practice of self-directed learning: The adult student perspective. *Journal of Further and Higher Education*, 41(1), 44–59. <https://doi.org/10.1080/0309877X.2015.1062849>
- Knopf, T., Stumpp, S., & Michelis, D. (2021, July). How online collaborative learning leads to improved online learning experience in higher education. In *8th European Conference of Social Media, ECSM 2021* (pp. 119–127). <https://doi.org/10.34190/ESM.21.010>
- Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers*. ERIC Number: ED114653. <https://eric.ed.gov/?id=ED114653>
- Lamon, S., Knowles, O., Hendy, A., Story, I., & Currey, J. (2020). Active learning to improve student learning experiences in an online postgraduate course. *Frontiers in Education*, 5(598560). <https://doi.org/10.3389/feduc.2020.598560>
- Lenny, D. J., Doleck, T., & Bazelaïs, P. (2019). Self-determination, loneliness, fear of missing out, and academic performance. *Knowledge Management & E-Learning*, 11(4), 485–496. <https://files.eric.ed.gov/fulltext/EJ1245586.pdf>
- Liu, Y., & Huang, X. (2021, August 31). Effects of basic psychological needs on resilience: A human agency model. *Frontiers in Psychology*, 12(700035). <https://doi.org/10.3389/fpsyg.2021.700035>
- Lopez-Garrido, G., & McLeod, S. (2023, July 10). Self-determination theory of motivation. *Simply Psychology*. <https://www.simplypsychology.org/self-determination-theory.html#>
- Lounsbury, J. W., Levy, J. J., Park, S. H., Gibson, L. W., & Smith, R. (2009). An investigation of the construct validity of the personality trait of self-directed learning. *Learning and Individual Differences*, 19(4), 411–418. <https://doi.org/10.1016/J.Lindif.2009.03.001>
- Martin, A. J., & Marsh, H. W. (2009). Academic resilience and academic buoyancy: Multidimensional and hierarchical conceptual framing of causes, correlates and cognate constructs. *Oxford Review of Education*, 35(3), 353–370. <https://doi.org/10.1080/03054980902934639>
- Mizani, H., Cahyadi, A., Hendryadi, H., Salamah, S., & Retno-Santi, S. (2022). Loneliness, student engagement, and academic achievement during emergency remote teaching during COVID –19: The role of the God locus of control. *Humanities and Social Sciences Communications*, 9(1), article 305, 1–9. <https://doi.org/10.1057/s41599-022-01328-9>
- Monroe, M. C., & Adams, D. C. (2012). Increasing response rates to web-based surveys. *The Journal of Extension*, 50(6), 34. <https://doi.org/10.34068/joe.50.06.34>
- Morris, T. H. (2019). Self-directed learning: A fundamental competence in a rapidly changing world. *International Review of Education*, 65, 633–653. <https://doi.org/10.1007/s11159-019-09793-2>

- Muñoz, M. (2024). *A meta-analysis on loneliness in relation to academic achievement and engagement in adolescence*. (Publication No. 31141960) [Master's thesis, University of Georgia]. ProQuest Dissertations & Theses.
- Nazeef, N. M., & Ali, J. (2024). Impact of collaborative learning on students' academic performance in teacher's education program. *Journal of Asian Development Studies*, 13(1), 1054–1068. <https://doi.org/10.62345/jads.2024.13.1.87>
- Ng, P. M. L., Chan, J. K. Y., & Lit, K. K. (2022). Student learning performance in online collaborative learning. *Education and Information Technology*, 27, 8129–8145. <https://doi.org/10.1007/s10639-022-10923-x>
- Nuryana, Z., Xu, W., Kurniawan, L., Sutanti, N., Makruf, S. A., & Nurcahyati, I. (2023). Student stress and mental health during online learning: Potential for post – COVID – 19 school curriculum development. *Comprehensive PsychoNeuroEndocrinology*, 14(100184). <https://doi.org/10.1016/j.cpnec.2023.100184>
- Olugbara, C. T., Letseka, M., & Akintolu, M. (2023). Student support as a panacea for enhancing student success in an open distance learning environment. *Journal of Educators Online*, 20(3), 1–13. <https://doi.org/10.9743/jeo.2023.20.3.9>
- Permatasari, N., Ashari, F. R., & Ismail, N. (2021). Contribution of perceived social support (peer, family, and teacher) to academic resilience during COVID – 19. *Golden Ratio of Social Science and Education*, 1(1), 1–12. <https://doi.org/10.52970/grsse.v1i1.94>
- Petchenik, J., & Watermolen, D. J. (2011). A cautionary note on using the internet to survey recent hunter education graduates: Advantages and disadvantages of online surveys, *Human Dimensions of Wildlife*, 16(3), 216–218. <https://doi.org/10.1080/10871209.2011.563434>
- Polat, M. (2024). Readiness, resilience, and engagement: Analyzing the core building blocks of online education. *Education and Information Technologies*, 29(3). <https://doi.org/10.1007/s10639-024-12534-0>
- Ravitch, S. M., & Riggan, J. M. (2016). *Reason and rigor: How conceptual frameworks guide research* (2nd ed.). Sage.
- Rudd, G., Meissel, K., & Meyer, F. (2021). Measuring academic resilience in quantitative research: A systematic review of the literature. *Educational Research Review*, 34(100402), 1–22. <https://doi.org/10.1016/j.edurev.2021.100402>
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemporary Educational Psychology*, 61(101860). <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1),

- 68–78. <https://doi.org/10.1037/0003-066X.55.1.68>
- Salama, R., & Hinton, T. (2023). Online higher education: Current landscape and future trends. *Journal of Further and Higher Education*, 47(7), 913–924. <https://doi.org/10.1080/0309877X.2023.2200136>
- Santaoja, M. (2024). Fifty shades of academic resilience. *Journal of Praxis in Higher Education*, 6(2), 13–22. <https://doi.org/10.47989/kpdc482>
- Sarkar, S. (2020). A brief history of online education. Adamas University of India and University of Sussex, UK. <https://adamasuniversity.ac.in/a-brief-history-of-online-education/>
- Setia, M. S. (2016). Methodology series module 3: Cross-sectional studies. *Indian Journal of Dermatology*, 61(3), 261–264. <https://doi.org/10.4103/0019-5154.182410>
- Singh, S., Loh, J. Y., & Lin, P. K. F. (2024). Impact of online learning experience during COVID –19: Exploring the relationship between academic resilience, academic self efficacy, and perceived social support. In M. Zangeneh (Ed.). *Essentials in health and mental health: Advances in mental health and addiction* (pp. 39-56). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-56192-4_3
- Smith, B. L., & MacGregor, J. T. (1992). What is collaborative learning? In A. Goodsell, M. Maher, V. Tinto, B. L. Smith, & J. T. MacGregor (Eds.), *Collaborative learning: A sourcebook for higher education*. Pennsylvania State University.
- Soloman, S. R., & Sawilowsky, S. S. (2009). Impact of rank-based normalizing transformations on the accuracy of test scores. *Journal of Modern Applied Statistical Methods*, 8(2), article 9, <https://doi.org/10.22237/jmasm/1257034080>
- Stadler, M., Kemper, C. J., & Greiff, S. (2021). Assessing subjective university success with the Subjective Academic Achievement Scale (SAAS). *The European Educational Researcher*, 4(3), 283–290. <https://doi.org/10.31757/euer.431>
- Strengthening the reporting of observational studies in epidemiology (STROBE). (2025). STROBE checklists. <https://www.strobe-statement.org/checklists/>
- Sun, W., Hong, J. C., Dong, Y., Huang, Y., & Fu, Q. (2023). Self-directed learning predicts online learning engagement in higher education mediated by the perceived value of knowing learning goals. *Asia-Pacific Education Research*, 32(3), 307–316. <https://doi.org/10.1007/s40299-022-00653-6>
- Tekkol, İ. A., & Demirel, M. (2018). An investigation of self-directed learning skills of undergraduate students. *Frontiers in Psychology*, 9, 410879. <https://doi.org/10.3389/fpsyg.2018.02324>
- Torun, E. D. (2020). Online distance learning in higher education: E–Learning readiness as a predictor of academic achievement. *Open Praxis*, 12(2), 191–208. <https://doi.org/10.5944/openpraxis.12.2.1092>

- Uilah, M. S., Hoque, R., Aziz, M. A., Islam, M. (2023, December 15). Analyzing students' e-learning usage and post-usage outcomes in higher education. *Computers and Education Open*, 5(100146), <https://doi.org/10.1016/j.caeo.2023.100146>
- U.S. Department of Health and Human Services. (2022). *The Belmont Report. Ethical principles and guidelines for the protection of human subjects of research*. <https://www.hhs.gov/ohrp/regulations-and-policy/belmont-report/index.html>
- U.S. Department of Health and Human Services. (2024). *What regulations protect research participants?* <https://www.hhs.gov/ohrp/education-and-outreach/about-research-participation/protecting-research-volunteers/principal-regulations/index.html>
- Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). Basic psychological need theory: Advancements, critical themes, and future directions. *Motivation and Emotion*, 44. <https://doi.org/10.1007/s11031-019-09818-1>
- Wang, Q., Xiong, C., & Liu, J. (2021). Does culture or self-directed learning drive online performance? *International Journal of Educational Management*, 35(6), 1077–1098. <https://www.emerald.com/insight/0951-354X.htm>
- Warganegara, D., & Gat, G. (2021). The influence of online learning on students' academic achievement: Mediated by collaborative learning. *International Journal of Advanced Trends in Computer Science and Engineering*, 10(1), 154–163. <https://doi.org/10.30534/ijtcse/2021/211012021>
- World Medical Association. (2023). *Declaration of Helsinki: Ethical principles for medical research involving human subjects*. <https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/>
- World Medical Association. (2024). *International code of medical ethics*. <https://www.wma.net/policies-post/wma-international-code-of-medical-ethics/>
- Yang, D., & Swekwi, U. (2021). The mediating effect of resilience on the relationship between loneliness and academic performance in Wuhan's college students. *Asian Journal of Management Sciences & Education*, 10(1), 96–107. [http://www.ajmse.leena-luna.co.jp/AJMSEPDFs/Vol.10\(1\)/AJMSE2021\(10.1-10\).pdf](http://www.ajmse.leena-luna.co.jp/AJMSEPDFs/Vol.10(1)/AJMSE2021(10.1-10).pdf)
- York, T. T., Gibson, C., & Rankin, S. (2015). Defining and measuring academic success. *Practical Assessment, Research, and Evaluation*, 20(5). <https://files.eric.ed.gov/fulltext/EJ1059739.pdf>
- Zarrinabadi, N., Lou, N. M., & Ahmadi, A. (2022). Resilience in language classrooms: Exploring individual antecedents and consequences. *System*, 109(102892). <https://doi.org/10.1016/j.system.2022.102892>
- Zhu, M., Bonk, C. J., & Berri, S. (2022). Fostering self-directed learning in MOOCs: Motivation, learning strategies, and instruction. *Online Learning*, 26(1), 153–173. <https://doi.org/10.24059/olj.v26i1.2629>

Supplemental Materials

A1. Psychometric Properties of Instruments

Table A1

Summarized Psychometric Properties of Study Instruments

Measure	Cronbach's α [95% CI]	McDonald's ω	Factor Structure	Key Fit Indices	Validity Assessment	Notable Observations
SDL	0.870 [0.853, 0.885] ^a	0.870 ^b	Unidimensional	CFI = 0.909, RMSEA = 0.096	Good	Potential refinement needed
COL	0.960 [0.953, 0.968] ^c	0.989	Seven-factor	CFI = 0.92, RMSEA = 0.06	Excellent	Strong reliability, distinct constructs
ISO	0.854 [0.827, 0.878]	0.848	Potential two-factor	CFI = 0.960, RMSEA = 0.081	Good	Suggests multi-dimensionality
AA	0.624 [0.539, 0.696]	0.682	Unidimensional	CFI = 0.976, RMSEA = 0.096	Acceptable	One weak item, moderate consistency
AR	0.903 [0.885, 0.918]	0.854	Three-factor	CFI = 0.828, RMSEA = 0.077	Good	High internal consistency

Note. SDL = Self-Directed Learning; COL = Collaborative Online Learning; ISO = Isolation; AA = Academic Achievement; AR = Academic Resilience; CFI = Comparative Fit Index; RMSEA = Root Mean Square Error of Approximation. ^a Greatest Lower Bound (GLB) = 0.914.

^b McDonald's ω calculation with CFA failed; value shown is equal to Cronbach's α . ^c Guttman's $\lambda_2 = 0.960$, Greatest Lower Bound = 0.989.

The SDL instrument demonstrated good internal consistency, with Cronbach's α and McDonald's ω both at 0.870 [95% CI: 0.853, 0.885], and the Greatest Lower Bound (GLB) at 0.914. Confirmatory Factor Analysis (CFA) supported a unidimensional structure with fit indices: CFI = 0.909 and RMSEA = 0.096. Factor loadings ranged from 0.410 to 0.649, all significant ($p < 0.001$).

Descriptive statistics revealed negatively skewed item distributions, indicating high reported levels of self-directed learning among participants. The COL instrument exhibited excellent reliability, with Cronbach's $\alpha = 0.960$ [95% CI: 0.953, 0.968] and McDonald's $\omega = 0.989$. The analysis supported a seven-factor structure with fit indices: CFI = 0.92 and RMSEA = 0.06. Factor loadings ranged from 0.58 to 0.89, demonstrating good convergent validity. The instrument demonstrated strong reliability and distinct constructs. The ISO instrument demonstrated good internal consistency with Cronbach's $\alpha = 0.854$ [95% CI: 0.827, 0.878] and McDonald's $\omega = 0.848$. CFA results (CFI = 0.960, RMSEA = 0.081) suggested a potential two-factor structure, indicating possible multidimensionality. The AA instrument demonstrated acceptable internal consistency with Cronbach's $\alpha = 0.624$ [95% CI: 0.539, 0.696] and McDonald's $\omega = 0.682$. CFA supported a unidimensional structure with fit indices: CFI = 0.976 and RMSEA = 0.096. The instrument showed one weak item and moderate consistency overall. The AR Scale demonstrated good internal consistency with Cronbach's $\alpha = 0.903$ [95% CI: 0.885, 0.918] and McDonald's $\omega = 0.854$. CFA supported a three-factor structure with fit indices: CFI = 0.828 and RMSEA = 0.077, indicating high internal consistency.

All instruments showed good to excellent validity assessments, with COL demonstrating the strongest reliability among the measures. Detailed information about each instrument's origin, structure, and original validation can be found in the Methods section.

A2. Data Transformation Procedures

A2.1. Rank-Based Inverse Normalized Z-Score Transformation. To address heterogeneous scale formats, non-normal distributions, and outliers, all variables were standardized using a rank-based inverse normal z-score transformation (Chien, 2020; Solomon & Sawilowsky, 2009). This method simultaneously transforms, normalizes, and standardizes data, producing scores with mean = 0 and standard deviation = 1 while maintaining the ordinal structure of the original responses. The transformation was implemented in four steps:

1. Ranking: All responses were ranked from lowest to highest.
2. Percentile conversion: each rank was converted to its percentile rank using:

$$P_i = \frac{R_i - 0.5}{n} \quad (1)$$

Where:

P_i is the percentile rank for the i^{th} data point

R_i is the rank of the i^{th} data point

n is the total number of data points

3. Inverse normal transformation: Percentile ranks were converted to z-scores using the inverse cumulative distribution of the standard normal distribution (Φ^{-1}):

$$Z_i = \Phi^{-1}(P_i) \quad (2)$$

Where:

Φ^{-1} is the inverse of the standard normal cumulative distribution function

Z_i score is the standardized value

4. Replacement: Original values were replaced with the calculated standardized scores. This transformation effectively represented the original data on a standard normal distribution while preserving order. Importantly, this step enabled the valid combination of predictors measured on different Likert scales (e.g., SDL on a 5-point scale and COL on a 7-point scale), ensuring that regression results reflected true associations rather than artifacts of scale differences.

A2.2. Sensitivity Analysis. To evaluate robustness, regression models were compared using raw Likert data versus transformed data. Results indicated:

Model fit: Transformed models yielded $R^2 = 0.441$ (AA) and 0.368 (AR), closely mirroring raw models ($R^2 = 0.439$ and 0.366).

Predictor stability: Significance levels and standardized β rankings were consistent across both raw and transformed datasets. For example, SDL remained the strongest predictor of AA (raw: $\beta = 0.498$; transformed: $\beta = 0.500$).

Residual diagnostics: Normality improved after transformation (AA: Shapiro–Wilk $W = 0.995$, $p = 0.521$; AR: $W = 0.993$, $p = 0.312$), compared with raw models (AA: $W = 0.991$, $p = 0.103$; AR: $W = 0.989$, $p = 0.056$).

Outlier influence: Cook’s distance decreased (AA: $0.092 \rightarrow 0.078$; AR: $0.115 \rightarrow 0.096$), indicating reduced sensitivity to influential observations.

Collectively, these findings justify the transformation: it preserved substantive conclusions while improving adherence to regression assumptions and minimizing outlier effects.

A3. ANOVA Results

Table A3.1

ANOVA for Model M_1 – Academic Achievement

Model		$\Sigma (X - \mu)^2$	<i>df</i>	Mean Square	<i>F</i>	<i>p</i>	VS-MPR [†]
M_1	Regression	10.283	3	3.428	18.703	< 0.001	3.124×10^8
	Residual	48.383	264	.183	--	--	--
	Total	58.665	267	--	--	--	--

Note. M_1 includes SDL, COL, ISO. [†]Vovk-Sellke Maximum *p*-Ratio: Based on the *p*-value, the maximum possible odds in favor of H_1 over H_0 equals $1/(-e p \log(p))$ for $p \leq 0.37$ (Sellke et al., 2001).

Table A3.2

ANOVA for Model M_1 – Academic Resilience

Model		$\Sigma (X - \mu)^2$	<i>df</i>	Mean Square	<i>F</i>	<i>p</i>	VS-MPR [†]
M_1	Regression	5.942	3.00	1.981	17.377	< 0.001	6.626×10^7
	Residual	30.093	264	0.114	--	--	--
	Total	36.035	267	--	--	--	--

Note. M_1 includes SDL, COL, ISO. Intercept model omitted due to lack of meaningful information. [†]Vovk-Sellke Maximum *p*-Ratio: Based on the *p*-value, the maximum possible odds in favor of H_1 over H_0 equals $1/(-e p \log(p))$ for $p \leq 0.37$ (Sellke et al., 2001).

A4. Regression Coefficients

Table A4.1

Coefficients for Model M_1 – Academic Achievement

Model		<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>	VS-MPR [†]	95% CI		Collinearity Stats	
								Lower	Upper	Tol.	VIF
M_0	IC	-0.677	0.029	--	-23.648	<0.001	1.264*10 ⁶⁴	-0.734	-0.621	--	--
M_1	IC	-0.478	0.045	--	-10.612	<0.001	1.950*10 ¹⁹	-0.567	-0.389	--	--
	SDL	0.199	0.051	0.228	3.871	<0.001	302.634	0.098	0.300	0.898	1.113
	COL	0.205	0.051	0.231	4.019	<0.001	509.024	0.105	0.305	0.942	1.061
	ISO	-0.050	0.021	-0.140	-2.403	0.017	5.327	-0.090	-0.009	0.920	1.087

Note. IC= Intercept; Tol.: Tolerance. [†]Vovk-Sellke Maximum *p*-Ratio: Based on the *p*-value, the maximum possible odds in favor of H_1 over H_0 equals $1/(-e p \log(p))$ for $p \leq .37$ (Sellke et al., 2001).

Table A4.2

Coefficients for Model M_1 – Academic Resilience

Model		<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>	VS-MPR [†]	95% CI		Collinearity Stats	
								Lower	Upper	Tol.	VIF
M_0	IC	-0.704	0.022	--	-31.376	<0.001	1.177*10 ⁸⁸	-0.748	-0.660	--	--
M_1	IC	-0.579	0.036	--	-16.290	<0.001	4.329*10 ³⁸	-0.649	-0.509	--	--
	SDL	0.114	0.041	0.167	2.815	0.005	13.364	0.034	0.194	0.898	1.113
	COL	0.157	0.040	0.226	3.896	<0.001	330.237	0.078	0.236	0.942	1.061
	ISO	-0.054	0.016	-0.196	-3.346	<0.001	56.235	-0.086	-0.022	0.920	1.087

Note. IC = Intercept; Tol.: Tolerance. [†]Vovk-Sellke Maximum *p*-Ratio: Based on the *p*-value, the maximum possible odds in favor of H_1 over H_0 equals $1/(-e p \log(p))$ for $p \leq .37$ (Sellke et al., 2001).

A5. Bayesian Robustness Analyses

Table A5.1

Posterior Summary for Predictors Across Prior Scales – Academic Achievement

<i>a priori</i> Scale(<i>r</i>)	Predictor	<i>P</i> (incl data) ¹	<i>BF</i> _Inclusion ²	Mean	<i>SD</i>	95% CI	
						Lower	Upper
0.2	SDL	0.998	645.931	0.190	0.051	0.085	0.281
	COL	0.999	971.791	0.194	0.050	0.091	0.282
	ISO	0.900	9.048	-0.042	0.024	0.091	0.282
0.354	SDL	0.998	636.730	0.193	0.052	0.097	0.302
	COL	0.999	955.046	0.197	0.051	0.101	0.303
	ISO	0.890	8.061	-0.042	0.024	-0.082	0.000
0.5	SDL	0.998	599.764	0.196	0.052	0.094	0.295
	COL	0.999	889.143	0.200	0.051	0.101	0.299
	ISO	0.876	7.075	-0.042	0.025	-0.081	0.000
0.7	SDL	0.998	534.430	0.199	0.053	0.088	0.284
	COL	0.999	773.616	0.203	0.051	0.098	0.292
	ISO	0.855	5.900	-0.042	0.025	-0.085	0.000

Note. This table shows the posterior inclusion probabilities, Bayes Factors for inclusion, and effect estimates (mean and standard deviation) for each predictor across different prior scales. ¹*P*(incl|data): This is the "posterior inclusion probability", representing the probability that a predictor should be included in the model, given the observed data. ²*BF*_Inclusion: This measure compares all models that include a particular predictor to all models that do not include

that predictor; and represents the average evidence for including each specific predictor (SDL, COL, or ISO) across all possible models. It quantifies the change from prior to posterior odds for including a predictor in the model.

Table A5.2

Posterior Summary for Predictors Across Prior Scales

<i>a priori</i> Scale(<i>r</i>)	Predictor	<i>P</i> (incl data) ¹	<i>BF</i> _Inclusion ²	<i>Mean</i>	<i>SD</i>	95% CI	
						Lower	Upper
0.2	SDL	0.962	25.083	0.103	0.044	0.017	0.189
	COL	0.999	6 69.891	0.147	0.040	0.069	0.225
	ISO	0.991	113.661	-0.051	0.016	-0.082	-0.020
0.354	SDL	0.958	22.754	0.105	0.045	0.017	0.193
	COL	0.998	661.623	0.150	0.040	0.072	0.228
	ISO	0.991	107.009	-0.052	0.017	-0.085	-0.019
0.5	SDL	0.953	20.191	0.106	0.046	0.016	0.196
	COL	0.998	619.056	0.153	0.040	0.075	0.231
	ISO	0.990	97.407	-0.053	0.017	-0.086	-0.020
0.7	SDL	0.944	16.988	0.106	0.047	0.014	0.198
	COL	0.998	544.001	0.155	0.041	0.075	0.235
	ISO	0.988	83.866	-0.053	0.017	-0.086	-0.020

Note. This table shows the posterior inclusion probabilities, Bayes Factors (BF) for inclusion, and effect estimates (mean and standard deviation) for each predictor across different prior scales. ¹ *P*(incl|data): This is the "posterior inclusion probability", representing the probability that a predictor should be included in the model, given the observed data. ² *BF*_Inclusion: This measure compares all models that include a particular predictor to all models that do not include that predictor and represents the average evidence for including each specific predictor (SDL, COL, or ISO) across all possible models. It quantifies the change from prior to posterior odds for including a predictor in the model.

The Bayesian analysis consistently supports the importance of all three predictors across different prior scales. Collaborative learning (COL) shows the strongest evidence for inclusion, followed by student isolation (ISO) and self-directed learning (SDL).

Challenges and Benefits of Collaborative Work in Online Courses

Sheri Conklin

University of North Carolina Wilmington

Stella Kim

University of North Carolina Charlotte

Beth Oyarzun

University of North Carolina Charlotte

Daniel Maxwell

University of North Carolina Charlotte

Abstract

This investigation examined student experiences with online collaborative learning, focusing on the types and frequency of support received and their relationship to the Community of Inquiry framework. An online survey of 110 students revealed that the majority received support from both instructors and peers, with informational support being predominant. Primary benefits included enhanced collaboration skills and increased awareness of others' perspectives, while challenges primarily involved workload management and scheduling. Higher frequency and clarity of support were correlated with greater teaching and social presence. The findings underscore the significance of balanced, frequent, and clear guidance in online collaborative work, as well as the necessity to address deficiencies in emotional support. Implications for instructional design and faculty development are discussed.

Keywords: Online collaborative learning, social presence, instructional design, teaching presence

Conklin, S., Stella, K., Oyarzun, B., & Maxwell, D. (2025). Challenges and benefits of collaborative work in online courses, *Online Learning*, 30(1), pp. 48-77.

<https://doi.org.10.24059/olj.v30i1.4801>

Critical in nearly every field, collaboration consistently emerges as one of the most in-demand skills of any recent college graduate (Martin et al., 2021; Marutschke et al., 2019). Furthermore, the availability and development of educational technologies create opportunities to construct online learning environments that are increasingly responsive to student needs and preferences (Ingram et al., 2024), especially in the wake of the COVID-19 pandemic, as more than 61% of United States undergraduate students were enrolled in an online course in 2021 (National Center for Education Statistics, 2023). The capabilities of these technologies and the ever-expanding role of online learning in higher education (Oyarzun et al., 2023) position educational institutions to more effectively equip students with the requisite skills for success in a rapidly evolving 21st-century workforce, particularly through online collaborative learning.

Through a systematic review of online learner collaboration research, Oyarzun et al. (2023) identified diverse interpretations that, when synthesized, establish a comprehensive Online Collaborative Learning (OCL) Framework for research, facilitating the definition of online learner collaboration. Oyarzun et al. (2023) OCL Framework is structured around four core components: 1) Collaboration Technologies, 2) Collaboration Design, 3) Collaboration Facilitation, and 4) Collaboration Outcomes (p. 76). The OCL Framework posits that online learner collaboration occurs when there is a deliberate utilization of technology in online learning environments designed to facilitate collaborative interactions between instructors and learners for the purpose of achieving specific, measurable learning outcomes. The breadth of this definition leaves room for varied, diverse learning experiences that can be categorized as online learner collaboration, which will be further discussed in the literature review.

The purpose of this study was to explore the experience of students engaged in online learning collaboration, with a specific focus on the sources and frequency of support they receive during those activities. Several studies have investigated the relationship between CoI elements and learning outcomes or student satisfaction but have not directly addressed student support, specifically within the context of collaborative learning (Li et al., 2023; Sonji et al., 2023; Zhang et al., 2023). Addressing student support within collaborative learning is crucial. Collaborative learning environments, particularly web-based and computer-supported platforms, can enhance student engagement and satisfaction. Studies indicate that factors such as social influence and motivation positively impact collaborative learning, thereby improving student satisfaction (Oluwajana et al., 2021). Group member familiarity in collaborative settings increases teamwork satisfaction, which in turn boosts student engagement and perceived knowledge construction (Zhang et al., 2023). However, collaborative learning, especially in online contexts, presents challenges. The COVID-19 pandemic highlighted the difficulties students face with remote learning, isolation, and collaboration (McKay & Sridharan, 2023). This underscores the necessity for support mechanisms to assist students in navigating these challenges. Addressing student support in collaborative learning is essential as it impacts learning outcomes, skill development, and satisfaction. Proper support can enhance critical reflection, self-assessment (Altınay, 2016), and the development of teamwork skills (McKay & Sridharan, 2023). Supported collaborative learning can improve students' learning achievement, self-efficacy, and motivation (Zheng et al., 2020). By focusing on student support, educators can maximize the benefits of collaborative learning while mitigating obstacles, leading to more effective educational experiences.

By examining the relationship between peer and instructor support and the two components (social and teaching) of the Community of Inquiry framework, this study aims to better understand the benefits and challenges associated with online collaboration and how different forms of support may influence student perceptions of their perceived benefits and challenges.

Literature Review

Online Collaborative Learning

As an educational strategy, learner collaboration is fundamentally rooted in the social constructivist theory, which posits that social interaction plays a crucial role in the learning process for individuals (Vygotsky, 1978). Furthermore, strategically designed collaborative learning experiences have the potential to create an environment conducive to meaningful social interaction. The constructivist philosophy, which posits that learning occurs when individuals construct meaning and knowledge through negotiation and interaction with their environment (Piaget, 1977), serves as the theoretical foundation for developing collaborative learning tasks. The integration of this constructivist approach in higher education represents a paradigm shift wherein learners are no longer perceived as passive recipients of information disseminated by an instructor but rather as active participants engaged in the construction of their own meaning within and through intentionally designed learning experiences (Barr & Tagg, 1995; Brooks & Brooks, 1995; Rovai, 2004).

The practice of online collaborative learning is firmly grounded within the Community of Inquiry (CoI) framework (Garrison et al., 2000). CoI comprises three interconnected core components: cognitive presence, social presence, and teaching presence. When strategically integrated, these components can facilitate the creation of rich, engaging online learning experiences (Garrison et al., 2000). While CoI is not inherently limited to collaborative learning experiences, it provides instructors with a comprehensive framework for developing collaborative learning environments that positively correlate with students' perceived learning and satisfaction (Martin et al., 2022). Furthermore, CoI serves as a supportive framework for research into the quality of online collaborative learning experiences (Shea et al., 2022; Stenbom, 2018).

Benefits of Online Collaborative Learning

The potential benefits of strategically designed online collaborative learning experiences are multifaceted and encompass enhancing student engagement and participation, fostering the development of critical thinking skills, improving flexibility and accessibility of learning experiences, and cultivating opportunities for peer support and feedback (Blumenfeld et al., 1996; Lyon et al., 2022; Pena-Shaff & Altman, 2009; Warsah et al., 2021; Wentzel & Watkins, 2011).

Perhaps one of the most frequently referenced benefits of online collaborative learning is the positive development of affective learning outcomes heavily linked to social presence (Garrison et al., 2000), such as an increased feeling of connectedness and the opportunity to build mutual trust through peer interaction (Grothaus, 2022; Oyarzun et al., 2023). These opportunities to foster community engagement in the online environment can contribute to

enhanced student learning outcomes (Chapman et al., 2005; Cherney et al., 2018; Gaad, 2022). Advancements in educational technologies, such as collaborative, cloud-based tools and videoconferencing software, increase the potential for more extensive collaboration as they facilitate interpersonal connections through visual, auditory, and efficient interactive communication among classmates (Grothaus, 2022). The benefits of online collaboration are also noted in asynchronous learning experiences as well, as Yoon et al. (2020) reported success in achieving high levels of dialogic transactivity through asynchronous discussion forums. These dialogic transactivity interactions are distinguished when an individual directly interacts with a peer's contribution by either elaborating on or otherwise agreeing with their sentiments (Vogel et al., 2016).

Expanding on the potential benefits of increased engagement and participation for online collaborative learning experiences, these experiences also create the opportunity to integrate critical thinking skills into the curriculum of online courses. Trespalcacios (2017) integrated collaboration through the utilization of case study analysis activities, requiring small groups to create a presentation about their assigned case through VoiceThread. Trespalcacios' (2017) example also illustrates the role of project-based collaboration in online learning, as strategically designed online collaborative learning experiences frequently incorporate some aspect of project-based collaboration, such as creating a presentation or a paper (Oyarzun et al., 2023). These types of small-group activities have the potential to yield positive academic outcomes (Blumenfeld et al., 1996; Gaad, 2022; Wentzel & Watkins, 2011) and enable instructors to design activities that further develop students' problem-solving and critical thinking skills (Kosar, 2021; Pena-Shaff & Altman, 2009; Rourke & Anderson, 2002).

Strategically designed collaborative learning in the online environment also enables instructors to utilize flexibility and accessibility, benefits of online learning. For example, Learning Management Systems (LMS) coupled with videoconferencing software enable instructors to host a mixture of synchronous and asynchronous discussions (Peterson et al., 2018). When strategically designed to leverage peer facilitation or through instructor-provided feedback throughout the discussion process, asynchronous discussion has been shown as an effective engagement strategy (Guo et al., 2014; Martin & Borup, 2022; Xie & Ke, 2011). This allows the flexibility of asynchronous discussion and the proven benefits of synchronous discussion for enhancing engagement and collaboration (Peterson et al., 2018) to create a learning environment that is robust, engaging, and responsive to the needs and preferences of learners (Ingram et al., 2024).

Online collaborative learning experiences facilitate instructors' ability to enhance the sense of community within an online environment through engaging, peer-oriented tasks. In face-to-face environments, a sense of community can be established through intentional, frequent opportunities for communication (Archambault et al. 2022; Dawson, 2006), and the establishment of an offline sense of community has been cited as an indicator of success in those communities (Baker & Moyer, 2018; Cameron et al., 2009). The significance of a sense of community in the face-to-face environment has naturally led to an increased focus on community engagement in online environments (Chatterjee & Correia, 2020), where online collaborative technologies, from cloud-based systems like Google Drive to discussion forums presented through learning management systems, are prevalent. These technologies enable instructors to

effectively integrate peer-oriented tasks, such as peer feedback opportunities or online discussion, in innovative ways to facilitate collaboration (Ishtaiwa & Aburezeq, 2015; Kerman, et al., 2024; Revere & Kovach, 2011).

Challenges of Online Collaborative Learning

Although there are evident advantages to online collaborative learning, the establishment and facilitation of effective collaboration in an online community presents significant challenges. Primarily, effective collaboration necessitates robust communication, and research indicates that the cognitive and social benefits of collaborative activities may be diminished if learners are unable to collaborate effectively (Jung et al. 2022; Soller, 2001). Communication challenges persist in both asynchronous and synchronous virtual environments (Clark & Brennan, 1991; Jung et al., 2022). In asynchronous spaces, these challenges manifest as potential delays in peer responses, which often predominantly reflect areas of agreement rather than critique (Yoon et al., 2020), thus necessitating explicit communication regarding the expectation for critical discourse, particularly in asynchronous communities (Garrison, 2007). Communication challenges also extend to synchronous spaces, where research suggests that students have reported experiencing feelings of judgment and fatigue during online synchronous sessions, as well as a perceived need to continuously monitor non-verbal cues such as facial expressions and visual appearances on camera (Grothaus, 2022). These concerns are corroborated by additional studies in which students reported reluctance to activate their cameras, citing privacy concerns or general discomfort with being visible on camera (Bedenlier et al., 2021; Brunet & Schmit, 2007; Kozar, 2016; Nilsen et al., 2013).

Additionally, communication concerns underscore student awareness regarding the potential for miscommunication in online interactions (Strauss & Rummel, 2020). Consistent with research indicating student apprehension about non-verbal miscommunication, particularly during video-based interactions (Bedenlier et al., 2021), students also express concerns about the impact of their interactions on their peers' emotional states, specifically citing instances of simultaneous speech attempts during videoconferencing (Grothaus, 2022). These communication challenges may be exacerbated by issues pertaining to equitable student access to adequate technologies, as technical difficulties arising from connectivity issues, operating system compatibility with student devices, or malfunctioning tools can impede engagement and, consequently, collaboration in online environments (Jeong & Hmelo-Silver, 2016; Strauss & Rummel, 2020).

Through their systematic review of online learner collaboration research, Oyarzun et al. (2023) revealed a diverse array of grouping methods utilized in online environments, including random assignment, criteria-based approaches such as heterogeneous or homogeneous grouping, student-created groups, instructor-assigned groups, and additional methods. The complexity of grouping methods is further compounded by conflicting findings in research on the effectiveness of group size (Cherney et al., 2018; Saqr et al, 2019). In essence, the process of grouping students in online environments is intricate, and the decisions made (or absence thereof) during the formation of student groups significantly influence group dynamics and accountability within those groups (Oyarzun et al., 2023). Unequal participation among group members represents a prevalent challenge in online learner collaboration, wherein social loafing, a phenomenon describing the tendency for individuals to exert less effort in collaborative tasks compared to

independent ones, is frequently observed (Karau & Williams, 1993). To mitigate the potential for social loafing within groups, Johnson and Johnson (2009) and Poort et al. (2020) recommend forming smaller groups, specifically those comprising fewer than five students when feasible, with clearly defined roles for participation assigned to each member (Cherney et al., 2018).

Group dynamics, while influenced by grouping decisions, also contribute to peer accountability, a significant challenge in online learner collaboration where managing group conflicts can be problematic. Various strategies, including collaboration scripts, virtual pinboards for accountability in short-term synchronous breakouts, and group presentations, can provide a measure of peer accountability when implemented strategically (Grothaus, 2022; Lingard & Berry, 2002; Strauss & Rummel, 2020). Nevertheless, a perceived deficiency in collaboration and communication skills among peers remains a limiting factor to the success of groups (Barak et al., 2016). This perceived lack of communication and collaboration skills among group members that can impede effective teamwork may also highlight challenges related to motivation and feelings of isolation in online environments (Cherney et al., 2018; Lingard & Berry, 2002). Although research indicates relationships between peers are not themselves a direct predictor of online learning satisfaction, peer relationships have been demonstrated to impact direct predictors of satisfaction, such as the quality of communication between peers and instructors and communication among peers (Wengrowicz et al., 2018).

Community of Inquiry Framework

The three overlapping core components of the CoI framework—cognitive presence, social presence, and teaching presence—can be utilized as a framework to develop comprehensive and engaging online learning experiences (Garrison et al., 2000). Social presence provides a fundamental basis for leveraging the interrelated components of CoI in online collaborative learning; as Garrison (2007) asserts, “understanding the role of social presence is essential in creating a community of inquiry in designing, facilitating, and directing higher-order learning” (p. 69). Social presence can be enhanced through the implementation of structured, collaborative tasks that incorporate clearly defined roles for participation (Cherney et al., 2018) and strategically formed groups comprising students capable of effectively initiating group interactions (Saqr & López-Pernas, 2023). These collaborative, substantive tasks demonstrate the close relationship between social and cognitive presence, and cognitive presence can be enhanced through online collaboration in various ways, including discussion forums for sustained reflection or groups with well-defined objectives capable of producing sustained collaboration, occasionally without necessitating synchronous engagement in a virtual environment (Baker, 2004; Garrison, 2007; McPherson & Nunes, 2004; Oyarzun et al., 2023; Wengrowicz et al., 2018).

The Community of Inquiry (CoI) framework emphasizes the importance of timely support and guidance for students in OCL environments. Timely support and guidance are primarily associated with the teaching presence component of the CoI framework. Teaching presence involves designing, facilitating, and directing cognitive and social processes to achieve meaningful learning outcomes (Tolu, 2013). In OCL, instructors play a vital role in providing timely feedback, addressing student concerns, and guiding discussions to maintain focus on learning objectives. Martin et al. (2021) found instructors’ timely responses were rated highly for enhancing instructor presence, engagement, and learning in online courses. Effective facilitation

by instructors is essential for successful online group work. While group work can be a valuable learning tool, students often resist it. However, with good design and effective facilitation, it can lead to positive outcomes (Gibson, 2019). Instructors need to discuss group management issues, use methods to evaluate individual performance within groups, and provide adequate support to facilitate students' group experiences (Chapman & Van Auken, 2001).

Examining the significance of social and cognitive presence highlights the substantial role that teaching presence plays in developing and managing online collaborative learning environments. Consideration of the importance of social and cognitive presence also reveals the outsized impact of teaching presence in the creation and facilitation of online collaborative learning experiences (Baker, 2004; Garrison, 2007). Instructors play an essential role in modeling productive critical discourse, in addition to their importance in facilitating collaboration through establishing clear measures for peer accountability (Garrison, 2007; Strauss & Rummel, 2020). Heilporn and Desrochers (2020) specifically mention instructor presence is evident to students through an instructors accessibility, availability, and follow-up, revealing to students that the instructor cares for students, which has "major impacts on students' perceptions in an online course" (p. 10). Therefore, the design of online collaborative learning experiences and the instructor's presence in that online environment through the effective use of accessible technologies, strategic grouping, and ensuring tasks require meaningful collaboration (Cherney et al., 2018; Heilporn & Desrochers, 2020), provides a critical foundation upon which effective collaboration between online learners can occur (Oyarzun et al., 2023).

Learner Support During Online Collaborative Learning

Learner support during online collaboration can happen in a variety of ways and come from multiple sources. Dolean and Kear (2024) conducted a systematic review of challenges and methods to address them and found that both instructor and peer support can mitigate online collaborative challenges. However, specific support strategies are not mentioned. Robinson et al. (2017) explored instructors' perceptions of online collaborative learning and found that learner support was at the core of collaborative learning success. They recommended instructors consider nurturing and scaffolding the learners during collaborative work. They also recommend considering learner comfort levels in collaboration, in addition to the instructional design of the task. Hernandez-Selles et al. (2019) emphasized that intragroup emotional support was a key factor in computer-supported collaborative learning. Paterson and Prideaux (2020) added that structured design coupled with supportive facilitation was important for collaborative learning activities' success. While the research points to a need for supportive facilitation of online collaborative learning, there is an opportunity to dig deeper into effective methods of providing support including source and frequency.

Methods

Research Questions

- (a) How frequently do students receive support or guidance in collaborative activities and what forms does this support take in online courses?
- (b) What are the perceived benefits and challenges associated with participating in collaborative work in online courses?

- (c) Do social presence and teaching presence vary depending on the source and frequency of support students receive during collaborative work? Do they also vary according to the level of guidance?

Procedures

The study was conducted at an urban institution in a southeastern U.S. city, with research approval granted by the Institutional Review Board (IRB) of the institution. An online survey was created using Qualtrics, and convenience sampling was used through various distribution methods. Initially, the survey was sent to a student listserv within the researchers' institution. Additionally, the survey link was shared with several pertinent professional organization special interest groups. The survey invitation was also posted in group pages on social media platforms, such as LinkedIn and Facebook.

Measures

The 39-item survey questions were developed following a comprehensive review of relevant literature and included some existing items from the CoI. Participants were initially asked six questions about basic details about the online course in which they participated in collaborative work, including the title of the collaborative work. They were then invited to report on any challenges or benefits related to online collaborative activities and to provide feedback on the clarity and source of guidance received for facilitating collaboration through eight researcher-generated items.

The survey utilized the Community of Inquiry (COI) framework (Garrison et al., 2000) to evaluate students' teaching presence and social presence, with each sub-scale comprising 10 and 9 items, respectively. Cronbach's alpha was calculated to determine internal consistency reliability, yielding values of .919 and .891 for the two subscales, which demonstrated satisfactory reliability.

The survey concluded with six demographic questions about participant age, gender, student status, student classification, employment status, and number of online classes taken. Prior to final distribution, the survey was reviewed by three content experts with expertise in online teaching and learning. They were informed about the study's goals and asked to identify any errors or issues. The survey was revised based on their feedback.

Participants

A total of 210 students took part in the survey. However, almost one-fourth were excluded because they reported not having engaged in any collaborative work in online courses over the past year. As a result, 148 students were included in the dataset. Of these, 38 cases were further excluded due to incomplete responses (with more than 30% of the data missing) leaving a total of 110 complete submissions. The demographic details of the remaining participants are presented in Table 1.

Table 1*Participants Demographics*

Category	N	%
Status		
Part-time student	27	24.5
Full-time student	81	73.6
Missing	2	1.8
Age		
18-24 years old	55	50.0
25-34 years old	21	19.1
35-44 years old	12	10.9
45-54 years old	14	12.7
55-64 years old	4	3.6
Prefer not to respond	2	1.8
Missing	2	1.8
Classification		
Undergraduate, Freshman	10	9.1
Undergraduate, Sophomore	11	10.0
Undergraduate, Junior	16	14.5
Undergraduate, Senior	18	16.4
Graduate, Master	40	36.4
Graduate, Doctorate	12	10.9
Other, Post Bacc	1	0.9
Missing	2	1.8
Number of Online Courses Taken		
Under 5	42	38.2
5-10	42	38.2
11-20	15	13.6
21-30	4	3.6
31+	5	4.5
Missing	2	1.8

Most of the participants were full time masters' students in the 18–24-year-old range who have taken 10 or less online courses. The courses that students reflected on in their survey responses were evenly distributed across three levels: introductory (N=39; 35.5%), intermediate (N=34; 30.9%), and advanced (N=37; 33.6%). Additionally, most students indicated that the course was offered online asynchronously (N=59; 53.6%). This was followed by synchronous online courses (N=23; 20.9%), hybrid courses combining online and face-to-face components (N=15; 13.6%), and bichronous courses that blend asynchronous and synchronous online formats (N=13; 11.8%).

Data Analysis

The exploratory study investigated the nature of support and guidance provided during collaborative work in online courses, and as a result, most findings were presented using descriptive statistics. The first two research questions were examined with frequency tables,

detailing both the actual counts and percentages for each category. The final research question was analyzed using an ANOVA procedure, which is appropriate for comparing means across multiple groups.

Results

Support and Guidance in Collaborative Work

Table 2 presents the nature of the support students received during their collaborative work. Nearly half of the students (N=52, 47.3%) reported receiving support equally from both their instructor and peers. About a quarter of participants received support exclusively from their instructor (N=26, 23.6%) or from their peers (N=27, 24.5%). Regarding the frequency of support, only one participant reported receiving no support, while the majority indicated that support was provided either sometimes (N=52, 47.3%) or often (N=43, 39.1%).

Students were also asked if they received clear guidance on how to collaborate with group members, including delineation of roles, responsibilities, and tools. Most participants reported receiving some level of guidance, though 6 students (5.5%) indicated that no guidance was provided.

In terms of support type, most students reported receiving informational support, such as suggestions or advice (N=95, 86.4%). As this survey question allowed multiple responses, students could identify more than one type of support. Network support, including communication or collaboration assistance, was also common (N=62, 56.4%). Esteem support, involving compliments or validation, was reported by (N=53, 48.2%). Emotional support was the least frequent, with only (N=20, 18.2%) of students reporting its provision.

Table 2

Collaborative Work Support

Category	N	%
Major Source of Support		
Instructor	26	23.6
Peer(s)	27	24.5
Both instructor and peers evenly	52	47.3
No support	4	3.6
Missing	1	0.9
Frequency		
Never	1	0.9
Rarely	13	11.8
Often	43	39.1
Missing	1	0.9
Level of Guidance		
No guidance	6	5.5
Somewhat clear guidance	27	24.5
Moderately clear guidance	36	32.7
Definitely clear guidance	40	36.4

Missing	1	0.9
Support Type		
Informational (suggestion or advice)	95	86.4
Esteem (compliment or validation)	53	48.2
Network (communication /collaboration assistance)	62	56.4
Emotional (sympathy or empathy)	20	18.2

Perceived Benefits and Challenges

Table 3 displays the frequency of potential benefits and challenges perceived by participants in online collaborative work. Students could select multiple options, as the question allowed for multiple responses.

Regarding benefits, about two-thirds of students felt that participating in online collaborative work helped them gain or improve collaboration skills (N=74, 67.3%). The second most common benefit reported was an increased awareness of others' perspectives (N=70, 63.6%). However, only about a quarter of students felt that collaborative work enhanced their overall satisfaction (N=29, 26.4%) or confidence (N=31, 28.2%).

In terms of challenges, more than half of the students identified workload balance (N=65, 59.1%) and scheduling conflicts (N=58, 50.9%) as significant issues in online collaborative work. Conversely, only 16.4% of students (N=18) cited technical issues as a challenge, indicating that most students did not experience major difficulties with technology during online collaborative activities.

Table 3

Benefits and Challenges

	N	%
Benefits		
Increased collaboration skills	74	67.3
Increased awareness of others' perspectives	70	63.6
Increased communication skills	66	60.0
Increased problem-solving skills	53	48.2
Relationship building	50	45.5
Increased confidence	31	28.2
Increased satisfaction	29	26.4
Challenges		
Workload balance	65	59.1
Scheduling conflicts	58	50.9
Communication issues	49	44.5
Anxiety/Stress	34	30.9
Technical issues	18	16.4

One question asked students to provide an example of a benefit or challenge they experienced. The qualitative analysis of those comments is summarized in the next two sections.

Benefits

Despite the challenges, students also identified several benefits associated with group work. The most frequently mentioned benefit, with ten references, was the opportunity for collaboration and learning. Students valued the diverse perspectives that their peers contributed, which enhanced their understanding of the course material. One participant noted, “I benefited from learning other people’s perspectives of the topics,” while another student indicated multiple benefits to group work including, “The benefit of having group work is so many... it helps us to think critically.”

Another benefit identified four times was the acquisition of new tools and skills. Several students reported that working in groups allowed them to familiarize themselves with new collaboration tools, which they found useful for managing group tasks. As one student noted, “I learned new collaboration tools,” indicating that these experiences extended beyond the immediate project to provide broader skill development.

Lastly, three students identified peer relationships as a benefit. Participants highlighted how group work fostered connections that they may not otherwise have developed with their classmates. One student explained, “I was able to build strong relationships with peers in my completely online/asynchronous class through group projects.” This sentiment emphasizes the social value of group work in a digital learning environment.

Challenges

The most frequently cited challenge involved scheduling conflicts, which accounted for 25 instances. Students encountered difficulties in aligning their schedules due to a combination of full-time and part-time commitments, varying work hours, and other personal responsibilities. As one participant stated, “Everyone had different work hours, hence communication was delayed, and it caused a few hurdles in time management.” Another participant emphasized, “We struggled scheduling when we would do things,” demonstrating the widespread difficulty in coordinating group activities.

Team participation emerged as another significant challenge, with ten references. Many students expressed dissatisfaction regarding unequal contributions from group members, resulting in imbalances in workload. One participant described the issue concisely: “One person just stopped replying to the group chat. No explanation.” Another reported, “It was hard to get people to do the work.” Such instances of disengaged team members placed additional burdens on those who remained active.

Communication issues, mentioned in twelve instances, further complicated group collaboration. Inadequate communication often resulted in confusion and delayed responses. As one student elucidated, “People not wanting to work or failing to communicate until the last minute” created stress and impeded project progress. Another participant observed, “Sometimes other students would take a while to post their discussions,” which hindered the timely completion of group assignments.

Workload imbalance, cited nine times, was a persistent source of dissatisfaction. Some students found themselves assuming additional responsibilities to ensure the project’s success.

One participant stated, “It felt more like the bystander effect than teamwork,” reflecting the uneven distribution of responsibilities. This challenge led to frustration and affected the overall group dynamic.

Relationships Between Teaching Presence, Social Presence, and Support/Guidance

No significant difference was observed in teaching presence based on the source of support, $F(3,105) = 2.223$, $p = 0.090$. However, there was a significant difference in social presence between students who received support solely from the instructor ($M = 33.08$) and those who received support equally from both the instructor and peers ($M = 37.87$), $F(3,104) = 3.184$, $p = 0.027$.

The ANOVA test revealed significant differences in teaching presence, $F(2,105) = 5.02$, $p = 0.008$, and social presence, $F(2,104) = 6.529$, $p = 0.002$, based on the frequency of support. For teaching presence, the Tukey HSD post-hoc test indicated that the mean score for “Often” ($M = 44.44$) was significantly higher than for “Rarely” ($M = 37.77$), $p = 0.008$. Similarly, for social presence, the mean score for “Often” ($M = 38.53$) was significantly higher than for “Rarely” ($M = 31.62$), $p = 0.003$. For both tests, the “Never” category was excluded from the analysis due to its limited sample size. Since a post-hoc test is not possible when any group has fewer than two cases, we only compared the three remaining categories: Rarely, Sometimes and Often.

When clear guidance, such as defined roles and responsibilities, was provided, students reported significantly higher teaching and social presence. Specifically, ANOVA results showed that those who received “Definitely clear guidance” had a higher mean teaching presence ($M = 46.10$) compared to those who received “No guidance” ($M = 34.33$), “Moderately clear guidance” ($M = 40.39$), or “Somewhat clear guidance” ($M = 40.78$), $F(3,105) = 9.074$, $p < 0.001$. A similar trend was observed for social presence, with “Definitely clear guidance” ($M = 38.90$) significantly higher than “Somewhat clear guidance” ($M = 34.65$) and “Moderately clear guidance” ($M = 34.81$), $F(3,104) = 3.792$, $p = 0.013$.

Discussion

The findings of this study provide valuable insights into the nature of support and guidance in online collaborative activities, perceived benefits and challenges of participating in such work, and how the source and frequency of support influences teaching and social presence. The results suggest that while students generally receive support during collaborative activities, the sources and frequencies of support vary, impacting their experiences in different ways.

In terms of the first research question—how frequently students receive support and what forms it takes—the majority of participants indicated that they receive support either from their instructors, their peers, or both. Informational support was the most frequently cited, followed by network and esteem support. Interactions between instructors and students should focus on the definition and discussion of group management, which will promote significant interactions leading to learning (Abdu et al., 2012; Bangert, 2009; Cherney et al. 2018; Saqr & López-Pernas, 2023). Notably, emotional support was the least common. This suggests that while students receive substantial guidance in terms of practical collaboration (e.g., suggestions, advice, and

assistance with communication), there may be a deficit in the emotional or empathetic support necessary to foster stronger group dynamics. Given the increasing emphasis on holistic student well-being in online learning, this finding could imply the need for more deliberate efforts to incorporate emotional support mechanisms in online courses to ensure students create a climate of trust and a sense of group belonging and responsibility throughout their collaborative work (Grieve et al., 2016; Hernandez-Selles et al., 2019; Molinillo et al., 2018; Reyes et al., 2012).

Regarding the second research question—what are the perceived benefits and challenges—students reported significant gains in collaboration skills, awareness of others’ perspectives, and communication skills. However, fewer students observed improvements in overall satisfaction and confidence, indicating that while collaborative work is evidently beneficial in terms of skill development, it may not consistently enhance students’ overall experience or self-efficacy. The challenges reported by participants that may negatively impact student experience, particularly workload balance and scheduling conflicts, align with common issues like communications challenges, increased potential for miscommunication, or connectivity issues in online collaborative environments (Bedenlier et al., 2021; Donelan & Kear, 2024; Strauss & Rummel, 2020). These findings highlight that while collaborative work has clear benefits, careful attention must be paid to managing group dynamics, scheduling, and equitable technology access and workload distribution to prevent these challenges from undermining the potential benefits (Jeong & Hmelo-Silver, 2016; Strauss & Rummel, 2020).

The third research question examined the variation in social and teaching presence based on the source and frequency of support. The findings indicate that while the source of support (whether from peers, instructors, or both) did not significantly impact teaching presence, it did have a measurable effect on social presence. Students who received support equally from both their instructor and peers reported a higher sense of social presence compared to those who received support solely from their instructor. This echoes the findings of prior research that suggests a more balanced approach, where the contributions of both instructors and peers to the support system may enhance the sense of community and belonging in online collaborative environments (Kerman et al., 2024; Molenaar et al., 2012; Tseng & Yeh, 2013).

Furthermore, the frequency of support significantly influenced both teaching and social presence. Students who received support more frequently, whether sometimes or often, reported higher levels of both presences. This finding is particularly significant, as it underscores the critical role that ongoing, consistent support plays in maintaining a strong teaching and social presence, which are essential elements of the CoI framework (Cherney et al., 2018; Rovai, 2004). Pedagogical and social aspects require careful planning and curricular and pedagogical implementation (Hernandez et al., 2014; Ornellas & Munoz Carril, 2014; Saqr & López-Pernas, 2023; Sims, 2003; Stahl et al., 2004). Without frequent interaction and engagement, students may experience a sense of disconnection, which could diminish the effectiveness of the collaborative learning experience (Kwon et al., 2014; Reyes et al., 2012; Wengrowicz et al., 2018).

Additionally, the clarity of guidance emerged as a critical factor influencing both teaching and social presence. Students who reported receiving “definitely clear” guidance on collaboration roles and responsibilities demonstrated significantly higher levels of both teaching

and social presence compared to those who received less clear guidance. This finding highlights the importance of clear communication and structure in online group work (Martin et al., 2021; Palacios-Nunez & Deroncel-Acosta, 2021). Without clearly defined roles and expectations, students may struggle to engage fully in the collaborative process, leading to lower levels of perceived presence and, potentially, a less effective learning experience (Kukulska-Hulme, 2005).

These findings suggest that effective support in online collaborative work is multifaceted, involving frequent and balanced interaction between instructors and peers and clear guidance on roles and responsibilities. While collaborative work is undoubtedly beneficial in developing key skills, challenges such as workload imbalance and scheduling conflicts remain significant barriers. Therefore, instructional designers and educators must carefully plan and structure online collaborative activities to optimize both teaching and social presence, ensuring that students feel supported, engaged, and capable of contributing meaningfully to group work (Donelan & Kear, 2024; Fiock, 2020).

Implications

The findings of this study underscore the critical importance of comprehensive support systems in online collaborative learning environments. While informational support is commonly provided, the study highlights a significant gap in emotional support mechanisms, crucial for fostering a positive and productive learning atmosphere (Strauss & Rummel, 2020). To address this, educators and instructional designers should implement strategies beyond mere information provision and actively promote emotional and empathetic support among students. This could include integrating peer mentorship programs, regular check-ins, and structured opportunities for emotional exchanges, such as reflective discussions or dedicated spaces for sharing personal challenges related to group work. These measures can help build trust, enhance group cohesion, and address feelings of isolation or frustration that are often prevalent in online settings (Donelan & Kear, 2024).

Moreover, the study's findings emphasize the need for a holistic approach to student support that recognizes the interconnectedness of emotional well-being and academic success. By incorporating explicit mechanisms for emotional support, educational institutions can create more inclusive and supportive online learning environments that cater to the diverse needs of students. This approach aligns with the growing recognition of student well-being as a key factor in academic achievement (Hernandez-Selles et al., 2019). Practical implementations could involve training both peers and instructors in providing emotional support, developing guidelines for supportive online interactions, and regularly assessing the emotional climate of online collaborative groups. By addressing the emotional aspects of online learning alongside the informational components, educators can foster more engaging, supportive, and ultimately more effective online collaborative learning experiences.

This study's findings underscore the critical role of a balanced approach to support in online learning environments. By emphasizing the importance of both instructor and peer support, the research reveals that students experience a more robust sense of social presence when they receive guidance from multiple sources. This dual-source approach not only enhances

students' feelings of belonging but also increases their overall engagement with the course material and their fellow learners (Donelan & Kear, 2024).

Frequency and clarity of support are also vital for fostering strong teaching and social presence. This underscores the need for instructors to provide ongoing, consistent feedback and clearly define roles and responsibilities within group activities (Abdu et al., 2012; Bangert, 2008; Hernandez-Selles et al., 2019). In online learning environments, where ambiguity can lead to disengagement, explicit instructions and well-structured group tasks are essential to keep students on track and motivated. These findings suggest that detailed guidelines, rubrics, and regular instructor involvement are beneficial and necessary to enhance collaborative activities' effectiveness (Van Thien, 2021).

Additionally, this study reinforces the notion that while online collaborative work provides numerous benefits, challenges such as workload imbalance and scheduling conflicts continue to impede its full potential (Hillard et al., 2020). To address these issues, educators must implement strategies that ensure equitable workload distribution and offer flexible scheduling options. Mechanisms that facilitate transparent tracking of group contributions and adaptive timelines may mitigate these common barriers, thereby enhancing group collaboration and reducing participant frustration (Oyarzun et al., 2023).

One strategy to address workload imbalances and scheduling conflicts is the implementation of a group charter. The collaborative group establishes the parameters of their communication at the commencement of the semester, encompassing meeting times, communication methods, conflict resolution protocols, and timelines for collaborative activities (Tu & Corry, 2002). Consequently, both the instructor and students are cognizant of the group expectations, and the instructor can, therefore, provide the necessary guidance to the students prior to their engagement in the collaborative activity (Gibson, 2019; Martin et al., 2021). Esarco (2009) determined that groups operated more efficiently and effectively due to the standardization of work and responsibilities among learners.

From a broader perspective, this study has implications for the ongoing development of the Community of Inquiry (CoI) framework, specifically regarding how teaching and social presence can be effectively cultivated through intentional instructional design. All three aspects of social presence (emotional expression, open communication, and group cohesion) require support (Donelan & Kear, 2024). Furthermore, the "facilitating discourse" element of teaching presence is particularly significant for achieving social presence (Donelan & Kear, 2024). By providing frequent, balanced, and clear support, instructors can not only enhance the collaborative learning experience but also strengthen the sense of community and engagement, which are critical for student success in online learning environments (Martin et al., 2021; Oyarzun et al., 2023).

These findings highlight the imperative for faculty development programs that prioritize facilitating online group work. Instructors should be trained to identify the various types of support that students require and to implement strategies that promote both cognitive and emotional well-being. By addressing these factors, online courses can be designed to provide not

only collaborative skill development but also a more comprehensive and supportive learning experience.

Limitations

The research encountered several limitations. The insufficient sample size impeded the generalization of findings. Additionally, the broad term “collaborative learning” encompasses diverse methodologies. Some potential participants may have declined involvement due to misinterpretation of the concept of collaborative work or learning, as evidenced by an incomplete submission citing confusion about the survey’s purpose. In addition, while the research team employed several recruitment strategies to reach a broader population of online learners in higher education in the U.S., it is highly likely that our participants are overrepresented from the study population of the participating institutions. Furthermore, the study’s wide-ranging topic and heterogeneous sample, spanning multiple disciplines and course levels, potentially complicated the process of drawing meaningful conclusions. Another limitation of the study design is that, due to the limited sample size, we could only perform a simple one-way ANOVA. This design does not allow for control over potential confounding variables. It is also important to note that, while the equal variance assumption was supported by the Levene’s test for the ANOVA, the normality assumption was not upheld based on the Kolmogorov-Smirnov test ($p < .001$ for teaching presence and $p = .017$). Although the ANOVA test is known to be fairly robust to violations of the normality assumption (Leech et al., 2015), caution is warranted when interpreting the results. Lastly, the investigation focused exclusively on the social dimensions of collaborative learning, assessing teaching and social presence within the Community of Inquiry (CoI) framework while omitting cognitive presence.

Conclusion

This study contributes to the understanding of effective support systems in online collaborative learning by highlighting the significance of both informational and emotional support mechanisms. While informational support, such as guidance on project management and task completion, is widely present in online group work, the absence of emotional support emerges as a critical area for improvement. This finding aligns with existing research, emphasizing the importance of integrating emotional and empathetic support to foster a positive learning environment (Strauss & Rummel, 2020). Implementing structured mechanisms such as peer mentorship programs, reflective discussions, and regular check-ins is essential for building trust, mitigating feelings of isolation, and promoting group cohesion (Donelan & Kear, 2024). Such support can significantly enhance students’ sense of belonging and their overall engagement with collaborative activities.

Moreover, the study underscores the importance of a balanced and frequent approach to support, involving contributions from both peers and instructors. This dual-source model of support not only strengthens social presence but also cultivates a more robust sense of community in online learning environments. Students who receive guidance and feedback from multiple sources experience higher levels of engagement and satisfaction, suggesting that educators should actively facilitate peer interactions alongside their own contributions to student support (Hernandez-Selles et al., 2019). The findings also address prevalent challenges in online group work, including workload imbalances and scheduling conflicts. Such impediments can

undermine the potential benefits of collaborative activities if not managed effectively (Hillard et al., 2020). Strategies to mitigate these issues, such as implementing tools for transparent tracking of group contributions, flexible scheduling options, and structured group charters, are essential to ensure that the collaborative learning experience is equitable and effective for all participants (Oyarzun et al., 2023; Tu & Corry, 2002).

Furthermore, the study has broader implications for refining the CoI framework. Intentional instructional design that prioritizes frequent, balanced, and explicit support not only enhances teaching and social presence but also promotes a more engaging and supportive online learning experience (Martin et al., 2021; Oyarzun et al., 2023). The results of this study highlight the necessity for faculty development initiatives that equip instructors with the skills to recognize and address both cognitive and affective needs in collaborative learning contexts. By adopting a comprehensive approach to support, educators can create more inclusive and impactful learning environments, ultimately contributing to improved student outcomes and satisfaction in online courses (Donelan & Kear, 2024; Esarco, 2009).

Declarations

Funding sources

This study did not receive any specific grants from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest statement

The authors declare that there are no conflicts of interest regarding the publication of this manuscript. No financial, professional, or personal relationships have influenced the research, analysis, or findings presented in this study.

References

- Abdu, R., DeGroot, R., & Drachman, R. (2012). Teacher's role in computer supported collaborative learning. In *Proceedings of the 7th Chais Conference for Innovation in Learning Technologies* (pp. 1-6). Raanana, Israel: The Open University of Israel.
- Altınay, Z. (2016). Evaluating peer learning and assessment in online collaborative learning environments. *Behaviour & Information Technology*, 36(3), 312–320.
<https://doi.org/10.1080/0144929x.2016.1232752>
- Archambault, L., Leary, H., & Rice, K. (2022). Pillars of online pedagogy: A framework for teaching in online learning environments. *Educational Psychologist*, 57(3), 178–191.
<https://doi.org/10.1080/00461520.2022.2051513>
- Baker, J. D. (2004). An investigation of relationships among instructor immediacy and affective and cognitive learning in the online classroom. *The Internet and Higher Education*, 7(1), 1-13. <https://doi.org/10.1016/j.iheduc.2003.11.006>
- Baker, K. Q., & Moyer, D. M. (2018). The relationship between students' characteristics and their impressions of online courses. *American Journal of Distance Education*, 33(1), 16–28. <https://doi.org/10.1080/08923647.2019.1555301>
- Bangert, A. (2008). The influence of social presence and teaching presence on the quality of online critical inquiry. *Journal of Computing in Higher Education*, 20, 34-61.
<https://doi.org/10.1007/bf03033431>
- Barak, M., Hussein-Farraj, R., & Dori, Y. J. (2016). On-campus or online: Examining self-regulation and cognitive transfer skills in different learning settings. *International Journal of Educational Technology in Higher Education*, 13(1), 35.
<https://doi.org/10.1186/s41239-016-0035-9>
- Barr, R. B., & Tagg, J. (1995). From teaching to learning: A new paradigm for undergraduate education. *Change*, 27(6), 13–25. <https://doi.org/10.1080/00091383.1995.10544672>
- Bedenlier, S., Wunder, I., Gläser-Zikuda, M., Kammerl, R., Kopp, B., Ziegler, A., & Händel, M. (2021). Generation invisible? Higher education students' (non)use of webcams in synchronous online learning. *International Journal of Educational Research Open*.
<https://doi.org/10.31234/osf.io/7brp6>
- Blumenfeld, P. C., Marx, R. W., Soloway, E., & Krajcik, J. (1996). Learning with peers: From small group cooperation to collaborative communities. *Educational Researcher*, 25(8), 37-40. <https://doi.org/10.2307/1176492>
- Brooks, M., & Brooks, J. (1995). *In search of understanding: The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

- Brunet, P. M., & Schmidt, L. A. (2007). Is shyness context specific? Relation between shyness and online self-disclosure with and without a live webcam in young adults. *Journal of Research in Personality*, 41(4), 938–945. <https://doi.org/10.1016/j.jrp.2006.09.001>
- Cameron, B. A., Morgan, K., Williams, K. C., & Kostecky, K. L. (2009). Group projects: Student perceptions of the relationship between social tasks and a sense of community in online group work. *American Journal of Distance Education*, 23(1), 20–33. <https://doi.org/10.1080/08923640802664466>
- Chapman, K. J., & Van Auken, S. (2001). Creating positive group project experiences: An examination of the role of the instructor on students' perceptions of group projects. *Journal of Marketing Education*, 23(2), 117–127. <https://doi.org/10.1177/0273475301232005>
- Chapman, C., Ramondt, L., & Smiley, G. (2005). Strong community, deep learning: Exploring the link. *Innovations in Education and Teaching International*, 42, 217–230. <https://doi.org/10.1080/01587910500167910>
- Chatterjee, R., & Correia, A. (2020). Online students' attitudes toward collaborative learning and sense of community. *American Journal of Distance Education*, 34(1), 53–68. <https://doi.org/10.1080/08923647.2020.1703479>
- Cherney, M. R., Fetherston, M., & Johnsen, L. J. (2018). Online course student collaboration literature: A review and critique. *Small Group Research*, 49(1), 98–128. <https://doi.org/10.1177/1046496417721627>
- Clark, H. H. & Brennan, S.E. (1991). Grounding in communication. *Perspectives on Socially Shared Cognition*, 13. 127–149. <https://doi.org/10.1037/10096-006>
- Dawson, S. (2006). A study of the relationship between student communication interaction and sense of community. *The Internet and Higher Education*, 9(3), 153–162. <https://doi.org/10.1016/j.iheduc.2006.06.007>
- Donelan, H., & Kear, K. (2024). Online group projects in higher education: persistent challenges and implications for practice. *Journal of Computing in Higher Education*, 36(2), 435–468. <https://doi.org/10.1007/s12528-023-09360-7>
- Esarco, A. (2009). *Group charters and online group collaboration: Instructional design elements that may enhance the learner's satisfaction with the online learning process* (Doctoral dissertation, Capella University). ProQuest Dissertations Publishing
- Fiock, H. (2020). Designing a community of inquiry in online courses. *The International Review of Research in Open and Distributed Learning*, 21(1), 135–153. <https://doi.org/10.19173/irrodl.v20i5.3985>
- Gaad, A. L. V. (2022). The effects of online collaborative learning (OCL) on student achievement and engagement. *IAFOR Journal of Education*, 10(3), 31–49. <https://doi.org/10.22492/ije.10.3.02>

- Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, 2(2-3), 87–105. [https://doi.org/10.1016/S1096-7516\(00\)00016-6](https://doi.org/10.1016/S1096-7516(00)00016-6)
- Garrison, D. R. (2007). Online Community of Inquiry review: Social, cognitive, and teaching presence issues. *Online Learning*, 11(1), 61–72. <https://doi.org/10.24059/olj.v11i1.1737>
- Garrison, R. (2022). Shared metacognition in a Community of Inquiry. *Online Learning*, 26(1), 6–18. <https://doi.org/10.24059/olj.v26i1.3023>
- Gibson, P. (2019). Online group work is possible, just not easy. In V. Wang (Ed.), *Handbook of Research on Transdisciplinary Knowledge Generation* (pp. 231-241). IGI Global Scientific Publishing. <https://doi.org/10.4018/978-1-5225-9531-1.ch017>
- Grieve, R., Padgett, C. R., & Moffitt, R. L. (2016). Assignments 2.0: The role of social presence and computer attitudes in student preferences for online versus offline marking. *The Internet and Higher Education*, 28, 8-16. <https://doi.org/10.1016/j.iheduc.2015.08.002>
- Grothaus, C. (2022). Collaborative online learning across cultures: The role of teaching and social presence. *Qualitative Research in Education*, 11(3), 298–326. <https://doi.org/10.17583/qre.10474>
- Guo, W., Chen, Y., Lei, J., & Wen, Y. (2014). The effects of facilitating feedback on online learners' cognitive engagement: Evidence from the asynchronous online discussion. *Education Sciences*, 4(2), 193–208. <https://doi.org/10.3390/educsci4020193>
- Heilporn, G., & Desrochers, M. (2020). Students' learning support and perceptions in an online mathematics course in a business faculty. *The Canadian Journal for the Scholarship of Teaching and Learning*, 11(1), Article 5. <https://doi.org/10.5206/cjsotl-rcacea.2020.1.10825>
- Hernández-Sellés, N., Muñoz-Carril, P. C., & González-Sanmamed, M. (2019). Computer-supported collaborative learning: An analysis of the relationship between interaction, emotional support and online collaborative tools. *Computers & Education*, 138, 1-12. <https://doi.org/10.1016/j.compedu.2019.04.012>
- Ingram, K., Oyarzun, B., Maxwell, D., & Salas, S. (2024). The difference a three-minute video makes: Presence(s), satisfaction, and instructor-confidence in post-pandemic online teacher education. *TechTrends*, 68(4), 723–733. <https://doi.org/10.1007/s11528-024-00979-6>
- Ishtaiwa, F. F., & Aburezeq, I. M. (2015). The impact of Google Docs on student collaboration: A UAE case study. *Learning, Culture and Social Interaction*, 7, 85–96. <https://doi.org/10.1016/j.lcsi.2015.07.004>
- Jeong, H. and Hmelo-Silver, C.E. (2016). Seven affordances of computer-supported collaborative learning: How to support collaborative learning? How can technologies

- help?, *Educational Psychologist*, 51(2). 247-265.
<https://doi.org/10.1080/00461520.2016.1158654>
- Johnson, D.W., & Johnson, R.T. (2009). An educational psychology success story. Social interdependence theory and cooperative learning. *Educational Researcher*, 38(5). 365–379. <https://doi.org/10.3102/0013189X09339057>
- Jung, S., Shin, H. W., Gohary, A., & Chan, E. Y. (2022). Benefits and challenges of online collaborative learning from the perspectives of non-traditional event management students: A comparison between asynchronous and synchronous learning. *Journal of Teaching in Travel & Tourism*, 23(2), 109–129.
<https://doi.org/10.1080/15313220.2022.2109553>
- Karau, S. J., & Williams, K. D. (1993). Social loafing: A meta-analytic review and theoretical integration. *Journal of Personality and Social Psychology*, 65, 684-695.
<https://doi.org/10.1037/0022-3514.65.4.681>
- Kerman, N. T., Banihashem, S. K., Karami, M., Er, E., Van Ginkel, S., & Noroozi, O. (2024). Online peer feedback in higher education: A synthesis of the literature. *Education and Information Technologies*, 29(1), 763-813. <https://doi.org/10.1007/s10639-023-12273-8>
- Koşar, G. (2021). Online collaborative learning: Does it improve college students' critical reading skills? *Interactive Learning Environments*, 31(8), 5114–5126.
<https://doi.org/10.1080/10494820.2021.1998137>
- Kozar, O. (2016). Perceptions of webcam use by experienced online teachers and learners: A seeming disconnect between research and practice. *Computer Assisted Language Learning*, 29(4), 779–789. <https://doi.org/10.1080/09588221.2015.1061021>
- Kukulska-Hulme, A. (2005). Group leadership in online collaborative learning. In *Encyclopedia of Distance Learning* (pp. 975-983). IGI Global. <https://doi.org/10.4018/978-1-60566-198-8.ch149>
- Kwon, K., Liu, Y. H., & Johnson, L. P. (2014). Group regulation and social-emotional interactions observed in computer supported collaborative learning: Comparison between good vs. poor collaborators. *Computers & Education*, 78, 185-200.
<https://doi.org/10.1016/j.compedu.2014.06.004>
- Leech, N., Barrett, K., & Morgan, G. (2012). *IBM SPSS for intermediate statistics; use and interpretation (4th ed.)*. Ringgold.
- Li, L., Zhang, R., & Piper, A. M. (2023). Predictors of student engagement and perceived learning in emergency online education amidst COVID-19: A community of inquiry perspective. *Computers in Human Behavior Reports*, 12.
<https://doi.org/10.1016/j.chbr.2023.100326>

- Lingard, R., & Berry, E. (2002). Teaching teamwork skills in software engineering based on an understanding of factors affecting group performance. In *Frontiers in Education, 2002. FIE 2002. 32nd Annual* (Vol. 3, p. S3G-1). IEEE. Boston, MA, November 6-9, 2002.
- Martin, F., & Borup, J. (2022). Online learner engagement: Conceptual definitions, research themes, and supportive practices. *Educational Psychologist, 57*(3), 162–177. <https://doi.org/10.1080/00461520.2022.2089147>
- Martin, F., Kumar, S., & She, L. (2021). Examining higher education instructor roles and competencies for online teaching. *Online Learning, 25*(4), 187–215. <https://doi.org/10.24059/olj.v25i4.2570>
- Martin, F., Wu, T., Wan, L., & Xie, K. (2022). A meta-analysis on the Community of Inquiry presences and learning outcomes in online and blended learning environments. *Online Learning, 26*(1). <https://doi.org/10.24059/olj.v26i1.2604>
- Marutschke, D. M., Kryssanov, V., Chaminda, H. T., & Brockmann, P. (2019). Smart education in an interconnected world: Virtual, collaborative, project-based courses to teach global software engineering. In *Smart Education and e-Learning 2019* (pp. 39-49). Springer, Singapore. https://doi.org/10.1007/978-981-13-8260-4_4
- McKay, J., & Sridharan, B. (2023). Student perceptions of collaborative group work (CGW) in higher education. *Studies in Higher Education, 49*(2), 221–234. <https://doi.org/10.1080/03075079.2023.2227677>
- McPherson, M. A., & Nunes, M. B. (2004). The failure of a virtual social space (VSS) designed to create a learning community: Lessons learned. *British Journal of Educational Technology, 35*(3), 305–321. <http://dx.doi.org/10.1111/j.0007-1013.2004.00391.x>
- Molenaar, I., Roda, C., van Boxtel, C., & Slegers, P. (2012). Dynamic scaffolding of socially regulated learning in a computer-based learning environment. *Computers & Education, 59*(2), 515-523. <https://doi.org/10.1016/j.compedu.2011.12.006>
- Molinillo, S., Aguilar-Illescas, R., Anaya-Sánchez, R., & Vallespín-Arán, M. (2018). Exploring the impacts of interactions, social presence and emotional engagement on active collaborative learning in a social web-based environment. *Computers & Education, 123*, 41-52. <https://doi.org/10.1016/j.compedu.2018.04.012>
- National Center for Education Statistics. (2023). Postbaccalaureate enrollment. *Condition of Education*. U.S. Department of Education, Institute of Education Sciences. <https://nces.ed.gov/programs/coe/indicator/chb>
- Nilsen, A. G., Almås, A. G., & Krumsvik, R. J. (2013). Teaching online or on-campus?—What students say about desktop videoconferencing. *Nordic Journal of Digital Literacy, 8*(01-02), 90–106. <https://doi.org/10.18261/issn1891-943x-2013-01-02-06>
- Ornellas, A., & Muñoz Carril, P. C. (2014). A methodological approach to support collaborative media creation in an e-learning higher education context. *Open Learning: The Journal of*

- Open, Distance and e-Learning*, 29(1), 59-71.
<https://doi.org/10.1080/02680513.2014.906916>
- Oluwajana, D., Adeshola, I., & Clement, S. (2021). Does the use of a web-based collaborative platform reduce cognitive load and influence project-based student engagement? *Current Psychology*, 42(10), 8265–8278. <https://doi.org/10.1007/s12144-021-02145-0>
- Oyarzun, B., & Martin, F. (2023). A systematic review of research on online learner collaboration from 2012–21: Collaboration technologies, design, facilitation, and outcomes. *Online Learning*, 27(1), 71–106. <https://doi.org/10.24059/olj.v27i1.3407>
- Paterson, T., & Prideaux, M. (2020). Exploring collaboration in online group based assessment contexts: Undergraduate business program. *Journal of University Teaching & Learning Practice*, 17(3), 3. <https://ro.uow.edu.au/jutlp/vol17/iss3/3>
- Pena-Shaff, J. B., & Altman, W. S. (2009). Case-based instruction using asynchronous online discussions: A synthesis. *Journal on Excellence in College Teaching*, 20(3), 97-121.
- Peterson, A. T., Beymer, P. N., & Putnam, R. T. (2018). Synchronous and asynchronous discussions: Effects on cooperation, belonging, and affect. *Online Learning*, 22(4), 7-25. <http://dx.doi.org/10.24059/olj.v22i4.1517>
- Piaget, J. (1977). *The development of thought: Equilibration of cognitive structures*. New York: Viking Press.
- Poort, I., Jansen, E., & Hofman, A. (2020). Does the group matter? Effects of trust, cultural diversity, and group formation on engagement in group work in higher education. *Higher Education Research & Development*, 41(2), 511–526.
<https://doi.org/10.1080/07294360.2020.1839024>
- Revere, L., & Kovach, J. V. (2011). Online technologies for engaged learning: A meaningful synthesis for educators. *Quarterly Review of Distance Education*, 12(2), 113–124.
- Reyes, M. R., Brackett, M. A., Rivers, S. E., White, M., & Salovey, P. (2012). Classroom emotional climate, student engagement, and academic achievement. *Journal of Educational Psychology*, 104(3), 700. <https://doi.org/10.1037/a0027268>
- Robinson, H., Kilgore, W., & Warren, S. (2017). Care, communication, support: Core for designing meaningful online collaborative learning. *Online Learning*, 21(4).
- Rourke, L., & Anderson, T. (2002). Using web-based, group communication systems to support case study learning at a distance. *International Review of Research in Open and Distance Learning*, 3(2), 1–13. <https://doi.org/10.19173/irrodl.v3i2.107>
- Rovai, A. P. (2004). A constructivist approach to online college learning. *The Internet and Higher Education*, 7(2), 79–93. <https://doi.org/10.1016/j.iheduc.2003.10.002>

- Saqr, M., Nouri, J., Jormanainen, I. (2019). A learning analytics study of the effect of group size on social dynamics and performance in online collaborative learning. In: Scheffel, M., Broisin, J., Pammer-Schindler, V., Ioannou, A., Schneider, J. (eds) *Transforming learning with meaningful technologies*. EC-TEL 2019. *Lecture Notes in Computer Science*, vol 11722. Springer, Cham. https://doi.org/10.1007/978-3-030-29736-7_35
- Saqr, M., & López-Pernas, S. (2023). The temporal dynamics of online problem-based learning: Why and when sequence matters. *International Journal of Computer-Supported Collaborative Learning*, 18(1), 11–37. <https://doi.org/10.1007/s11412-023-09385-1>
- Shea, P., Richardson, J., & Swan, K. (2022). Building bridges to advance the Community of Inquiry framework for online learning. *Educational Psychologist*, 57(3), 148–161. <https://doi.org/10.1080/00461520.2022.2089989>
- Sims, R. (2003). Promises of interactivity: Aligning learner perceptions and expectations with strategies for flexible and online learning. *Distance Education*, 24(1), 87–103. <https://doi.org/10.1080/01587910303050>
- Soller, A. (2001). Supporting social interaction in an intelligent collaborative learning system. *International Journal of Artificial Intelligence in Education (IJAIED)*, 12, 40–62.
- Sonji, G., Sonji, N., Hammoudi Halat, D., Mourad, N., Rahal, M., & Mehyou, Z. (2023). Pharmacy students' perceptions and satisfaction with blended instruction in quantitative chemical analysis course. *Pharmacy Education*, 23(1), 269–282. <https://doi.org/10.46542/pe.2023.231.269282>
- Stahl, G. (2004). Building collaborative knowing: Elements of a social theory of CSCL. In J.W. Strijbos, P.A. Kirschner, & R.L. Martens (Eds.), *What we know about CSCL*. Computer-supported collaborative learning series (Vol. 3, pp. 53–85). Springer, Dordrecht. https://doi.org/10.1007/1-4020-7921-4_3
- Strauss, S., & Rummel, N. (2020). Promoting interaction in online distance education: Designing, implementing and supporting collaborative learning. *Information and Learning Sciences*, 121(5/6), 251–260. <https://doi.org/10.1108/ILS-04-2020-0090>
- Stenbom, S. (2018). A systematic review of the Community of Inquiry survey. *The Internet and Higher Education*, 39, 22–32. <https://doi.org/10.1016/j.iheduc.2018.06.001>
- Tolu, A. T. (2013). Creating effective Communities of Inquiry in online courses. *Procedia - Social and Behavioral Sciences*, 70, 1049–1055. <https://doi.org/10.1016/j.sbspro.2013.01.157>
- Trespalcacios, J. (2017). Exploring small group analysis of instructional design cases in online learning environments. *Online Learning*, 21(1), 189–200. <http://dx.doi.org/10.24059/olj.v21i1.928>
- Tu, C. H., & Corry, M. (2002). Research in online learning community. *E-journal of Instructional Science and Technology*, 5(1), 1–10.

- Tseng, H. W., & Yeh, H. T. (2013). Team members' perceptions of online teamwork learning experiences and building teamwork trust: A qualitative study. *Computers & Education*, 63, 1-9. <https://doi.org/10.1016/j.compedu.2012.11.013>
- Van Thien, N. (2021). Effectiveness of online learning when implementing collaborative online learning in flipped classroom. *Technium Social Sciences Journal*, 26, 234-249. <https://doi.org/10.47577/tssj.v26i1.5253>
- Vogel, F., Kollar, I., Ufer, S., Reichersdorfer, E., Reiss, K., & Fischer, F. (2016). Developing argumentation skills in mathematics through computer-supported collaborative learning: The role of transactivity. *Instructional Science*, 44(5), 477–500. <https://doi.org/10.1007/s11251-016-9380-2>
- Vygotsky, L. (1978). Interaction between learning and development. *Readings on the Development of Children*, 23(3), 34-41.
- Warsah, I., Morganna, R., Uyun, M., Hamengkubuwono, & Afandi, M. (2021). The impact of collaborative learning on learners' critical thinking skills. *International Journal of Instruction*, 14(2), 443-460. <https://doi.org/10.29333/iji.2021.14225a>
- Wengrowicz, N., Swart, W., Paul, R., Macleod, K., Dori, D., & Dori, Y. J. (2018). Students' collaborative learning attitudes and their satisfaction with online collaborative case-based courses. *American Journal of Distance Education*, 32(4), 283–300. <https://doi.org/10.1080/08923647.2018.1511509>
- Wentzel, K. R., & Watkins, D. E. (2011). Instruction based on peer interactions. In R. E. Mayer & P. A. Alexander (Eds.), *Handbook of research on learning and instruction* (pp. 322–343). New York, NY: Routledge.
- Xie, K., & Ke, F. (2011). The role of students' motivation in peer-moderated asynchronous online discussions. *British Journal of Educational Technology*, 42(6), 916–930. <https://doi.org/10.1111/j.1467-8535.2010.01140.x>
- Yoon, S. A., Miller, K., Richman, T., Wendel, D., Schoenfeld, I., Anderson, E., & Shim, J. (2020). Encouraging collaboration and building community in online asynchronous professional development: Designing for social capital. *International Journal of Computer-Supported Collaborative Learning*, 15(3), 351–371. <https://doi.org/10.1007/s11412-020-09326-2>
- Zhang, Y., Hussain, S., Huang, J., & Dong, Y. (2023). Investigating the impact of the Community of Inquiry presence on online learning satisfaction: A Chinese college student perspective. *Psychology Research and Behavior Management*, 16, 1883–1896. <https://doi.org/10.2147/prbm.s409229>
- Zheng, X., Zhou, C., & Johnson, T. E. (2020). A pilot study examining the impact of collaborative mind mapping strategy in a flipped classroom: Learning achievement, self-efficacy, motivation, and students' acceptance. *Educational Technology Research and Development*, 68(6), 3527–3545. <https://doi.org/10.1007/s11423-020-09868-0>

Appendix

Directions: Think of a single course in which collaborative learning was an intentional part of an online course you taught and think about the primary collaborative work within that course.

1. Please indicate a course level.
 - a. Undergraduate
 - b. Graduate, Masters Level
 - c. Graduate, Doctorate Level
2. Please indicate course difficulty.
 - a. Foundation/Beginner/Introductory
 - b. Intermediate
 - c. Advanced
3. Was the course a(n)
 - a. Elective course
 - b. Required course
4. Please indicate the discipline of the course.
 - a. Humanities (i.e., arts, history, etc.)
 - b. Social Science (i.e., Anthropology, Sociology, Psychology, Education, etc.)
 - c. Natural Science (i.e., Biology, Chemistry, Physics, etc.)
 - d. Formal Science (i.e., Computer Science, Statistics, Mathematics, etc.)
 - e. Applied Science (i.e., Business, Engineering, Medicine, etc.)
 - f. Other _____
5. How was the course delivered?
 - a. 100% asynchronous online
 - b. 100% synchronous online
 - c. Bichronous (blend of asynchronous and synchronous online)
 - d. Hybrid (blend of online and f2f)
6. Please provide the title or short description of the primary collaborative work.

Thinking about a specific course and specific collaborative work within that course, please answer or rate the following questions regarding the design of the collaborative work.

7. What was the group size for the collaborative work?
 - a. Small (2-4)
 - b. Medium (5-8)
 - c. Large (9+)
 - d. Whole class
8. How were the groups formed?
 - a. Randomly assigned
 - b. The instructor assigned based on certain criteria
 - c. Self-selected
 - d. Other
9. What type(s) of collaboration were required with the work (Check all that apply)
 - a. Discussion
 - b. Project
 - c. Peer review
 - d. Activity (non-graded)
 - e. Assignment (graded)

- f. Informal/Social
 - g. Other
10. What was the duration of the collaborative work
- a. A small part of the semester (i.e., a single module/weeks/unit)
 - b. An intermediate part of the semester (i.e., some modules/weeks/units)
 - c. A large part of the semester (i.e., many modules/weeks/units)
 - d. The entire semesters (i.e., entire course)

Please answer or rate the following questions regarding the facilitation of the collaborative work

11. What role(s) did you play? (Check all that apply)
- a. Designer/Planner of the activity or product
 - b. Developer
 - c. Facilitator/Coordinator/Supporter
 - d. Information provider
 - e. Other _____
12. What support was given during the collaborative work? (Check all that apply)
- a. Informational support (suggestion or advice)
 - b. Esteem support (compliment or validation)
 - c. Network support (communication/collaboration assistance)
 - d. Emotional Support (Sympathy or empathy)
 - e. Other _____
13. How often was support given during the collaborative work?
- a. Often
 - b. Sometimes
 - c. Rarely
 - d. Never
14. Who primarily gave support during the collaborative work?
- a. Instructor
 - b. Peer(s)
 - c. Both instructor and peers evenly
 - d. Neither

Rate your level of agreement with each of the following statements using the Likert Scale from 1 Strongly disagree to 5 Strongly agree.

15. The collaborative work provided the following benefits:
- a. Increased my students' communication skills
 - b. Increased my students' collaboration skills
 - c. Helped the students build relationship
 - d. Increased students' awareness of others' perspectives
 - e. Increased students' problem-solving skills
 - f. Increased students' confidence
 - g. Other _____
16. The collaborative work presented the following challenges
- a. Scheduling conflicts
 - b. Workload balance
 - c. Technical issues
 - d. Communication issues
 - e. Anxiety/Stress

- f. Other _____
- 17. Please rate the effectiveness of the collaborative work in promoting students learning.
 - a. Not effective
 - b. Somewhat effective
 - c. Very effective
 - d. Extremely effective
- 18. Please provide a brief reason for your effectiveness rating.
- 19. Please rate your level of agreement with each of the following statements using the Likert Scale from 1 Strongly disagree to 5 Strongly agree.
 - a. I clearly communicated important course topics
 - b. I clearly communicated important course goals
 - c. I provided clear instructions on how to participate in course learning activities
 - d. I was helpful in identifying areas of agreement and disagreement on course topics that helped course participants to learn
 - e. I was helpful in guiding the class toward understanding course topics in a way that helped course participants clarify their thinking
 - f. I helped to keep course participants engaged and participating in productive dialogue
 - g. I helped keep the course participants on task in a way that helped them to learn
 - h. I encouraged course participants to explore new concepts in this course
 - i. My actions reinforced the development of a sense of community among course participants
- 20. (optional) Please share the details or example of the collaborative work that you implemented with your students.
- 21. What is your gender?
 - a. Male
 - b. Female Transgender
 - c. Non-binary/nonconforming
 - d. Prefer not to respond
 - e. Other
- 22. What is your age ranges?
 - a. 18-24 years old
 - b. 25-34 years old
 - c. 35-44 years old
 - d. 45-54 years old
 - e. 55-64 years old
 - f. 65-74 years old
 - g. 75 years or older
 - h. prefer not to respond
- 23. What is your faculty rank?
 - a. Tenure-track Assistant Professor
 - b. Tenure-track Associate Professor
 - c. Tenure-track Professor
 - d. Non-tenure track faculty (Clinical, Teaching, Research)
 - e. Lecturer
 - f. Adjunct

24. How many online courses have you taught (including the same course repeatedly taught over time)?
- a. Under 5
 - b. 5-10
 - c. 11-20
 - d. 21-30
 - e. 31+
25. What is your level of comfort in online teaching?
- a. Not at all
 - b. A little comfortable
 - c. Fairly comfortable
 - d. Very comfortable
26. Does your institution offer professional development opportunities (e.g., workshop) to enhance your online teaching skills?
- a. Yes
 - b. No
 - c. I don't know

Teaching Engineering Online: Examining Instructor Practices Through the Community of Inquiry Framework

Secil Akinci-Ceylan
Iowa State University

Evrin Baran
Iowa State University

Abstract

A growing number of engineering instructors, previously accustomed to face-to-face teaching, have transitioned to online instruction, particularly after the pandemic. The teaching strategies used have become more critical in ensuring the design and delivery of quality online courses. Thus, there is a need to examine engineering instructors' approaches to designing and delivering quality online engineering courses to enhance online teaching. This study examined the online teaching practices of engineering instructors and whether and how cognitive, social, and teaching presence were integrated into their online learning environments. In this case study, the Community of Inquiry (CoI) framework was used to guide the research design. Semi-structured interviews were conducted with seven engineering instructors whose courses received Quality Matters (QM) certification across the United States. The findings revealed similarities and differences in how instructors teach online and establish teacher, cognitive, and social presence. Social presence, particularly group cohesion and affective expression emerged as an area that received comparatively less emphasis in the online teaching environment. While similarities exist across instructors, the limited emphasis on social presence suggests a need for further exploration and support in this aspect of online instruction.

Keywords: Case study; Community of Inquiry; quality online education; teaching engineering online

Akinci-Ceylan, S. & Baran, E. (2025). Teaching engineering online: Examining instructor practices through the Community of Inquiry framework, *Online Learning*, 30(1), pp. 78-113. <https://doi.org/10.24059/olj.v30i1.4856>

Online education has emerged as a significant development in higher education over the past three decades and has been ubiquitously adopted in many disciplines. Its penetration into engineering education has gathered speed and attracted increasing interest in recent years (Koclar et al., 2021). Conventionally, engineering education has been content- and teacher-centered, but this trend has shifted towards applying more contemporary pedagogies with more hands-on and practical applications in engineering courses (Broo et al., 2022). The COVID-19 pandemic has further accelerated the growth of online education in engineering education, with many universities transitioning to remote learning and prompting a surge in demand for online engineering courses and programs.

Quality online education requires educators to employ effective teaching methods, conduct careful instructional design and planning, and follow a systematic course development model (Hodges et al., 2020). Efforts worldwide have been made to analyze standards for assessing quality, some of which include course design, faculty support, and teacher interaction (Mathes, 2019; Online Learning Consortium, n.d.). However, the term “quality” in online education is complex and relative, formed within the context and process of learning (Ossiannilsson et al., 2015). McNeil and Ohland (2015) discovered that engineering faculty lacked a common understanding of quality online teaching, with many advocating for better student admissions to improve education. Faculty encounter challenges in teaching effectively online, often due to a lack of recognition and collaboration regarding quality standards. Inconsistencies in applying these standards are observed at institutional and course levels. Therefore, there is a need to understand quality online teaching practices in engineering education.

The Community of Inquiry (CoI) framework is one of the most widely used frameworks for designing and teaching meaningful online learning experiences (Valverde-Berrocoso et al., 2020). While the CoI has been extensively applied across various disciplines since its emergence, its adoption in engineering education is relatively new. In this study, the CoI framework is used as a theoretical lens to investigate instructors’ approaches to designing and teaching quality online engineering courses. Examining instructors’ online teaching practices using this framework helps understand both the design of online courses and the execution of teaching strategies online to provide quality learning experiences. Thus, the primary focus of this study is to investigate how instructors design and teach quality online engineering courses.

Literature Review

Online Education in Engineering Education

Despite the widespread acceptance and integration of online education in higher education, its adoption in engineering education has been slower compared to other fields. This delay can be attributed to the field’s reliance on hands-on laboratories, challenges in ensuring the integrity of assessments, and the technical complexity of engineering courses that necessitate instructional guidance (Kanyarusoke & Uziak, 2011; Odom et al., 2019). In recent years, there has been a surge in the implementation of online education within the field of engineering education (Koclar et al., 2021). Insights gathered from interviews with the majority of the leaders at renowned engineering education programs indicate a widespread acceptance of online education, with many institutions expressing an interest in blending online and on-campus

learning; however, reservations about the effectiveness of online learning persist for some (Graham, 2018).

The number of institutions offering the Accreditation Board for Engineering and Technology (ABET)-accredited online engineering programs has seen a significant rise from 11 in 2019 to 40 in 2023, a shift that could be influenced by the COVID-19 pandemic. According to the ABET website, there are currently 66 accredited online engineering programs, including 59 undergraduate and seven master's programs. However, it should be noted that ABET evaluates all delivery methods (on-site instruction, online instruction, and a combination of both) using the same criteria, lacking separate criteria for face-to-face and online delivery, with the definition of online learning remaining ambiguous during the evaluation process. Given the increasing number of online engineering programs and a lack of a well-defined definition of online learning, crucial questions emerge: Do these expanding online programs ensure quality engineering education? Are online engineering instructors adequately trained and supported in designing and teaching online courses?

Enhancing engineering education involves focusing on six critical areas, including interdisciplinary curricula, team-based learning, research-based teaching, academia-industry collaborations, distance learning skills, and support for underrepresented students, with online learning recognized as one of the key components (Mann & Tan, 2021). While research suggests that incorporating new technologies like augmented and mixed reality, along with virtual labs, can enrich the learning experience by providing hands-on skills and practical application of theoretical knowledge in a more accessible, flexible, and cost-effective manner, concerns about faculty preparedness persist in online courses. Thus, the literature recommends adopting online education models, such as the CoI framework, to address these concerns and further enhance student learning (Koclar et al., 2021). These approaches can play an important role in designing and teaching quality online courses.

The CoI Framework for Designing and Implementing Quality Online Courses

Developed by Garrison, Anderson, and Archer (2000), the CoI framework is designed to foster collaborative learning, meaningful discussion, and inquiry-based activities to enhance the quality of online learning experiences. The CoI framework consists of three interdependent components: cognitive presence, social presence, and teaching presence, as shown in Figure 1.

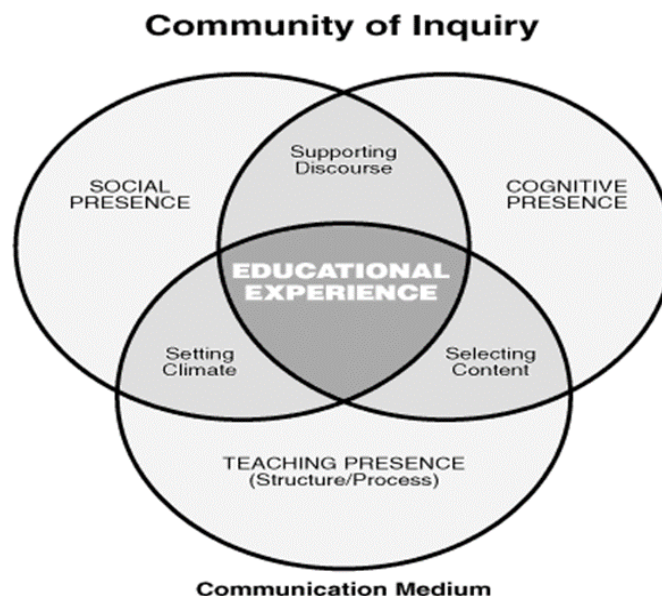
Cognitive Presence

Cognitive presence is “the extent to which learners are able to construct meaning through sustained reflection and discourse” (Garrison et al., 2001, p. 11) and involves four elements. The first element is a triggering event or a stimulus that captures learners' attention and motivates them to engage in further exploration and inquiry. The second element is exploration, which refers to the phase in which learners engage in searching for information or clarification through critical reflection to help understand the initial stimulus (Akyol & Garrison, 2011). The third element, integration, refers to the process of synthesizing and integrating the information using the ideas generated in the exploration phase and constructing meaning (Garrison, 2017). The fourth element, resolution, is the final phase of cognitive presence and is described as an application of new understanding or knowledge to real-world situations, including educational and workplace environments (Garrison, 2017). All categories of cognitive presence work

together to promote higher-order knowledge acquisition and application in which learners engage in critical thinking, reflection, and collaborative knowledge construction.

Figure 1

Community of Inquiry Framework (Garrison et al., 2000)



Research has explored how students engage with each phase of cognitive presence in online environments. Students in the triggering and exploration phases respond to a triggering question and build initial understanding through dialogue, representing lower levels of cognitive presence, whereas integration and resolution involve synthesizing information, reflecting higher-level cognitive engagement (Sadaf & Olesova, 2017). Studies show that triggering and exploration are the most commonly observed phases in online learning environments (Chen et al., 2019; Jo et al., 2017; Sadaf et al., 2021; Shea et al., 2010), while integration and resolution is less frequently achieved, often limited to surface-level exploration (Sadaf & Olesova, 2017; Shea & Bidjerano, 2009). However, some studies report integration as the most active phase (Akyol & Garrison, 2011; Richardson & Ice, 2010). Overall, reaching integration, and especially resolution, is uncommon, with resolution sometimes nearly absent (Moore & Miller, 2022; Vaughan & Garrison, 2005). Factors such as course duration (Akyol et al., 2011), discussion and facilitation strategies, and the types of questions posed in discussions influence the depth of cognitive engagement (Chen et al., 2019; Darabi et al., 2011).

Social Presence

Rooted in the idea that community involves the interests of individuals and groups on a sociological and psychological level reflectively and collaboratively, social presence is defined as a collaborative experience in which learners project their personality socially and emotionally (Garrison et al., 2000; Garrison, 2017). It is established when learners have a sense of acceptance and belonging, perceive others as real, and feel connected in a group environment to achieve meaningful learning outcomes (Garrison, 2017). The first element of social presence is affective

expression. It is defined as the expression of emotion and feelings related to educational experience (Garrison et al., 2000) and includes using emojis, humor, and self-disclosure. Teasing and joking are effective in decreasing social distance and constructing group cohesion in a learning environment. Likewise, sharing experiences and interests with group members aids in establishing trust and lessens the feeling of social isolation. The second element of social presence is open communication (Garrison & Akyol, 2013). It refers to the degree to which individuals communicate openly and respectfully with each other in the online environment. Open communication promotes mutual awareness, recognition of others' contributions, and dialogue among participants. Group cohesion, the third category of social presence, is defined as a sense of belonging and group commitment (Garrison & Akyol, 2013). This includes the connection between individuals and shared values and emphasizes that learning is optimized when learners see themselves as part of the learning community.

Research on social presence has shown a positive correlation with perceived learning (Richardson et al., 2017; Türel, 2016), student satisfaction (Borup et al., 2012; Richardson et al., 2017), and a sense of belonging within a learning community (Delmas, 2017). However, social presence is complex, as its indicators can vary depending on factors such as group size, type of task (e.g., reading vs. project-based), prior relationships among group members, instructor involvement, student needs, and communication styles (Lowenthal & Dunlap, 2020). To foster social presence, studies recommend the use of small group discussions, collaborative and problem-solving tasks to promote group cohesion, meaningful connections between students and between students and instructors, as well as setting course rules such as netiquette for open communication, along with opportunities to share personal information and emotions to support emotional expression and strengthen social presence (Fiock, 2020; Richardson et al., 2012).

Teaching Presence

Teaching presence is a binding element between social and cognitive presence and is described as “the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes” (Garrison & Arbaugh, 2007, p. 163). Teaching presence consists of three interrelated elements. The first one is design and organization, and it is described as the planning and designing of learning activities prior to and during the educational experience, preparation of methods and assessments aligned with the learning outcomes and the needs of the learners and designating time parameters and netiquette. The second element, facilitation of discourse, is concerned with creating a learning environment that maintains participants' interaction, motivation, interest, and engagement (Anderson et al., 2001). The teacher reads and comments on students' posts, encourages less participating individuals to be more active, identifies agreement and disagreement areas, and models netiquette. The third is direct instruction, described as providing learners with subject matter knowledge, feedback, guidance, and support. The teacher presents the course content, identifies misconceptions, guides learners to information resources, and answers students' questions.

Studies have shown that teaching presence positively influences students' learning engagement behaviors in online learning (McNeill et al., 2019; Zhang et al., 2016), fosters deep and meaningful learning (Garrison & Cleveland-Innes, 2005), and enhances perceived satisfaction related to autonomy and competence (Turk et al., 2022). Teaching presence also plays a critical role in supporting the transition from social to cognitive presence (Garrison &

Cleveland-Innes, 2005) and in promoting both social and cognitive presence (Adam et al., 2025; Kozan, 2016). The dimensions of teaching presence account for 45.3% of behavioral engagement, 34.3% of cognitive engagement, and 40.9% of emotional engagement in online courses (Wang, 2022). Direct feedback, effective course organization, and instructor facilitation have been found to support students' critical thinking and help them maintain focus (Hosler & Arend, 2012). Overall, these studies show that course design, facilitation, and direct instruction are closely linked to the development of social and cognitive presence and play a key role in enhancing learner engagement in online learning environments.

Although the CoI framework was developed to be generic and applicable across most educational environments (Garrison, 2023), how it is applied and perceived varies across disciplines due to different values and emphasis associated with each discipline (Richardson et al., 2024). For example, research has shown that the strength of the relationship between social presence and students' perceived learning and satisfaction varies by academic field, with stronger effects found in disciplines such as life sciences and computer skills, followed by education and business (Richardson et al., 2017). Gorsky et al. (2010) found that teaching presence was more prominent among science students than in humanities, where it was almost absent. They also observed that all cognitive presence categories, except for resolution, were commonly found in science courses, and science instructors posted more messages related to exploration than their humanities counterparts. Instructors in the sciences show higher levels of direct instruction, including giving feedback and clarifying misconceptions, whereas humanities instructors place more emphasis on facilitating discourse and encouraging reflection (Arbaugh, 2010).

Reflecting these disciplinary trends, Kim and Gurvitch (2020) conducted a systematic review of research on the CoI framework from 2009 to 2019 and found that the majority of studies focused on education, followed by business, with relatively few studies in engineering, mathematics, and computer science, highlighting a research gap in STEM fields. Research on the CoI framework continues to lag in STEM disciplines, where online courses consistently face high student withdrawal rates (Faculconer & Chamberlain, 2022). In engineering courses, instructors are less likely to share personal beliefs, provide alternative perspectives, or summarize discussions, compared to instructors in other disciplines (Richardson et al., 2024). Students in engineering, information sciences, and mathematics tend to report lower levels of social presence (Lim & Richardson, 2022; Padayachee & Campbell, 2021), with affective expression being particularly uncommon in STEM fields (Faculconer & Chamberlain, 2022). Even within STEM, there are variations. Olesova et al. (2024) found that students in a graduate Data Analytics program reported higher levels of cognitive presence than those in an Applied Information Technology program. Given these disparities and the limited attention engineering has received in CoI research, this study focuses on online teaching practices in engineering through the lens of the CoI framework, an area that remains underexplored.

The CoI Framework in Engineering Education

Given the surge in online engineering courses, an increasing number of studies have begun to use the CoI framework to examine different aspects of online engineering education. Prior work has focused on student perceptions of online learning experiences and the CoI presences (Baytiyeh, 2018; Jaksic, 2021; Lim & Richardson, 2022; Purwandari et al., 2022; Szeto, 2015). Lim and Richardson's (2022) findings revealed that students' perceptions of social

presence varied across academic disciplines. In contrast to students in the social sciences, engineering students did not consider social presence as crucial to achieving learning outcomes; instead, they emphasized the importance of teaching presence. Another study found that teaching presence had a more significant impact on cognitive presence than social presence (Purwandari et al., 2022). Similarly, teaching presence was discovered to have a greater influence on the attainment of learning outcomes than cognitive and social presence, highlighting its importance (Szeto, 2015). These results indicate that engineering students value teaching presence the most.

Other studies have investigated the effects of technology use and self-regulation on the development of cognitive presence (Kovanović et al., 2015) and the impact of feedback on the three presences (Rutz & Ehrlich, 2016). Some have employed the CoI framework to (re)design engineering courses (Cabrera et al., 2017) and to develop educational models and recommendations to increase student satisfaction (Chernosky et al., 2021; Dunlap et al., 2016). As expected, studies on online learning in engineering education have gained momentum, particularly in response to the pandemic. Few studies explored different aspects, such as how engineering faculty supported student success during emergency remote teaching (Douglas et al., 2022), the effectiveness of online discussion forums in fostering a community of learning (Padayachee & Campbell, 2022), and comparisons of different online instructional practices (Beneroso & Robinson, 2022).

Most studies mentioned above employed the CoI framework to investigate student perceptions of the CoI presences, (re)design courses, and promote student learning. These studies predominantly focused on the students' perspectives and used quantitative surveys to explore student learning and their perceptions of online learning. Instructor perceptions and how they design and teach online courses were given limited attention, with only a few studies including interviews with instructors. In these cases, instructor interviews were typically conducted alongside student interviews and were not the primary focus (Douglas et al., 2021; Szeto, 2015). Additionally, some of the courses in these studies were transitioned to online formats during emergency remote teaching without adequate preparation and under time and budget constraints. Thus, there is a major gap in studies exploring how engineering instructors teach quality online courses and how they view the integration of teaching, social, and cognitive elements, if present, in their online courses. The following research question is addressed in the study: What teaching practices do engineering instructors use to establish teaching, social, and cognitive presence within the CoI framework, if any, in quality online courses?

Methods

This study employed a multiple case study design, “a special effort to examine something having lots of cases, parts, or members” (Stake, 2013, p. vi). The primary goal is to understand a specific phenomenon or an issue, which Stake refers to as a “quintain,” and how this quintain functions within various contexts. By examining the individual parts or cases of the quintain, a more comprehensive understanding of the whole can be achieved. Each case has its own unique story to contribute; thus, analyzing each case within its specific setting enhances the understanding of the quintain. In this study, each instructor, their teaching background, context, and institution is treated as an individual case. By exploring seven cases in distinct contexts, the purpose is to gain insights into how engineering instructors design and teach quality online courses, comparing their similarities and differences.

Context

In this study, online engineering instructors who designed and/or taught Quality Matters (QM)-certified courses were interviewed. QM is dedicated to ensuring quality online education by reviewing and evaluating online and hybrid courses using its framework and rubric (Quality Matters, n.d.). Its primary aim is to equip instructors with the skills to evaluate courses according to the rubric's standards, grant certification for the quality of online and blended courses in higher education and K–12 settings and offer guidance for improving course quality (Quality Matters, n.d.). A review team, comprising a team chair, one subject matter expert, and an external reviewer, assesses courses using the rubric and provides feedback to enhance the course's quality. QM has documented positive impacts on student learning and satisfaction (Varonis, 2014), and its guidelines are used to develop new online courses and enhance existing ones in engineering programs (Eggleston & Rabb, 2021; Wang, 2018).

We should note that neither of the authors is affiliated with the QM program. The first author participated in a training session on applying the QM rubric and obtained certification. However, apart from this, neither of the authors has submitted a course for QM review or served as a reviewer. In this study, QM-certified instructors were chosen for the interviews due to the strong emphasis on course quality and student learning in their online courses.

Recruitment and Sampling

To identify engineering instructors whose courses were QM-certified (Quality Matters, n.d.), the QM website was manually scoured in September of 2023. This website is regularly updated to reflect newly certified courses. At the time of the review, the website included courses certified between 2019 and 2023. We focused on courses in higher education and carefully reviewed engineering courses certified in 2022 and 2023. This involved sifting through a total of 337 institutions and 1,986 courses listed under higher education.

The courses on the QM website are categorized by subject, and we included all those under the engineering category. This search process yielded 34 engineering courses at the graduate and undergraduate levels. We reviewed and contacted 30 instructors via email for participation in our study (four courses were taught by the same instructors). We reached out to potential participants three times, with approximately one week between each email. Nine instructors volunteered to take part in interviews. However, upon conducting the interviews, we found that two of the courses were not fully online—one was flipped with no online students, and the other was a hybrid course with both face-to-face and online components. As our study exclusively focused on fully online courses, these two were excluded.

Participants

The participants of this study were seven instructors who designed and/or taught QM-certified online courses in engineering in the U.S. These instructors taught in five different institutions across the country. Among them, one was an associate professor, one was an associate teaching professor, two were adjunct professors, two served as assistant teaching professors, and one was a professor and chaired the engineering department, as shown in Table 1. Their educational backgrounds included engineering, computer science, and statistics, with degrees earned from various U.S. universities. Participants were affiliated with departments such

as the School of Engineering, Mechanical and Materials Engineering, Computer and Information Sciences, and Electrical and Computer Engineering.

Participants' institutions encompassed five universities: two very high research-activity universities, two master's universities, and one baccalaureate college (Carnegie Classification, n.d.). Three participants came from a Southeastern university, two from Southern universities, and two from Midwestern universities. Of seven participants, five identified themselves as White, one was White and Hispanic/Latinx, and one was Hispanic/Latinx. Six instructors had taught at least one QM-certified online course at the time of the interview, while one designed a QM course but had not taught it yet.

Table 1

Characteristics of Participants

Pseudonym	Gender	Rank	Current department	Online teaching experience
Albert	Male	Professor & Department Chair	Engineering Department	3 years
Alfred	Male	Assistant Teaching Professor	Mechanical and Materials Engineering School of Engineering	2 years
Carolina	Female	Adjunct Instructor	School of Engineering	4 years
Jean	Female	Assistant Teaching Professor	School of Computing and Information Science	20 years
John	Male	Associate Teaching Professor	Statistics	2 Years
Sasha	Male	Associate Professor	Electrical and Computer Engineering	10 Years
Willie	Male	Adjunct Instructor	Engineering Department	2 years

Case Vignettes

In this section, we offer detailed descriptions of each participant in the form of case vignettes. Vignettes are detailed depictions of scenarios with the goal of uncovering participants' beliefs, emotions, judgments, attitudes, and values regarding particular phenomena (Skilling & Stylianides, 2020). In this study, the vignettes aim to provide background and contextual information about each instructor and their online courses. Pseudonyms selected by participants will be used throughout the rest of the paper.

Case Vignette 1: An Online Engineering Course with a Focus on Economics

Carolina is an adjunct instructor within the School of Engineering at a university located in the Southern region of the U.S. She comes from a systems engineering background and has a total of nine years of teaching experience, the last four of which have been dedicated to teaching online. She is currently teaching an engineering course with a focus on economics. This is a required asynchronous course with approximately 50 junior-level students. Her experience with this course spans nine years, initially conducted in a face-to-face format before transitioning to an online mode for the past four years.

This course is the only QM-certified course she teaches and remains the only QM-certified online engineering offering within her institution. She believes that one impact that the certification process has been on accessibility. Each semester, Carolina welcomes students with disabilities, and the certification has proven useful in enhancing the course's accessibility. In evaluating her comfort and effectiveness as an online instructor, Carolina rates herself at a nine because she recognizes the need for continuous improvement.

Case Vignette 2: An Online Mechanical and Materials Engineering Course

Alfred is an assistant teaching professor with 11 years of industry experience in the mechanical and materials engineering department at a southeastern university in the U.S. His institution is one of the largest Hispanic-serving institutions across the country. Alfred's university requires QM certification for online courses. Faculty receive financial incentives if their courses receive this certification. He has a total of three years of teaching experience, with the last two years dedicated to online course delivery. Alfred is currently teaching a senior-level course, the only QM-certified course he teaches. The course has an asynchronous format with an average enrollment of approximately 60 students.

Reflecting on his experiences, Alfred notes that the certification process has contributed a sense of structure, logic, and alignment with best practices in online teaching. Alfred describes his online teaching approach as creating opportunities for students to connect to real-world applications through the examples he provides and his prior industry experience. On a scale of 1 to 10, Alfred rates his comfort and effectiveness in teaching online at an eight. However, he acknowledges that increased interaction with students and greater input from them could further enhance his confidence and effectiveness in online instruction.

Case Vignette 3: An Online Electrical Engineering Course

Albert is a professor in the engineering department at a Midwestern university and serves as the chair of the same department. His teaching experience spans a period of 28 years. For the past three years, he has been teaching an asynchronous junior-level online course typically attended by approximately 20-25 students. It is a required course for electrical engineering and computer science students.

At Albert's institution, all online courses must undergo the QM certification process if taught more than once. Additionally, in response to the institution's recent launch of an online engineering program and the need to adhere to ABET guidelines, Albert, as department chair, sought to set an example by going through the certification process and observed a noticeable improvement in course quality. Albert rated his comfort and effectiveness in online teaching at 8 and 7, respectively, because of challenges related to the absence of formal online teaching training and limitations in hands-on lab equipment for online lab sessions.

Case Vignette 4: An Online Engineering Course with a Focus on Technology and Ethics

Jean is an assistant teaching professor in the School of Computing and Information Science within the College of Engineering at a university in the southeastern U.S. While she works in the same institution as Alfred, she belongs to a different department. It is a requirement for all online courses to undergo QM certification at her institution. Jean currently has four QM-certified courses. With 30 years of teaching experience, including the last 20 years of online teaching, Jean holds a Ph.D. in educational technology.

Among the courses she currently teaches is one focused on the global impact of technology, an asynchronous course with approximately 60 junior-level enrolled students. Jean's teaching approach is student-centered, emphasizing active student involvement. She places significant importance on building connections with her students, positivity, and enjoyment while teaching, grading, and interacting with students. Jean feels highly confident and effective in her online teaching abilities, rating herself a ten out of ten.

Case Vignette 5: An Online Electrical and Computer Engineering Course

Sasha is an associate professor in the department of electrical and computer engineering at a university in the Southeastern region of the United States. His engineering program has achieved full accreditation from ABET. He has an extensive 20-year teaching background, including 10 years of experience in online teaching. Sasha works at the same institution as Alfred and Jean, and like the other two participants, he mentioned an institution-wide initiative to achieve QM certification for online courses.

In his QM course, Sasha has approximately 70 students. It is an elective course for senior-level students, conducted asynchronously. He strongly values the thoughtful design of online courses and sees his role as an online course instructor overseeing the course content and student activities. According to him, QM makes a significant contribution by setting standards for designing high-quality online courses. Sasha rates his comfort and effectiveness in teaching as a ten out of ten. He attributes this to his structured, pre-planned approach and well-defined roadmap for online course delivery.

Case Vignette 6: An Online Electrical Engineering Course

Willie serves as an adjunct professor at a community college in the Southern region of the United States. In this study, he stands out as the only participant with QM certification at a community college. He has over 30 years of experience in the engineering industry and 13 years of teaching, including two years of online teaching experience. In his QM-certified course, he typically has 12 students, delivering a required course asynchronously.

Willie pursued the certification of this course, positioning himself as a leading instructor in this regard within his department. He characterized his approach to online teaching as one that incorporates students' needs into the online course platform, offering an organized and structured learning experience. Regarding his comfort level in teaching online, Willie expressed complete comfort, rating himself at a ten on a scale of 1 to 10. He emphasized his effectiveness as an online instructor by giving himself a rating of eight, underlining his continuous efforts for improvement in his teaching practices.

Case Vignette 7: An Online Engineering Course with a Focus on Statistics

John is an associate teaching professor at a midwestern University. He has nine years of teaching experience, with two years of online teaching experience. He has developed an online QM-certified course for engineering students, offered at a junior level and conducted asynchronously. This course typically enrolls approximately 60 students.

When it comes to his online teaching approach, John emphasizes the importance of fostering interaction with his students by organizing live meetings and utilizing real-world examples to capture their interest. He rates his comfort level with online teaching at an eight and

acknowledges that further familiarity with technological tools would enhance his confidence in delivering online courses. In terms of effectiveness, he self-assesses at a seven and anticipates that his effectiveness will improve with more experience teaching the same course.

Data Collection

We conducted semi-structured interviews with seven instructors, each lasting between 60 and 90 minutes. These interviews aimed to gather insights into their online teaching practices, and strategies for establishing teaching presence, social presence, and cognitive presence in online courses. Before the actual interviews, each participant completed a demographics survey. Additionally, to ensure the effectiveness of our interview protocol, we conducted a pilot interview with an engineering faculty member who did not participate in the study. We revised the interview questions based on the faculty member's feedback for better clarity.

The interview questions covered various aspects, including the specific context of the courses they taught, their comfort and effectiveness in online teaching, any prior training they had received in online teaching, their motivation for obtaining QM certification for their courses and the ways they establish the three presences, as shown in Table 2. The interview questions related to the CoI framework were informed by the CoI survey. In cases where participants provided short answers or did not fully address a question, follow-up or clarifying questions were asked. All interviews were conducted and recorded using the Webex platform. After each interview, memo writing was carried out to record observations of the events experienced during the interview.

Table 2
Example Interview Questions and Their Categories

Category	Question
Background/Context	For how long have you been teaching online?
	Can you tell me about the context of the course?
	How would you describe your online teaching approach as an instructor?
	How did you decide to get this course QM-certified?
Teaching Presence	Can you tell me about how you planned and designed this course?
	How do you communicate course instructions, topics, goals, and due dates to students in this course?
	How do you facilitate student learning and the learning environment?
	How do you check if your students are understanding the material and provide feedback to them?
Cognitive Presence	How do you make your online courses interesting and encourage students to be curious about the subject?
	How do you encourage students to search for information, knowledge, and clarification?
	After students explore information, how do you encourage students to integrate the searched information into course activities/assignments?
	How do you motivate students to use what they've learned outside of class?
Social Presence	How do you make sure your students feel included and valued in the course?
	How do you encourage your students to express themselves personally and convey their values?

Can you tell me how you create a safe and open environment for students to interact with each other?
How do you encourage collaboration among your online students?

Data Analysis

This study included seven cases involving online instructors and their specific teaching environments. To ensure the accuracy and completeness of our analysis, we used verbatim transcripts from Webex and read through all of them while simultaneously listening to the recordings to ensure there was no missing information and that the recording and the transcript matched. Our first approach followed Saldaña's (2016) structural coding method, which allows researchers to assign conceptual labels to a portion of data related to specific interview questions used during the interviews. For instance, we had main codes, such as social presence, cognitive presence, and teaching presence, each further broken down into sub-codes, such as design and organization, facilitation, and direct instruction, all elements of teaching presence. This structural coding process helps identify significant text segments, which serve as the foundation for more in-depth analyses within or across various topics (Saldaña, 2016).

After labeling the seven transcripts using structural coding, we thoroughly examined all transcripts. After structural coding, we employed open coding for further data analysis. This process also involved developing in-vivo codes using the exact words of the study participants. We used the elements of the CoI framework to label the main categories in the codebook; however, we remained open to participant responses to authentically elicit their teaching practices under these categories, which are listed as key findings in Table 3. We identified the similarities and differences between participant responses and refined or rephrased some codes after carefully examining the transcripts through several iterations.

Trustworthiness

To ensure trustworthiness, we implemented various strategies as recommended by Lincoln and Cuba (1985). Initially, the first author coded the transcripts, while the second author independently reviewed and examined the coded transcripts to address any inconsistencies. To enhance the credibility of our findings, regular peer debriefing meetings were conducted on a weekly basis. These sessions not only fostered consistency but also served as a platform for resolving any disagreements between the authors. In addition, we actively engaged in member checking to validate the accuracy of our data. This involved sending the completed manuscript to the participants via email, seeking confirmation from them, and providing an opportunity for them to identify and correct any potential errors. Some participants responded with recommendations, and we incorporated their feedback, making necessary corrections to improve the overall accuracy of the research.

To enhance the transferability of our findings, we incorporated thick participant descriptions through case vignettes and presentation of results. These detailed descriptions provided rich insights into the backgrounds and experiences of the participants, shedding light on how they design and deliver online courses. For increased confirmability, both authors maintained a reflective stance throughout the research process. The first author has experience as an instructional designer and has been actively involved in developing online courses. The second author, a faculty member in educational technology, has extensive experience as an

online instructor and course developer, utilizing the CoI framework in her research. Throughout the research process, we were mindful of the potential impact of our positions and backgrounds on the investigation.

Results

In this section, we present our findings on the practices of engineering educators regarding the integration of teaching, social, and cognitive elements within quality online courses. We organize the participant responses according to each presence and their respective components. Table 3 summarizes the key findings.

Table 3

Key Findings of How Instructors Establish the Three Presences in Online Engineering Courses

Strategies used to establish cognitive presence	# of occurrence	Strategies used to establish social presence	# of occurrence	Strategies used to establish teaching presence	# of occurrence
<i>Triggering Event</i>		<i>Affective Expression</i>		<i>Design and Organization</i>	
Link assignments/examples to real-world	6	Use of humor (GIFs, comics, jokes)	5	Maintain consistent course structure	7
Add an element of fun and engagement into assignments	2	Share personal information (hobbies, likes and dislikes)	2	Welcome students to the online course	6
Build well-structured courses	1	Emojis	2	Send weekly 'to do' emails	5
Build well-structured courses	1	Listen to students' feelings and try to help out	2	Be available for student inquiries on multiple channels in a timely manner	5
Create personalized lecture videos	1	Use of visuals	1		
<i>Exploration</i>		<i>Open Communication</i>		<i>Facilitation</i>	
Encourage students to use outside resources	5	Netiquette statement in the syllabus	3	Monitor discussion forums and grades	4
Provide additional learning	3			Encourage student participation and a positive learning environment	2

resources on course site				
Encourage students to ask questions	1			
<i>Integration</i>		<i>Group Cohesion</i>		<i>Direct Instruction</i>
Require students to cite outside resources when submitting assignments	3	Respect their preferred names	2	Assess student progress
		Discussion boards and collaborative projects	1	Provide feedback
		Inclusivity statement	1	7
<i>Resolution</i>				
Provide real- world examples	3			
Design hands-on activities	3			
Share career stories	2			
Emphasize the link between skills taught and students' future careers	2			

Note. The numbers provided in the table represent the number of participants who used each strategy.

Cognitive Presence

Triggering Event

To capture students' attention and enhance engagement, instructors employed diverse strategies. The approaches included linking assignments and examples to real-world scenarios, injecting an element of fun into assignments, designing well-structured courses, improving the effectiveness and engagement of lecture slides, and creating personalized lecture videos.

A predominant theme among six instructors was the integration of real-world examples into their online courses to establish relevance for students as Albert stated, "When I'm discussing a topic, I always explain how that topic is applicable to something in real life. Like, a television, how this certain algorithm would work. I think that gets the students interested." John and Jean stressed the significance of connecting examples to students' interests, stating that relevance sparks curiosity. Alfred underscored the value of relating course content to real-life scenarios, drawing on his industry experience and allowing students to select project topics aligned with their interests.

Carolina and Jean focused on adding a fun element to assignments to sustain student interest. Jean employed online quizzes such as Kahoot to enhance engagement. Carolina used surveys to find out students' movie and TV preferences, incorporating related examples into problem-solving tasks. Similarly, Jean incorporated an engaging approach by having students watch a movie and using it as a scenario for assignments. She shared:

After the last Jurassic Park movie came out, I had them do a little research on dinosaurs, they did the inheritance based on urban version carnivores, and then they basically did a small dino- family tree of a couple levels. It was fun because it kind of connected with something cultural.

Additionally, Sasha emphasized the importance of a well-structured and organized course, stressing the need for guidance throughout the week to maintain student motivation. Willie enhanced engagement by incorporating elements like animations into PowerPoint slides. Carolina created personalized lecture videos instead of relying on generic content from platforms like YouTube. This yielded benefits, as evidenced by the student feedback that she shared. Students appreciated the ability to rewind and rewatch the videos, which contributed to increased interest in the subject matter and overall course engagement. Overall, instructors predominantly utilized real-world scenarios and introduced elements of fun to enhance course appeal and capture students' interest.

Exploration

Instructors used three methods to encourage students to search for information or clarification and understand the course content, which included encouraging students to use outside resources, incorporating additional learning resources into the course learning management system (LMS), and creating a learning environment where students feel comfortable asking questions. Five instructors specifically encouraged students to use outside resources, such as books and journals, to supplement their understanding of the course material. Alfred, for instance, mentioned that students often approach him seeking additional data, and he acts as a guide by directing them to specific journals. Sasha and Alfred both recognized this approach as a valuable means of fostering student independence, encouraging autonomy and self-directed inquiry in the learning process.

The second method employed involved providing supplementary learning resources within the course LMS. This included integrating extra links to tutorials, reading materials, and websites, offering students additional venues for learning information. Albert noted the existence of a folder on the course site containing materials, such as examples of lab reports and reference guides, providing students easy access to course-related documents and outside resources. Similarly, Sasha emphasized the foundational knowledge gained while encouraging students to seek additional resources for a more comprehensive understanding. Sasha remarked, "By using additional resources, they can augment that knowledge. It might clarify for them and might give them a deeper understanding. It might also even broaden their understanding because it might interject additional items that I might not have covered."

Another strategy employed to promote exploration involved encouraging students to pose questions. Among the instructors, Carolina was the only instructor taking this approach, highlighting the creation of a supportive environment for student inquiries through forums and emails. Carolina facilitates a comfortable atmosphere by allowing anonymous postings on the course forum pages, aiming to foster confidence in students to ask questions, seek new information, or clarify questions.

In contrast to other instructors, John did not employ the mentioned methods; however, he expressed his willingness to encourage exploration when students seek help during office hours or discussions, primarily on a case-by-case basis. Overall, the responses from instructors indicate

that the methods employed were to guide students to use external resources, incorporate additional learning materials into the course LMS, and motivate them to ask questions.

Integration

Instructors' responses revealed that three instructors, Jean, Alfred, and Sasha, actively support the integration of information into course assignments. Jean takes an approach by encouraging her students to watch a relevant movie, conduct research on its characters, and connect it to the assignment. Similarly, Sasha and Alfred encourage students to cite external sources when incorporating information into assignments, emphasizing responsible and accountable integration. Additionally, Sasha expressed openness to incorporating valuable student-found resources into the course to enhance the learning experience.

The other four instructors noted that due to the technical nature of the course content, there is limited opportunity to integrate searched information into assignments. Willie stated, "Since this is basically a subset of physics, the resolution of criteria for the course is kind of cut and dried. You might have to do that with things like social issues, but in this particular field, not so much." These examples illustrate that the majority of instructors do not encourage the integration of information into course assignments due to the nature of the course subject.

Resolution

Instructors employed four different ways to encourage students to apply new knowledge to real-world situations, including providing real-life scenarios, designing hands-on course activities, sharing their personal career stories, and emphasizing the link between the skills taught in class and students' future professions. Carolina, Jean, and Alfred used real-life scenarios to motivate students to apply their acquired knowledge beyond the classroom. They achieved this by connecting the scenarios to students' personal lives and demonstrating everyday relevance. Their goal was to emphasize that the knowledge gained in class is theoretical but can be applied to everyday situations, highlighting the practical value and relevance of what students learn.

Another approach was the design of hands-on activities that mimic professional workplace scenarios. For instance, Jean, Alfred, and Willie indicated that they structure course projects to encourage students to apply their knowledge to real-world settings. Willie further elaborated on this approach, stating that he allows students to choose project topics aligned with their interests, extending the application of their learning beyond the classroom. Additionally, Alfred pointed out that discussion forums play a role in helping students reflect on how the knowledge gained in the course can be directly applicable to their own work.

Albert, drawing from his past experience in the industry, noted that he uses stories from his own career as a motivational tool. Through these anecdotes, he aims to underscore the significance of specific skills in professional settings. Similarly, Alfred shared that he tries to be a role model for students, leveraging his industry experience to guide them, emphasizing the relevance and importance of what they learn in class within the workplace.

The final approach involved explaining to students the connection between what is learned in class and their future careers. Sasha and John used this strategy, emphasizing to students that the skill sets acquired through the course would be essential in their field when seeking employment. These approaches collectively highlight that instructors employ different

methods to demonstrate to students the relevance of the course material to their future careers through underscoring the real-world applicability of acquired skills and incorporating hands-on activities and real-world scenarios for practical application and reinforcement of learned concepts.

Instructors' responses revealed diverse strategies to foster cognitive presence within their courses. They employ a variety of methods to enhance engagement and sustain students' interest. Encouraging the utilization of external resources and highlighting the real-world applications of course topics and assignments are common practices among these instructors. Our findings indicate that integration is the least used component of cognitive presence. Instructors attribute this to the technical and non-subjective nature of the course content. The majority of instructors do not encourage integrating researched information into assignments; however, they express openness to incorporating external resources into their courses.

Social Presence

Affective Expression

Instructors employed five strategies to foster students' affective expression. These included the use of humor, sharing personal information, emojis, listening to students' feelings and encourage them to express feelings, and use of visuals. While these methods reflected instructors' own emotional expression, they were primarily used to model affective behavior and invite students to feel comfortable engaging emotionally in the online classroom.

Most instructors emphasized the use humor to convey feelings and build relationships with students, encouraging them to express themselves more freely. Carolina, for instance, used GIFs and shared personal information to create an emotionally open environment. She explained:

I like to use humor, I put like the GIF so that they don't feel like I'm this very like serious person that they cannot like, kind of like, look approachable. But also, my introduction, I put it in a funny way. This is what I like, my degrees, but then I turn to the dark side after graduating, and I put fun things like, Oh, I like Mac and cheese or fun facts.

Jean also created space for affective engagement by beginning her weekly announcements with personal reflections and references to common experiences like the weather or weekend events. Her goal was to normalize emotional expression and encourage a connection between students and herself and among students. She used emojis intentionally, acknowledging their role in conveying warmth and tone in the absence of physical cues. According to Jean, this modeling helped students feel more comfortable opening up, asking questions, and connecting with one another. She elaborated:

You have to be very deliberate in the online environment. Things that you naturally do like when you walk into a classroom and you smile, right, it makes connections organically, you don't have to think about should I smile, right? In the online environment, they can't see you smile. So, I use lots of emojis.

Similarly, Alfred incorporated comics as part of his humor strategy and viewed discussion forums as a platform for students to come out of their shells, interact with others, express feelings, and share personal information. In contrast, Sasha used light humor occasionally but did not actively encourage personal sharing or emotional expression among

students, attributing this to his identity as an engineer, noting, “I do not use emojis, if I do, it’s, you know, very light humor, but not very often. I don’t know maybe because we’re engineers, but there’s not a whole lot of personal information sharing.”

To further support affective expression, instructors provided structures that encouraged emotional sharing. Welcome forums and introductory videos were used to invite students to share personal interests and concerns. Carolina reported responding empathetically to students who expressed anxiety about taking their first online course, modeling emotional openness and validating their feelings. She also encouraged them to share visuals in the Q&A forums, such as pictures of their work or anything they found challenging to understand and noted that students often included respectful emojis in their email communication.

Listening to and acknowledging students’ emotions was another way instructors supported affective expression. Alfred described scheduling one-on-one meetings when students expressed distress, while Jean encouraged students to openly share when they were confused or lost. By reinforcing that no question was “dumb” and validating students’ emotional reactions, these instructors aimed to encourage students to openly share their feelings, assuring them that there will be no judgment. Jean shared:

You gotta tell me what that look on your face is, right? Is it that you’re bored, or did I say something, and have no idea what I’m saying? I try to help them overcome that because once they feel like they can ask questions without fear of judgment, they tend to be much more forthcoming.

However, some instructors encountered challenges in supporting affective expression due to the nature of their course content or the limitations of asynchronous delivery. Albert, for example noted that the highly technical nature of his course, characterized by numbers and codes, left limited room for emotional interaction. Similarly, Willie described difficulty fostering emotional connections in his asynchronous course, observing that students interacted infrequently with him and other students. This indicates that, while some instructors do not prioritize affective expression due to the technical nature of the course content and the challenges associated with an asynchronous format, others employ various methods to encourage students to express their feelings.

Open Communication

To establish open communication and a risk-free learning environment, some instructors added a netiquette section to their syllabi to encourage respectful behavior among students. Willie shared his practice of using the statement provided by his institution to create a safe online environment. He emphasized that, given the absence of interactions between students in his course, there is little opportunity for bullying or an unsafe environment to develop. In line with Willie’s approach, Albert explained that the absence of online discussions also eliminated the opportunity for any unsafe environment to arise. On the other hand, John used his institution’s netiquette and developed an orientation module for his students. This module instructs them on how to behave in an online class and how to conduct themselves appropriately.

Group Cohesion

Students do not engage in collaborative and interactive assignments in six of the courses examined in this study. Although instructors encourage collaboration, the prevailing expectation

is that students complete and submit assignments individually. For instance, John mentioned that he provides a disclaimer that allows students to collaborate with others on assignments, but they must independently write up their solutions. This tendency may arise from instructors' challenges in assessing whether all team members contribute equally to collaborative projects. Likewise, Sasha mentioned that he used to include a group project in his course before QM certification. However, in the certified course, he eliminated it to ensure that all students are actively learning. He explained, "If students work together, I have no problem with that. What I don't want is one student doing the work and the other ones, just kind of watching. I want the learning process to occur for everybody."

The nature of the course and its content also influenced whether instructors incorporate collaboration. John explained that his course follows an individual learning approach, with students tackling problems that typically have a single answer. While he desires to introduce a more team-based approach, he has not yet found a way to implement it. Alfred noted that he assigns group projects to students in regular semesters, but in his summer class, time constraints make it more challenging to integrate such projects. These examples underscore that factors such as course content, concerns about the balanced distribution of work in team projects, and the course duration impact instructors' decisions regarding collaboration.

Jean was the only instructor who had her students work together to learn the course material, including having students work on a real-world project in teams and interact through discussion boards. She believes designing such group projects in an asynchronous environment is more challenging for instructors. Students tend to favor multiple-choice assessments over group work because they find them easier. However, Jean sees value in student collaboration. Addressing the concern about students not contributing equally in teams, as discussed earlier, Jean mentioned that she has each team member evaluate the performance and contributions of their peers and assigns points accordingly. Furthermore, to foster a sense of community in her course, Jean has students introduce themselves at the beginning of the semester. This practice helps students get to know their classmates better and allows for personal connections between Jean and her students when she responds to their posts.

Beyond collaboration, instructors also emphasized the importance of inclusive learning environments. Sasha, recognizing the diverse nature of his student body, added an equity, diversity, and inclusion statement to his syllabus. He also proactively monitored student responses and behavior to ensure that inappropriate language or behavior is addressed promptly. Similarly, Alfred and Albert expressed their commitment to maintaining a safe learning environment. They mentioned that they are prepared to intervene if they ever notice interactions going in the wrong direction, although such situations have not arisen thus far.

Jean places great emphasis on empowering students to find their voice in her class. She achieves this by asking students about their preferred names and hobbies, addressing them by their chosen names. Jean assures her students that there are no "dumb" questions in her class and encourages them to ask questions without fear of judgment. Like Jean, Alfred further emphasized the importance of allowing students to express themselves freely and respecting their choices regarding how they wish to be addressed.

In summary, we found various practices instructors use in online classes to establish social presence. Of the three components of social presence, collaborative and interactive assignments received the least emphasis from instructors.

Teaching Presence

Design and Organization

Instructors adopted similar approaches regarding the design of the online learning environment and course activities. These included maintaining a consistent course structure and availability for student inquiries through multiple channels, welcoming students to the online course, and sending weekly “to do” emails. All instructors highlighted the importance of maintaining a uniform structure throughout the course, ensuring consistency in the layout for each module. For instance, John shared that he outlines course-level and module-level learning outcomes on the course site, arranging all course materials into groups for enhanced student navigation. Willie specified his approach, stating, “There’s a set of pre-lecture review questions. Uh, there is the lecture itself and then there’s some post lecture review problems. And then there’s labs that will validate everything will also be unit tests. And a final exam.” All instructors adopted a similar method to Willie, maintaining a standardized module structure for a cohesive learning experience.

Several instructors emphasized accessibility considerations. This involved incorporating features such as alt text for images, captions for lecture videos, and the use of suitable colors. Many admitted that they had not given much thought to these aspects, and integrating accessibility requirements was a learning curve during the course design process. While instructors are expected to follow a consistent course structure and address accessibility due to QM certification requirements, it is noteworthy that they also gained new insights during this process. This learning experience suggests that instructors actively expanded their understanding beyond merely adding materials to their LMS, a knowledge gain they are likely to apply in future online course designs.

Five instructors emphasized the significance of their availability to students, providing various communication channels to address questions and offer assistance. They encouraged students to arrange online or in-person meetings, including virtual office hours. In addition to accessibility, these instructors underscored the importance of responding promptly to student inquiries. Sasha, for instance, expressed his commitment to quick responses as follows:

I tend to respond rather quickly because many of my students will work because we’re a computer school and they’ll be doing homework like on a Saturday. If I respond to them on Tuesday who cares by that time. So, I think trying to respond to their questions in extremely timely manner is a huge advantage.

Welcoming students to the online course, either through synchronous meetings or introductory videos recorded by instructors, emerged as a common method to enhance the organization of the course. Sasha, for example, incorporates synchronous meetings at the beginning of the semester along with a welcome video on the LMS to discuss course expectations and orient students. He also holds synchronous review sessions to actively engage with students, address their concerns, and clarify expectations. Similarly, John values the opportunity to have live sessions with students, considering it a chance to be present as an instructor.

Five instructors—Carolina, Willie, John, Jean, and Alfred—indicated that they regularly send weekly emails to students, typically at the start of a new module. These emails

communicate reminders, highlight upcoming assignments, and outline upcoming week expectations. John, for example, emphasized that his emails aim not only to remind students of upcoming assignments but to establish a sense that “there is someone behind the screen,” fostering support for students. Similarly, Jean stated:

My announcement starts out with happy Monday, and then I use something personal, but not like super personal, like, what happened over the weekend, and then I tell them a little bit about what they can expect for the week and then a reminder again, of, I’m always here to help.

Facilitation

Instructors acknowledged the increased difficulty of facilitating the learning environment in an online setting compared to face-to-face interactions. To address this challenge, they employed various strategies, including monitoring the learning environment and fostering student participation and a positive learning atmosphere.

Willie, John, Alfred, and Carolina shared their practices of regularly checking the learning environment, specifically discussion forums and the grade center, to track student participation and assignment submissions. In cases where they identified students who had not submitted assignments or showed inactivity, they reached out via email to inquire about their well-being and offer assistance. Despite the constraints of handling a considerable number of students and additional teaching responsibilities, they acknowledged their commitment to monitoring student interactions and providing responses, recognizing the importance of staying engaged with the online learning community.

Albert and Alfred acknowledged the varied pace at which students progress in online courses, citing instances of some students completing all course materials ahead of their peers. They emphasized recognizing and accommodating these differing learning paces in monitoring student learning. Alfred specifically addressed the challenge of detecting cheating in an online course. When identifying instances of cheating, Alfred engages in conversations with the students involved as part of addressing the issue.

Jean and John emphasized the importance of fostering a positive learning environment, acknowledging the complexity of the subject matter and the potential challenges students may face in understanding it. Jean was the only instructor whose course included collaborative activities and assignments. She ensures equal opportunities for all students to contribute during these interactive sessions by actively facilitating the learning environment. When certain students dominate discussions, Jean expresses gratitude for their input while actively encouraging less participating students to become part of the conversation.

Direct Instruction

To check student understanding and offer feedback and guidance, all instructors engaged in two key practices: (1) evaluating student progress and (2) providing feedback. Grading assignments emerged as an important tool for understanding student advancement and their grasp of the material. Carolina, for instance, takes a personalized feedback approach, focusing on highlighting areas of improvement rather than simply categorizing answers as right or wrong. She encourages students to schedule online meetings to discuss the feedback further and address any questions they may have. Jean employs detailed rubrics for discussion forums and

assignments to ensure precise feedback. Many instructors use multiple-choice questions for assessing learning, using automated grading within their LMS. For those incorporating open-ended questions, they make it more personalized. Jean follows a “feedback sandwich” model, beginning with positive feedback, providing constructive critique, and concluding with additional positive feedback. Overall, assessing student learning and providing feedback were the two major methods instructors used to enhance direct instruction.

In summary, we observed similar approaches to course design, likely influenced by the expectations of the QM certification process. Instructors recognized facilitation as a challenge in online courses. This was accomplished by ensuring their availability to students, promoting active participation, and actively monitoring the learning environment. To check student understanding, they concentrated on assignments and assessments, delivering constructive feedback.

Discussion

This study examined the teaching practices of online engineering instructors to establish cognitive, social, and teaching presence in their QM-certified online courses. The identified strategies for establishing teaching presence, such as sending weekly emails, being available, maintaining a consistent course structure, assessing progress and providing feedback, were consistent across all instructors. This shared approach can be attributed to the assistance provided by instructional designers and the expectations to adhere to QM guidelines and rubrics during course design.

However, fewer instructors employed facilitation strategies, often citing the difficulty of doing so in an online setting. This may be due to disciplinary norms, as facilitation is generally less emphasized in hard disciplines like engineering, where knowledge transmission from the content expert is prioritized over free-ranging nature of knowledge development (Arbaugh et al., 2010). Yet, facilitation plays a critical role in engineering education, particularly in problem-based learning environments, by guiding the problem-solving process and modeling effective problem solving approaches for students (Arena et al., 2021). Facilitation has been shown to positively impact key aspects of the engineering design process, such as enhancing psychological safety and reducing perceived task load during idea generation (Murphy et al., 2023). When facilitation is absent or weak in science classes, both social and cognitive presence suffer (d'Alessio et al., 2019). Given the hands-on nature of STEM disciplines, which often involve not only facilitating online classrooms but also managing online labs, it is essential to prepare STEM educators for the challenges of facilitating in virtual environments.

To foster cognitive presence, instructors used diverse methods to enhance course engagement and relate course materials to real-world applications. These efforts primarily targeted the early phases of cognitive presence, triggering events and exploration, aligning with prior research that found these two dimensions particularly common in STEM courses (Faulconer & Chamberlain, 2022). Contrary to earlier work suggesting that resolution is rarely achieved, especially in shorter courses or when students are new to the subject matter (Moore & Miller, 2022), our findings indicate that some instructors did incorporate resolution practices.

One area of cognitive presence that received the least attention was the integration of externally sourced knowledge. Most instructors, while supplementing their courses with additional resources within the LMS, believed the provided textbook and their generated

materials were sufficient. Such decisions may stem from the technical nature of the engineering courses, which typically do not necessitate reliance on external information. This finding is consistent with prior research suggesting that integration and resolution may be less prominent in hard applied disciplines because these fields often emphasize the acquisition of knowledge and expert-delivered solutions rather than open-ended exploration and constructive nature of knowledge building (Arbaugh et al., 2010). However, other studies have shown that integrating external resources in engineering courses can enhance learning outcomes (Maclaren, 2018).

In this study, three instructors employed strategies to encourage integration, while four did not. Because participants taught different engineering courses, these variations may have influenced their instructional decisions. This echoes previous findings of variation in cognitive presence across different STEM disciplines (Olesova et al., 2024). Additionally, two of the instructors who promoted integration had 10 and 20 years of online teaching experience, while another had significant industry experience. This supports prior findings that STEM instructors with industry backgrounds tend to incorporate more examples of industrial applications to formulate course structure and that their industry background influences their teaching practices (Hu et al., 2019), which may encourage students to seek and apply external knowledge. Still, further research is needed to better understand the impact of teaching and industry experience on how instructors foster cognitive presence in online engineering education.

Limited student interaction in six of the courses, along with a reliance on multiple-choice assessments, may also have contributed to the limited emphasis on resolution and particularly integration. Prior research has shown that collaborative activities and reflective assessments are important for supporting higher levels of cognitive development within the CoI framework (Garrison et al., 2000; Kanuka & Garrison, 2004). Most instructors cited the practicality of using multiple-choice formats due to large class sizes, which may have influenced their assessment choices and reduced opportunities for deeper forms of cognitive engagement.

A notable finding from the study is the limited emphasis on social presence, particularly in terms of group cohesion. In six of the seven courses, collaborative activities were minimal and often limited to introductory posts or optional interactions in help forums. This finding aligns with Gorsky et al. (2010), who reported that group cohesion tends to be lower in the sciences, while open communication is more common compared to the humanities. Participants in this study may have encountered difficulties in monitoring and facilitating group work, possibly due to concerns about unequal student contributions or challenges in assessing individual performance within teams, as some instructors noted. These concerns echo those reported by Richardson et al. (2024), who found that engineering instructors often worry about academic dishonesty and view their courses as offering limited opportunities for collaboration.

In this study, several instructors placed limited emphasis on social presence in their courses, which may help explain the lower levels of social presence reported among engineering students in previous research (Lim & Richardson, 2022). When instructors do not intentionally foster practices that promote social connection, such as collaborative activities or affective expression, students may not perceive these elements as important to their learning. Instructors' beliefs about engineering, along with how they were taught as students, may also have influenced their teaching practices, including the extent to which they emphasized social presence (Kim et al., 2013; Tekmen-Araci & Mann, 2019).

The limited emphasis on student collaboration may also stem from broader challenges inherent in teaching engineering online. Engineering faculty often have limited experience or training in facilitating and assessing teamwork, and supporting effective collaboration in virtual environments requires significant time and effort (Lingard & Barkataki, 2011). This underscores the need for greater faculty support in guiding team-building activities and in fostering communication among students (Belanger et al., 2021).

Similarly, affective expression, including sharing feelings and personal information, emerged as another aspect of social presence receiving less attention, echoing the findings of Faculconer and Chamberlain (2022), who noted that affective expressions are particularly uncommon in STEM. Science classes are often viewed as emotionally neutral spaces that prioritize objectivity, logic, and detachment over emotional expression (Pierson et al., 2023). However, emotional expression in engineering education has been shown to play a vital role in advancing social justice, problem-solving, student development and retention, ethics, and diversity and inclusion (Lönngren et al., 2023). The limited attention to emotional expression observed among participants may be attributed to the technical nature of their courses, which often focus on numerical analysis, coding, and single-solution problems. Additionally, engineers typically perceive their work as rational, beyond emotion, scientific, and focused on technical solutions for real-world issues (Cech, 2018). These disciplinary norms and the instructors' own identities as engineers may have contributed to the observed underemphasis on this aspect of social presence.

Implications for Practice

This study offers practical implications for online instructors in engineering and other STEM fields. One key implication is the need to support the higher phases of cognitive presence, especially integration and resolution. Instructors can foster integration by designing prompts and assignments that require students to connect ideas across modules or apply concepts in course contexts. Encouraging resolution can involve incorporating real-world problems or project-based learning tasks where students can apply what they have explored to problem-solving or decision-making activities.

Findings also suggest that instructors benefit from collaboration with instructional designers, especially in designing well-structured online courses. Departments and online learning centers should continue providing instructional design support during course development, regardless of whether the course is pursuing QM certification. Instructors reported that they learned valuable practices, such as adding alternative text, designing for accessibility, and organizing course content more effectively, through working with instructional designers. This emphasizes the broader benefit of such support beyond formal certification process.

The study further highlights that instructors often face challenges in facilitating online environments and tend to avoid collaborative assignments due to concerns about unequal participation or course logistics. To address this, professional development opportunities could be designed to help instructors build strategies for effective facilitation. Likewise, sharing models of successful collaborative activities could encourage more instructors to integrate peer interaction into their course designs, which could strengthen social presence.

Finally, modeling affective expression, creating spaces such as welcome forums and reflective check-ins can enhance social presence and engagement. Instructors can enhance

students' affective expression by intentionally modeling emotional openness, such as using humor, personal stories, emojis, or visual communication and by creating opportunities for students to share their own experiences and concerns.

Overall, the findings emphasize the need for professional development that goes beyond instructional design to include facilitation techniques, strategies for fostering higher levels of cognitive presence, promoting collaboration among students, and encouraging emotional expression. This is particularly important for faculty from traditionally lecture-driven disciplines such as engineering, where these practices may not be emphasized in standard instructional practices.

Limitations

This study was limited to seven engineering instructors, which does not fully capture the diversity of practices across different institutions, disciplines, and courses. While the multiple case study design provides rich, contextualized insights into online teaching practices in engineering education, the findings are not generalizable but instead offer in-depth insights from a specific group of instructors. The comparison of commonalities and differences across instructors may have been constrained by variations in institutional contexts, teaching styles, or course content and format, which could limit the ability to draw broad conclusions. Participants were selected based on their experience with QM-certified courses, which may have led to a sample of instructors who are more familiar with course design standards than typical faculty. Additionally, the study relied on self-reported data through interviews, which may reflect personal bias. While the CoI framework provided a useful lens for analyzing teaching practices, it is also important to note that instructors were not trained in or asked about the CoI framework, and their practices were interpreted through this lens by the researchers.

Recommendations For Future Research

Future research should explore online teaching approaches among engineering instructors in a broader range of contexts to gain a more comprehensive understanding of effective practices. Expanding the sample to include a more diverse group of instructors can provide deeper insights into how quality online engineering courses are designed and delivered. In addition, incorporating student perspectives on the effectiveness of these courses and measuring learning outcomes can further enhance our understanding of effective online teaching strategies in engineering education. Research should also examine how instructors approach online teaching across different delivery formats, such as synchronous and blended environments.

As the Community of Inquiry (CoI) framework continues to evolve with the inclusion of elements such as learner presence and emotional presence (Honig & Salmon, 2021; Majeski et al., 2018), future research can benefit from incorporating these additional dimensions to enhance our understanding of online teaching practices in engineering education. Additionally, exploring alternative frameworks for assessing the quality of online teaching may offer valuable insights into identifying effective online teaching methods in engineering education.

Conclusion

This study examined how engineering instructors design and deliver quality online courses and implement cognitive, social, and teaching presence, if applicable. We conclude that

certain elements of social presence receive comparatively less attention in online engineering courses. The use of the CoI framework has been relatively new in engineering education, and its adoption to explore instructor approaches to online teaching remains limited. Thus, this study contributes to the field by using the CoI framework to investigate engineering instructors' educational practices and methods in quality online courses.

Declarations

The authors declare no competing interests with respect to the research, authorship, and/or publication of this article.

The study was conducted in accordance with the ethical standards and received approval from the university's Institutional Review Board.

References

- ABET (2023). *Accredited Programs*. Retrieved November 26, 2023, from <https://amspub.abet.org/aps/online-search>
- Adam, M. S., Abd Hamid, J., Khatibi, A., & Azam, S. F. (2025). Investigating the effects of direct instruction and facilitated discourse on social and cognitive presence in blended learning. *Online Learning*, 29(1), 89–108. <https://doi.org/10.24059/olj.v29i1.4182>
- Akyol, Z., & Garrison, D. R. (2011). Understanding cognitive presence in an online and blended community of inquiry: Assessing outcomes and processes for deep approaches to learning. *British Journal of Educational Technology*, 42(2), 233–250. <https://doi.org/10.1111/j.1467-8535.2009.01029.x>
- Akyol, Z., Vaughan, N., & Garrison, D. R. (2011). The impact of course duration on the development of a community of inquiry. *Interactive Learning Environments*, 19(3), 231–246. <https://doi.org/10.1080/10494820902809147>
- Anderson, T., Liam, R., Garrison, D. R., & Archer, W. (2001). Assessing teaching presence in a computer conferencing context. *Journal of Asynchronous Learning Networks*, 5(2). <https://doi.org/10.24059/olj.v5i2.1875>
- Arbaugh, J. B., Bangert, A., & Cleveland-Innes, M. (2010). Subject matter effects and the community of inquiry (CoI) framework: An exploratory study. *The Internet and Higher Education*, 13(1–2), 37–44. <https://doi.org/10.1016/j.iheduc.2009.10.006>
- Arena, S. L., Lee, Y. W., Verbridge, S. S., Muelenaer, A., VandeVord, P. J., & Arena, C. B. (2021). Web conferencing facilitation within problem-based learning biomedical engineering courses. *Biomedical Engineering Education*, 1, 127–131. <https://doi.org/10.1007/s43683-020-00020-1>
- Baytiyeh, H. (2018). Progreen online engineering diploma in the Middle East: Assessment of the educational experience. *European Journal of Engineering Education*, 43(2), 264–277. <https://doi.org/10.1080/03043797.2017.1359240>
- Belanger, E., Bartels, C., & She, J. (2021, August). *Challenges and strategies in remote design collaboration during pandemic: A case study in engineering education*. International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. American Society of Mechanical Engineers. <https://doi.org/10.1115/DETC2021-68485>
- Beneroso, D., & Robinson, J. (2022). Online project-based learning in engineering design: Supporting the acquisition of design skills. *Education for Chemical Engineers*, 38, 38–47. <https://doi.org/10.1016/j.ece.2021.09.002>
- Borup, J., West, R. E., & Graham, C. R. (2012). Improving online social presence through asynchronous video. *The Internet and Higher Education*, 15(3), 195–203. <https://doi.org/10.1016/j.iheduc.2011.11.001>

- Cabrera, I., Villalon, J., & Chavez, J. (2017). Blending communities and team-based learning in a programming course. *IEEE Transactions on Education*, 60(4), 288–295. <https://doi.org/10.1109/TE.2017.2698467>
- Carnegie Classification of Institutions of Higher Education (n.d.). Retrieved April 12, 2024, from <https://carnegieclassifications.acenet.edu/>
- Cech, E. A. (2018). The (mis)framing of social justice: why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices. In J. C. Lucena (Ed.), *Engineering Education for Social Justice* (pp. 67–84). Springer.
- Chen, Y., Lei, J., & Cheng, J. (2019). What if online students take on the responsibility: students' cognitive presence and peer facilitation techniques. *Online Learning*, 23(1), 37–61. <https://doi.org/10.24059/olj.v23i1.1348>
- Chernosky, J., Ausburn, J., & Curtis, R. (2021). Students as consumers: Retaining engineering students by designing learner-centric courses of value. *The Journal of Continuing Higher Education*, 69(2), 100–120. <https://doi.org/10.1080/07377363.2020.1786342>
- d'Alessio, M. A., Lundquist, L. L., Schwartz, J. J., Pedone, V., Pavia, J., & Fleck, J. (2019). Social presence enhances student performance in an online geology course but depends on instructor facilitation. *Journal of Geoscience Education*, 67(3), 222–236. <https://doi.org/10.1080/10899995.2019.1580179>
- Darabi, A., Arrastia, M. C., Nelson, D. W., Cornille, T., & Liang, X. (2011). Cognitive presence in asynchronous online learning: A comparison of four discussion strategies. *Journal of Computer Assisted Learning*, 27(3), 216–227. <https://doi.org/10.1111/j.1365-2729.2010.00392.x>
- Delmas, P. M. (2017). Using VoiceThread to create community in online learning. *TechTrends*, 61(6), 595–602. <https://doi.org/10.1007/s11528-017-0195-z>
- Douglas, K. A., Johnston, A. C., Martin, J. P., Short, T., & Soto-Pérez, R. A. (2022). How engineering instructors supported students during emergency remote instruction: A case comparison. *Computer Applications in Engineering Education*, 30(3), 934–955. <https://doi.org/10.1002/cae.22495>
- Dunlap, J. C., Verma, G., & Johnson, H. L. (2016). Presence+ Experience: A framework for the purposeful design of presence in online courses. *TechTrends*, 60, 145–151. <https://doi.org/10.1007/s11528-016-0029-4>
- Eggleston, A. G., & Rabb, R. J. (2021, July). *Faculty development and instructional design through a quality matters tool for online and hybrid course assessment*. American Society for Engineering Education (ASEE) Virtual Annual Conference. <https://peer.asee.org/faculty-development-and-instructional-design-through-a-quality-matters-tool-for-online-and-hybrid-course-assessment>

- Faulconer, E. K., & Chamberlain Jr, D. J. (2022). A case study of community of inquiry presences and cognitive load in asynchronous online STEM courses. *Online Learning Journal*, 26(3), 46. <https://doi.org/10.24059/olj.v26i3.3386>
- Fiock, H. (2020). Designing a community of inquiry in online courses. *The International Review of Research in Open and Distributed Learning*, 21(1), 135–153. <https://doi.org/10.19173/irrodl.v20i5.3985>
- Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, 2(2–3), 87–105. [https://doi.org/10.1016/S1096-7516\(00\)00016-6](https://doi.org/10.1016/S1096-7516(00)00016-6)
- Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education*, 15(1), 7–23. <https://doi.org/10.1080/08923640109527071>
- Garrison, D. R., & Cleveland-Innes, M. (2005). Facilitating cognitive presence in online learning: Interaction is not enough. *The American Journal of Distance Education*, 19(3), 133–148. https://doi.org/10.1207/s15389286ajde1903_2
- Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry framework: Review, issues, and future directions. *The Internet and Higher Education*, 10(3), 157–172. <https://doi.org/10.1016/j.iheduc.2007.04.001>
- Garrison, D. R., & Akyol, Z. (2013). The community of inquiry theoretical framework. In M. Cleveland-Innes, D.R. Garrison, & N. Vaughan (Eds.), *Handbook of distance education* (pp. 122–138). Routledge.
- Garrison, D. R. (2017). *E-Learning in the 21st century: A community of inquiry framework for research and practice* (3rd ed.). Routledge/Taylor and Francis.
- Garrison, D. (2023). *CoI effectiveness and future development*. The Community of Inquiry. Retrieved June 4, 2025, from <https://www.thecommunityofinquiry.org/editorial40>
- Gorsky, P., Caspi, A., Antonovsky, A., Blau, I., & Mansur, A. (2010). The relationship between academic discipline and dialogic behavior in open university course forums. *International Review of Research in Open and Distributed Learning*, 11(2), 49–72. <https://doi.org/10.19173/irrodl.v11i2.820>
- Graham, R. (2018). *The global state of the art in engineering education*. Massachusetts Institute of Technology (MIT) Report.
- Gürdür Broo, D., Kaynak, O., & Sait, S. M. (2022). Rethinking engineering education at the age of industry 5.0. *Journal of Industrial Information Integration*, 25, 100311. <https://doi.org/10.1016/j.jii.2021.100311>
- Hodges, C. B., Moore, S., Lockee, B. B., Trust, T., & Bond, M. A. (2020). *The difference between emergency remote teaching and online learning*. Educause Review.

<https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning>

- Honig, C. A., & Salmon, D. (2021). Learner presence matters: A learner-centered exploration into the Community of Inquiry framework. *Online Learning*, 25(2), 95–119. <https://doi.org/10.24059/olj.v25i2.2237>
- Hosler, K. A., & Arend, B. D. (2012). The importance of course design, feedback, and facilitation: Student perceptions of the relationship between teaching presence and cognitive presence. *Educational Media International*, 49(3), 217–229. <https://doi.org/10.1080/09523987.2012.738014>
- Hu, D., Zwickl, B. M., & Carusone, C. (2019). Impact of industry experience on faculty teaching practices in STEM. In Y. Cao, S. Wolf, & A. Bennett (Eds.), *Physics Education Research Conference Proceedings* (pp. 239–244). American Association of Physics Teachers. <https://doi.org/10.1119/perc.2019.pr.Hu>
- Jaksic, N. I. (2021, July). *Pair-to-pair peer learning: comparative analysis of face-to-face and online laboratory experiences*. American Society for Engineering Education (ASEE) Virtual Annual Conference. <https://strategy.asee.org/pair-to-pair-peer-learning-comparative-analysis-of-face-to-face-and-online-laboratory-experiences>
- Jo, I., Park, Y., & Lee, H. (2017). Three interaction patterns on asynchronous online discussion behaviours: A methodological comparison. *Journal of Computer Assisted Learning*, 33(2), 106–122. <https://doi.org/10.1111/jcal.12168>
- Kanuka, H., & Garrison, D. R. (2004). Cognitive presence in online learning. *Journal of Computing in Higher Education*, 15, 21–39. <https://doi.org/10.1007/BF02940928>
- Kanyarusoke, K. E., & Uziak, J. (2011). Spreadsheets: The ideal tool for distance learning in engineering education. *Computer Applications in Engineering Education*, 19(2), 216–223. <https://doi.org/10.1002/cae.20235>
- Kim, G. C., & Gurvitch, R. (2020). Online education research adopting the community of inquiry framework: A systematic review. *Quest*, 72(4), 395–409. <https://doi.org/10.1080/00336297.2020.1761843>
- Kim, M., McFeetors, P., Jin, Q., Rose, K., Carey, J., Miller-Young, J., Jamieson, M., & Adeeb, S. (2023). “We learn things to solve real-life problems”: Understanding how nature of engineering beliefs situate developing pedagogical content knowledge in a modular engineering education professional development program. *Journal of University Teaching & Learning Practice*, 20(3). <https://doi.org/10.53761/1.20.3.07>
- Koclar, S., Bozkurt, A., & Goru Dogan, T. (2021). Engineering through distance education in the time of the fourth industrial revolution: Reflections from three decades of peer reviewed studies. *Computer Applications in Engineering Education*, 29(4), 931–949. <https://doi.org/10.1002/cae.22367>

- Kovanović, V., Gašević, D., Joksimović, S., Hatala, M., & Adesope, O. (2015). Analytics of communities of inquiry: Effects of learning technology use on cognitive presence in asynchronous online discussions. *The Internet and Higher Education*, 27, 74–89. <https://doi.org/10.1016/j.iheduc.2015.06.002>
- Kozan, K. (2016). A comparative structural equation modeling investigation of the relationships among teaching, cognitive and social presence. *Online Learning*, 20(3), 210–227. <https://doi.org/10.24059/olj.v20i3.654>
- Lim, J., & Richardson, J. C. (2022). Considering how disciplinary differences matter for successful online learning through the Community of Inquiry lens. *Computers & Education*, 187, 104551. <https://doi.org/10.1016/j.compedu.2022.104551>
- Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.
- Lingard, R., & Barkataki, S. (2011). Teaching teamwork in engineering and computer science. In *2011 Frontiers in Education Conference (FIE)* (pp. F1C-1–F1C-5). IEEE. <https://doi.org/10.1109/FIE.2011.6143000>
- Lowenthal, P. R., & Dunlap, J. C. (2020). Social presence and online discussions: A mixed method investigation. *Distance Education*, 41(4), 490–514. <https://doi.org/10.1080/01587919.2020.1821603>
- Lönngren, J., Direito, I., Tormey, R., & Huff, J. L. (2023). Emotions in engineering education. *International handbook of engineering education research*. Routledge.
- Lönngren, J., Direito, I., Tormey, R., & Huff, J. L. (2023). Emotions in engineering education. In A. Johri (Ed.), *International handbook of engineering education research* (pp. 156–182). Routledge.
- Maclaren, P. (2018). How is that done? Student views on resources used outside the engineering classroom. *European Journal of Engineering Education*, 43(4), 620–637. <https://doi.org/10.1080/03043797.2017.1396445>
- Majeski, R. A., Stover, M., & Valais, T. (2018). The community of inquiry and emotional presence. *Adult Learning*, 29(2), 53–61. <https://doi.org/10.1177/1045159518758696>
- Mann, M. M., & Tan, G. (2021). Recent strategies for improving undergraduate engineering education: A review. *Proceedings of the ASEE Gulf-Southwest Annual Conference*. ASEE Peer. <https://peer.asee.org/recent-strategies-for-improving-undergraduate-engineering-education-a-review.pdf>
- Mathes, J. (2019). *Global quality in online, open, flexible and technology enhanced education: An analysis of strengths, weaknesses, opportunities and threats*. International Council for Open and Distance Education. <https://onlinelearningconsortium.org/read/global-quality-in-online-open-flexible-and-technology-enhanced-education/>

- McNeil, J. C., & Ohland, M. W. (2015). Engineering faculty perspectives on the nature of quality teaching. *Faculty Scholarship*, 407. <https://ir.library.louisville.edu/faculty/407>
- McNeill, L., Rice, M., & Wright, V. (2019). A confirmatory factor analysis of a teaching presence instrument in an online computer applications course. *Online Journal of Distance Learning Administration*, 22(4), 1–16.
- Moore, R. L., & Miller, C.N. (2022). Fostering presence in online courses: A systematic review (2008–2020). *Online Learning*, 26(1), pp. 130–149. <https://doi.org/10.24059/olj.v26i1.3071>
- Murphy, A. R., Moseley, E., Weaver, M., & Linsey, J. S. (2023). The impact of facilitation during idea generation in engineering design. *Proceedings of the International Design Engineering Technical Conferences and Computers and Information in Engineering Conference*. <https://doi.org/10.1115/DETC2023-113583>
- Odom, P. W., Merzdorf, H. E., Montalvo, F. J., & Davis, J. M. (2019). Analysis of student engagement data from U.S. News & World Report regarding online graduate engineering programs. *Proceedings of the American Society for Engineering Education Annual Conference & Exposition*. <https://peer.asee.org/analysis-of-student-engagement-data-from-u-s-news-world-report-regarding-online-graduate-engineering-programs.pdf>
- Olesova, L., Sadaf, A., Boicu, M., Foxwell, H. J., Pham, T. L. B., & Rytikova, I. (2024). Understanding the influence of program of study and age on shared metacognition within the community of inquiry in stem education. *International Association for Development of the Information Society*.
- Our Quality Framework. (n.d.). *Online Learning Consortium*. Retrieved October 22, 2023, from <https://onlinelearningconsortium.org/about/quality-framework-five-pillars/>
- Ossiannilsson, E., Williams, K., Camilleri, A. F., & Brown, M. (2015). *Quality models in online and open education around the globe. State of the art and recommendations*. International Council for Open and Distance Education. <https://www.icde.org/publication/quality-models-in-online-and-open-education-around-the-globe/>
- Courses Currently QM-Certified. (n.d.). *Quality Matters*. Retrieved September 22, 2023, from <https://www.qualitymatters.org/reviews-certifications/qm-certified-courses>
- Padayachee, P., & Campbell, A. L. (2022). Supporting a mathematics community of inquiry through online discussion forums: Towards design principles. *International Journal of Mathematical Education in Science and Technology*, 53(1), 35–63. <https://doi.org/10.1080/0020739X.2021.1985177>
- Pierson, A. E., Brady, C. E., & Lee, S. J. (2023). Emotional configurations in STEM classrooms: Braiding feelings, sensemaking, and practices in extended investigations. *Science Education*, 107(5), 1126–1162. <https://doi.org/10.1002/sce.21799>

- Purwandari, E. P., Junus, K., & Santoso, H. B. (2022). Exploring e-learning Community of Inquiry framework for engineering education. *International Journal of Instruction*, 15(1), 619–632. <https://doi.org/10.29333/iji.2022.15135a>
- Richardson, J. C., & Ice, P. (2010). Investigating students' level of critical thinking across instructional strategies in online discussions. *The Internet and Higher Education*, 13(1–2), 52–59. <https://doi.org/10.1016/j.iheduc.2009.10.009>
- Richardson, J. C., Arbaugh, J. B., Cleveland-Innes, M., Ice, P., Swan, K. P., Garrison, D. R. (2012). *Using the community of inquiry framework to inform effective instructional design*. In L. Moller, J. Huett (Eds.), *The next generation of distance education*. Springer. https://doi.org/10.1007/978-1-4614-1785-9_7
- Richardson, J. C., Maeda, Y., Lv, J., & Caskurlu, S. (2017). Social presence in relation to students' satisfaction and learning in the online environment: A meta-analysis. *Computers in Human Behavior*, 71, 402–417. <https://doi.org/10.1016/j.chb.2017.02.001>
- Richardson, J. C., Koehler, A. A., Tagare, D., Urena-Rodriguez, L., Xu, Q., Zhang, Z., ... & Duha, M. S. U. (2024). Community of Inquiry design decisions across disciplines. *Journal of Computing in Higher Education*, 1–42. <https://doi.org/10.1007/s12528-024-09417-1>
- Rutz, E., & Ehrlich, S. (2016, June). *Increasing learner engagement in online learning through use of interactive feedback: Results of a pilot study*. American Society for Engineering Education (ASEE). <https://peer.asee.org/increasing-learner-engagement-in-online-learning-through-use-of-interactive-feedback-results-of-a-pilot-study.pdf>
- Rutz, E., & Ehrlich, S. (2016, June). *Increasing learner engagement in online learning through use of interactive feedback: Results of a pilot study*. American Society for Engineering Education (ASEE). <https://peer.asee.org/increasing-learner-engagement-in-online-learning-through-use-of-interactive-feedback-results-of-a-pilot-study.pdf>
- Rutz, E., & Ehrlich, S. (2016). Increasing learner engagement in online learning through use of interactive feedback: Results of a pilot study. *Proceedings of the American Society for Engineering Education Annual Conference & Exposition*. <https://peer.asee.org/increasing-learner-engagement-in-online-learning-through-use-of-interactive-feedback-results-of-a-pilot-study.pdf>
- Sadaf, A., & Olesova, L. (2017). Enhancing cognitive presence in online case discussions with questions based on the practical inquiry model. *American Journal of Distance Education*, 31(1), 56–69. <https://doi.org/10.1080/08923647.2017.1267525>
- Sadaf, A., Wu, T., & Martin, F. (2021). Cognitive presence in online learning: A systematic review of empirical research from 2000 to 2019. *Computers and Education Open*, 2, 100050. <https://doi.org/10.1016/j.caeo.2021.100050>

- Shea, P., & Bidjerano, T. (2009). Cognitive presence and online learner engagement: A cluster analysis of the community of inquiry framework. *Journal of Computing in Higher Education*, 21, 199–217. <https://doi.org/10.1007/s12528-009-9024-5>
- Shea, P., Hayes, S., Vickers, J., Gozza-Cohen, M., Uzuner, S., Mehta, R., ... & Rangan, P. (2010). A re-examination of the community of inquiry framework: Social network and content analysis. *The Internet and Higher Education*, 13(1–2), 10–21. <https://doi.org/10.1016/j.iheduc.2009.11.002>
- Saldaña, J. (2016). *The coding manual for qualitative researchers*. Sage.
- Skilling, K., & Stylianides, G. J. (2020). Using vignettes in educational research: a framework for vignette construction. *International Journal of Research & Method in Education*, 43(5), 541–556. <https://doi.org/10.1080/1743727X.2019.1704243>
- Stake, R. E. (2013). *Multiple case study analysis*. Guilford Press.
- Szeto, E. (2015). Community of Inquiry as an instructional approach: What effects of teaching, social and cognitive presences are there in blended synchronous learning and teaching? *Computers & Education*, 81, 191–201. <https://doi.org/10.1016/j.compedu.2014.10.015>
- Tekmen-Araci, Y., & Mann, L. (2019). Instructor approaches to creativity in engineering design education. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, 233(2), 395–402. <https://doi.org/10.1177/095440621875879>
- Turk, M., Heddy, B. C., & Danielson, R. W. (2022). Teaching and social presences supporting basic needs satisfaction in online learning environments: How can presences and basic needs happily meet online? *Computers & Education*, 180, 104432. <https://doi.org/10.1016/j.compedu.2022.104432>
- Türel, Y. K. (2016). Relationships between students' perceived team learning experiences, team performances, and social abilities in a blended course setting. *The Internet and Higher Education*, 31, 79–86. <https://doi.org/10.1016/j.iheduc.2016.07.001>
- Valverde-Berrocoso, J., Garrido-Arroyo, M. D. C., Burgos-Videla, C., & Morales-Cevallos, M. B. (2020). Trends in educational research about e-learning: A systematic literature review (2009–2018). *Sustainability*, 12(12), 5153. <https://doi.org/10.3390/su12125153>
- Varonis, E. M. (2014). Most courses are not born digital: An overview of the Quality Matters peer review process for online course design. *Campus-Wide Information Systems*, 31(4), 217–229. <https://doi.org/10.1108/CWIS-09-2013-0053>
- Vaughan, N., & Garrison, D. R. (2005). Creating cognitive presence in a blended faculty development community. *The Internet and Higher Education*, 8(1), 1–12. <https://doi.org/10.1016/j.iheduc.2004.11.001>

- Wang, H. (2018, July). *Improving an online STEM course through Quality Matters certification-A case study*. American Society for Engineering Education (ASEE) Conference.
<https://peer.asee.org/improving-an-online-stem-course-through-quality-matters-certification-a-case-study>
- Wang, Y. (2022). Effects of teaching presence on learning engagement in online courses. *Distance Education*, 43(1), 139–156.
<https://doi.org/10.1080/01587919.2022.2029350>
- Zhang, H., Lin, L., Zhan, Y., & Ren, Y. (2016). The impact of teaching presence on online engagement behaviors. *Journal of Educational Computing Research*, 54(7), 887–900.
<https://doi.org/10.1177/0735633116648171>

Online versus Classroom teaching: Differences and Specificities in Teacher-student Interaction Processes

Francesca Giovanna Maria Gastaldi
Università degli studi di Torino, Italy

Claudio Longobardi
Università degli studi di Torino, Italy

Ali Ijaz
Università degli studi di Torino, Italy

Sofia Mastrokourou
Universitas Mercatorum, Italy

Michele Settanni
Università degli studi di Torino, Italy

Abstract

The introduction of information and communication technologies (ICT) in elementary education has radically changed the way of teaching and learning in recent decades. In addition, the recent acceleration in the use of online learning due to the pandemic period has increased the reliance on these teaching methods. Online learning has become a popular teaching practice in recent years in parallel with traditional teaching, yet there are still few studies in the literature that delve into a comparison between the two learning situations and in particular studies focusing on these methods within the elementary education are scarce. The purpose of this study is to examine the characteristics of student-to-student and student-to-teacher interactions that occur in online learning as compared to typical face-to-face classroom interactions, with a specific focus on the elementary school level. The quality of teacher-student interactions was measured using the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). Elementary students were selected from 36 classes ranging from second to fifth grade. The total sample included 769 students (48% male). The majority of teachers were female (N = 31, 86%). The study shows that online teaching can have positive or negative effects on the quality of interaction between teachers and students, depending on the dimensions considered and the age of the participants. This study helps to highlight the differences and specificities of interaction and learning processes in the two situations (online and face-to-face): online teaching seems to improve positive climate, behavior management, and didactic learning formats, while face-to-face teaching seems to provide greater teacher sensitivity and better-quality feedback.

Keywords: Student-teacher relationship; COVID-19; online learning; face-to-face teaching; school climate

Gastaldi, F. G. M., Longobardi, C., Ijaz, A., Mastrokourou, S., Settanni, M. (2025). Online versus Classroom teaching: Differences and specificities in teacher-student interaction processes. *Online Learning*, 30(1), 114-137. <https://doi.org/10.24059/olj.v28i1.4293>

Introduction

Digital Learning Environment

In recent decades, information and communication technologies (ICT) used in education have drastically changed the way of teaching and learning (Li & Zheng, 2018; Wu et al., 2017), and this evolving familiarity has become an everyday act for students. Furthermore, UNESCO also advocates the use of ICT as a means to improve education systems in terms of dissemination of and access to knowledge (UNESCO, 2017). The use of ICT can also play a formative role in promoting basic digital skills, especially in primary education. Digital learning environments can provide a wealth of opportunities for interaction on multiple levels: Student-student, student-teacher, student-content, and different types of structures such as collaborative groups and/or communities. The adoption of digital learning environments has traditionally been practiced primarily in secondary and higher education (Greenhow et al., 2020; Redpath, 2012), but emerging trends also point to the relevance and possibilities of digital learning environments in primary education. In this context, it has been shown that the use of digital environments can also contribute to achieving the Sustainable Development Goals (Ahel & Schirmer, 2023).

The variety and availability of digital devices not only allow students to be constantly connected to the Internet, but can also promote student motivation and engagement in learning (Chen & Wang, 2015; Nygren & Vikström, 2013), an engagement that is linked to creativity and metacognition, possibly due to components of gamification-inspired teaching (game-based learning) (Braad et al., 2020). These findings are significant for elementary school as the practices associated with engagement are related to long-term outcomes and digital literacy development. The characteristics of online learning have also been associated with the forms of final assessment of learning (Thomas et al., 2018): There is evidence of positive effects of blended learning and formative assessment in digital spaces. Some research reports make interesting comparisons between learning in digital environments and more traditional face-to-face learning: in this case, Pirlott (2022) suggests that online learning represents greater accessibility to learning opportunities and/or content that can be used anywhere, anytime, e.g., through videos or other learning outcomes. Although synchronous virtual teaching is still fundamentally different from face-to-face teaching, the motivation and interaction problems that occur in asynchronous online learning are reduced. The authors found no significant differences in terms of grade point average (GPA), ethnicity, or age. However, interactions in primary education have unique aspects when considering the learning characteristics associated with learners' developmental levels. Petchamé et al. (2021) also provide additional details about the comparison between face-to-face (F2F) and online learning contexts: While students certainly prefer relationship building in F2F contexts, they see relationship building in digital contexts as less problematic. At the same time, they associate online didactics with a greater potential for distraction. Comparisons between F2F and online learning contexts also indicate that students in F2F courses perceive their relationship with instructors as more conflictual (Vagos & Carvalhais, 2022), suggesting that there are subtle contexts in the classroom dynamics between modalities.

Recently, Tsai et al. (2023) suggest that peer-supported learning and the positive

outcomes of peer-supported learning are important for learning motivation in elementary school, where peer dynamics have a significant impact on the learning experience of the students being taught. To date, a literature review provides sufficient evidence of the modal experience/impact of online instruction on student learning outcomes and the quality of interactions between participants and faculty, but most studies focus only on higher education. New studies are now beginning to document hopeful pedagogical outcomes of increased online teaching and learning practice, particularly in the context of elementary school (Greenhow et al., 2022). Recent studies provide interesting insights into the quality of classroom climate in the social context of online education: Gherghel et al. (2023) discuss that social interactions in online contexts have an indirect positive impact on autonomy in managing learning time, mediated by emotional and behavioral engagement related to online learning. Cole et al. (2021) talk about the relationship between students' perceived classroom climate in an online learning environment and academic performance, suggesting that perceived classroom climate could be a strong predictor of academic performance. Harris et al. (2020) mention the importance of building positive relationships as an important strategy that teachers use to increase learner engagement in online courses. Despite the increasing interest in classroom climate among individuals studying in online education contexts, a systematic approach to classroom climate is lacking in the literature, meaning that there is still much to learn and many important issues to consider (Goagoses et al., 2023).

Online Teaching and Learning

The literature has primarily examined the impact of distance learning on learning outcomes and related cognitive aspects: For learners with ADHD, difficulties resulting from the experience of online are associated with worsening symptoms of inattention and hyperactivity, as well as the expression of oppositional behavior and emotional problems; executive functions are also severely impaired (He et al., 2021).

Online learning is associated with poorer scores on disciplinary assessment tests: In the elementary context, Skar and colleagues (2021) report lower writing skills among first graders who learned writing through distance learning compared to students who learned the skill in face-to-face classes instead. Tomasik and colleagues (2021) suggest that individual differences in learning rates and outcomes increase significantly during distance learning, especially for elementary students.

However, recent studies have also shown various positive effects of digital learning environments on educational outcomes. Maryani et al. (2022) found that targeted online training significantly improved students' reasoning and metacognitive skills. Choy and Cheung (2022) emphasized the positive impact of digital learning environments on peer collaboration and improving self-directed learning skills. In addition, the integration of ICT has been positively associated with increased motivation (Sahlin et al., 2017; Siddiq et al., 2017) and improved academic performance (Genlott & Grönlund, 2016).

Heo and Han (2018) investigated whether motivation, academic stress and age influence students' readiness for self-directed learning (SDLR) in online contexts. Their findings highlight that motivation and academic stress significantly influence SDLR, while age does not appear to have a significant impact. In addition, the literature highlights the importance of considering contextual variables such as the digital divide, teachers' ICT skills

and infrastructure, all of which can have a significant impact on the effectiveness of online teaching and student outcomes, particularly in the context of primary education.

The Italian Context

In Italy, the education sector has experienced a gradual digitalization push since the 1990s, which intensified in the 2000s with ministerial initiatives for digital transformation. The first national plan for digital schools implemented by the Ministry of Education dates back to 2007 and promotes digital innovation and improved digital skills, which are particularly important for early childhood education. In 2008, the Ministry launched the “LIM” action to facilitate the widespread introduction of interactive multimedia whiteboards with the aim of making teachers and students more familiar with multimedia technologies (www.miur.gov.it).

The subsequent introduction of Law 107/2015 (The Good School, 2015) produced a new national plan for digital schools, aligned with the European Commission’s broader vision for education in the digital age and addressing modern educational challenges such as lifelong and lifewide learning.

The current National Plan for Digital Schools includes measures in several important areas. First, the connectivity initiatives target structural improvements to enhance institutional connectivity and create innovative digital learning environments. In addition, the measures aimed at cultural change focus on improving students’ digital skills, developing high-quality digital teaching materials and providing comprehensive training and coaching for school staff.

The educational landscape has thus undergone significant changes, which can already be observed in the international context (Dhawan, 2020) and have been dramatically accelerated by the COVID-19 pandemic. The need to maintain uninterrupted teaching during school closures accelerated the digitalization process and increased the reliance on online teaching and virtual learning environments.

Italy was one of the first European countries to be severely affected by the pandemic and quickly introduced strict containment measures. The emergency measures issued on February 23, 2020 led to the suspension of face-to-face teaching in severely affected regions (DPCM 23/2/2020). The abrupt switch to distance learning was initially a major challenge, particularly for primary school students who reported greater effort in completing learning tasks, difficulty understanding lesson feedback, increased stress and anxiety (Petillion & McNeil, 2020). Teachers similarly faced increased anxiety (Li et al., 2020), depression (Cormier et al., 2022), and burnout (Sokal et al., 2020).

In recent years, online teaching has become increasingly established in the Italian primary school system and has developed from an emergency solution to a regular teaching method (Alon et al., 2023). After the initial lockdown in 2020, “distance learning” became “integrated digital teaching,” where face-to-face and online learning phases are blended or online teaching is used selectively based on specific student needs. In addition, video teaching was increasingly used for supporting activities in the classroom, embedding digital practices even more into the standard educational framework.

Online Teaching and Emotional Support

The assessment of the impact of distance learning on classroom climate was primarily studied at higher levels of education (secondary and above). The construct of emotional support includes both a positive classroom climate, characterized by enthusiasm and emotional closeness between teachers, students and peers, and a negative climate, characterized by emotions such as anger, aggression, or hostility. Emotional support also includes teacher sensitivity, which reflects attention and responsiveness to the educational and emotional needs of elementary school students (Pianta & Hamre, 2009).

Vaillancourt et al. (2022) reported that elementary students who participated in face-to-face instruction considered face-to-face interactions more important than older students who placed less value on blended online/face-to-face formats. Conversely, primary school students valued certain aspects of distance learning, such as less bullying, less peer pressure, and less social anxiety. The literature emphasizes the critical role of effective student-teacher interactions in promoting the academic success and learning processes of elementary school students (Pianta et al., 2002). Nevertheless, online learning is often criticized by educators because it is difficult to build authentic relationships and effectively monitor student progress (Niemi & Kousa, 2020). Similar challenges were noted in U.S. K–12 teachers' experiences during remote learning, where rebuilding caring relationships with students became a central concern (Miller, 2021).

Online Teaching and Classroom Organization

Classroom organization refers to teachers' control and flexibility in managing classroom activities, adapting to primary students' interests and schedules, and managing student behavior, productivity and instructional support (Pianta et al., 2012). Instructional support specifically includes strategies that stimulate varied thinking, encourage problem solving and promote active discussions. It also includes structured learning formats, quality feedback, and the language patterns used by teachers that impact students' cognitive development, learning outcomes, and academic achievement (Jamil et al., 2015).

Distance learning can have a negative impact on the communicative quality of feedback. Alawamleh et al. (2020) found that online teaching is associated with lower quality teaching materials, poorer learning outcomes, and less communicative interaction between students and teachers. In contrast, higher level distance learning experiences often showed positive learning outcomes and fewer academic failures. Reyes-Mercado et al. (2023) reported that digital learning environments improve students' ability to complete courses and thus facilitate effective learning processes.

Observational Studies on Digital Learning

Digital learning environments are inherently different from traditional face-to-face classrooms in terms of content delivery, type of feedback, and type of interaction, which largely depend on the communication channels and learning formats (synchronous or asynchronous). These different characteristics require specialized observation methods to

accurately capture interactions in digital contexts.

Ariffin and Darus (2022) used the Classroom Assessment Scoring System (CLASS) to investigate the teaching strategies used by teachers in online settings. The study found that online instructional leadership was effective with varying levels of teacher seniority, consistently emphasizing positive interactions and appropriate support. The findings confirm the applicability of the CLASS domains—emotional support, classroom organization, and didactic support—when observing online interactions, particularly in foreign language classrooms.

Rif et al. (2023) used observation methods to evaluate digital foreign language teaching practices and emphasized the effectiveness of debriefing techniques to promote critical thinking and linguistic fluency. Similarly, Shakina et al. (2022) investigated the effectiveness of co-operative learning and discovery learning strategies used by English teachers in online environments. Moon et al. (2023) presented the System for Observing Virtual Real-Time Lessons in Physical Education (SOVRTL-PE), a tool specifically designed to assess pedagogical practices and instructional quality in online physical education, providing a comprehensive framework for observational assessments.

Online learning thus represents both a complex educational context and a unique opportunity to systematically analyze formative and relational processes. Comparison with established face-to-face teaching practices reveal important insights into relational, emotional and organizational dynamics. Despite extensive public debate, exemplified by articles in prominent media outlets such as the New York Times (Marcus, 2022), there remains a notable lack of rigorous empirical research. As a result, policy decisions on online education have often been made without a thorough assessment of the potential consequences.

Aims

Given this discrepancy and the heated public debate, there is a need to examine the characteristics of online learning from a scientific perspective and compare them with those of face-to-face learning. Despite this, there is a dearth of studies in the literature that organically and systematically compare the processes related to the two learning situations (face-to-face vs. online) and several research questions also remain open about how online interactions influence fundamental features of the educational setting, that in turn have been recognized as relevant for the educational outcomes. In this we considered in particular the dimensions that have been proposed by Pianta and colleagues (2008) and for the measurement of which a standardized observational instrument is available (Pianta et al., 2008). These dimensions are “emotional support,” a measure of teachers’ responsiveness and creation of a warm atmosphere in the classroom, “classroom organization,” a measure of effective behavior management and structuring of learning activities, and “instructional support” that refers to teachers’ facilitation of cognitive development and their ability to provide constructive feedback.

In this study in particular we aim to compare the two experiences (face-to-face vs. online learning) in the elementary school context to answer the following research questions:

1. How do online and face-to-face learning environments differentially impact the dimensions of Emotional Support, Classroom Organization, and Instructional Support in

elementary education?

2. Is the age of the children related to the quality of interactions between pupils and teachers in the two different educational settings? That is, are older students more likely to experience higher (or lower) quality interactions in the online environment?

With respect to the first research question, we hypothesized that online learning would be positively related to positive characteristics of classroom climate, because group management is facilitated by the online mode. We also hypothesized that online instruction would be positively related to classroom organization, because the online context would facilitate the processes of organizational management of behaviors (especially with reference to disruptive and problem behaviors) and instructional formats. Lastly, we hypothesize that face-to-face instruction would facilitate the expression of teacher sensitivity and the ability to provide targeted feedback to learners, as the face-to-face teaching situation would facilitate the activation of multiple interactions between teacher and students, as already found in recent studies on the topic. With regard to the associations with age, we have no a priori hypotheses, as there are hardly any studies comparing the quality of student-teacher interaction in face-to-face and online settings with children of this age (7–10 years).

Method

Research Model and Procedure

The study used an observational procedure to collect data on the quality of teacher-student interactions in second-to-fifth grade classes. Observations were carried out in two different contexts: during face-to-face and online lessons. For the face-to-face context, observers conducted in-class observations, while for lessons conducted online (via Zoom or Teams) observers were included as guests during the online lessons. Six 20-minute observation sessions were conducted for each class (three in the online setting and three in the face-to-face setting), during which notes were taken on the specific aspects of each dimension, which formed the basis for the coding that took place in the 10 minutes following the observation. Observations were conducted at different times of the day to capture the teacher's various activities with the students. Observations were conducted as planned in all participating classes and no data were missing. On the whole the observers conducted classroom observations in two different days for each class. This within-subjects design served as the main methodological control to reduce variability across classes, teachers, and student composition.

The period in which the observations were conducted lasted 3 months. Each class consisted of approximately 21 students. A total of 108 observation cycles for each educational setting were performed (total: 216 cycles). One of the observers was the certified CLASS observer, while the other observer was trained by the certified CLASS coder. The training included four sessions (8 hour, 2 hour/time) and two practice sessions (4 hour, 2 hour/time). The training was conducted both on the online and the face-to-face context. The ethical code of the Italian Association of Psychology (AIP) was followed in this study and it was approved by the ethical review board of the university.

Research Context and Sample

The study was conducted during the pandemic period characterized in Italy by repeated

lockdowns that led schools to provide students with the opportunity during certain periods to do online teaching, by means of tools such as Zoom and Microsoft Teams. The observations analyzed in this study were made in a period (spring 2021) during which teaching was delivered in a mixed mode, alternating days of online and face-to-face teaching.

Students from 36 primary school classes, ranging from second to fifth grade, took part in the study. To recruit teachers to participate in the research, invitation letters were sent to principals of 5 public ($n = 3$) and private ($n = 2$) elementary schools located in Northern Italy. The principals agreed to forward the request for participation to teachers in their respective schools. Teachers who agreed to participate were asked to hold informational meetings with students' parents in which the researchers presented the research project and subsequently collected informed consents from parents. The 36 classes in the final sample were those with respect to which informed consent was obtained from all students' families (both parents). The teachers involved in the research were all Italian nationals, the majority of whom were women ($N = 31$, 86%). Adherence to participation in the research was total from students in the classes involved, from whom we collected parental consent. The total sample size was 769 students: about half of the student sample was male (48%), and 7% of the sample were first- or second-generation immigrants.

Instrument Used and Its Validation

Classroom Assessment Scoring System

The quality of teacher-student interactions was measured using the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008). The CLASS is an observational instrument with three domains (emotional support, classroom organization, and instructional support) and 10 dimensions (positive climate, negative climate, teacher sensitivity, consideration of student perspective, behavior management, productivity, instructional learning format, concept development, quality of feedback, and language modelling). Each dimension was assigned a score from 1 to 7 (low = 1, 2; medium = 3, 4, 5; high = 6, 7). Observers were required to follow the dimension descriptions for the low, medium, and high domains in the manual CLASS when scoring each dimension. Scores for the domains were then calculated by adding the scores for the dimensions and dividing by the number of dimensions (Pianta et al., 2008). The CLASS framework delineates three domains: "Emotional Support," which evaluates the depth and affective quality of teacher-student interactions, reflecting the teacher's capacity to offer a responsive and emotionally conducive learning milieu; "Classroom Organization," which appraises the teacher's efficacy in orchestrating a structured and goal-oriented learning environment conducive to educational engagement; and "Instructional Support," which quantifies the teacher's role in fostering cognitive development and articulating constructive feedback to support students' academic progression.

The instrument CLASS has been internationally validated to observe the dynamics of interaction and classroom management in face-to-face lectures (Kirk et al., 2022; Pakarinen et al., 2010; Stuck et al., 2016). In this study, we adapted the instrument to apply the observation protocol to online lectures. In this context, the study conducted by Ariffin and Darus (2022) demonstrates the applicability of CLASS to observe interaction and learning processes in an

online context. Recent studies also highlight the feasibility of applying observation techniques in online teaching (Salekdeh & Hassaskhah, 2023). For example, Khlaif et al. (2021) used an observation protocol developed based on checklists designed for observing face-to-face learning processes (Wheeler et al., 2019; Topçu et al., 2018).

To assess the applicability of the instrument in an online context, experienced psychological researchers skilled in the use of CLASS conducted pre-observations. They found that all dimensions captured by CLASS could be effectively observed in online interactions between students and between teachers and students. Reliability analyses were also conducted to ensure the validity of the instrument. Inter-observer agreement was calculated separately for online and face-to-face instruction using intraclass correlations. The interrater reliabilities of the domains from CLASS were 0.81 and 0.86 for emotional support, respectively for face-to-face and online observations, 0.80 (face-to-face) and 0.83 (online) for classroom organization, and 0.78 (face-to-face) and 0.83 (online) for instructional support.

The internal consistency reliabilities for the three domains were emotional support (face-to-face: $\alpha = 0.90$; online: $\alpha = 0.86$), classroom organization (face-to-face: $\alpha = 0.93$; online: $\alpha = 0.96$), and classroom support (face-to-face: $\alpha = 0.88$; online: $\alpha = 0.93$).

Data Analysis

Data analysis was performed as follows: Descriptive statistics on the dimensions measured by CLASS were compiled in advance, distinguishing between face-to-face and online contexts. To answer to the first research question, we performed paired sample t-tests to identify possible significant differences between the average scores of CLASS results obtained in the two different educational settings. Then, in order to explore the association between age and CLASS dimensions we calculated Pearson correlations between the sub-dimensions of CLASS and the age of the students.

Results

Table 1 shows the descriptive statistics for the class dimensions measured for each of the online and face-to-face interactions.

Table 1

Means, Standard Deviations, and Paired Sample T-Tests of the Variables

	Online		Face-to-face				
	M	SD	M	SD	t-test	p	d
<i>Emotional support</i>							
Positive climate*	6.42	0.27	5.96	0.49	5.932	<.001	0.99
Negative climate	2.97	0.53	3.18	0.69	-1.867	.07	-0.31
Teacher sensitivity*	6.26	0.27	6.56	0.26	-3.803	.001	-0.63
Regard for student perspectives	4.67	0.67	4.83	0.77	-1.261	.22	-0.21
<i>Classroom organization</i>							
Behavior management*	6.01	0.43	5.69	0.59	3.077	.004	0.51

Productivity	3.33	0.63	3.53	0.76	-1.061	.30	-0.18
Instructional learning formats*	5.93	0.40	5.71	0.46	2.515	.02	0.42
<i>Instructional support</i>							
Concept development	4.83	0.86	4.67	0.63	1.206	.24	0.20
Quality of feedback*	5.89	0.44	6.19	0.42	-3.064	.004	-0.51
Language modelling	6.26	0.25	6.28	0.26	-0.206	.84	-0.03

Note. *Statistically significant difference

In order to answer to the first research questions, we conducted paired sample t-tests comparing the average scores obtained by the classrooms on the 10 subdimensions of the CLASS in the online vs. face-to-face setting. As can be seen from the table, there are statistically significant differences in all three domains examined by CLASS. In particular, with respect to the domain of emotional support, it appears that the classroom climate seems to be more positive in the online context than in the face-to-face context. The dimensions of teacher sensitivity are also more pronounced in the face-to-face context than in the online context. As regards Classroom organization, the online context is characterized by significantly higher values for the dimensions of behavior management and instructional formats. Finally, in the area of instructional support, only a significant difference was found with respect to the Quality of feedback dimension, which reached higher average values in the face-to-face context. According to the d-cutoff values proposed by Cohen (1988), the effect sizes for the significant differences are: low for Instructional learning formats, medium for Teacher sensitivity, Behavior management, and Quality of feedback, and high for Positive climate.

With respect to the second research question, we examined the Pearson's correlations between the average scores obtained by the classrooms in the two settings and age. Table 2 reports these correlations. It emerges that regarding Emotional Support, a negative correlation is observed between Teacher Sensitivity and Age in Face-to-face Context (-.63*). For the area domain of classroom organization, a negative correlation is observed between productivity and age (-.69*) in the online context. Regarding the area of instructional support, a positive correlation is observed between concept development and age in the face-to-face context (.35*) and between language modelling and age (.52*) in the online context.

Table 2*Correlations Between CLASS subdimensions and Students' Age*

		Correlations with age	
		Face-to-face	Online
<i>Emotional support</i>	Positive climate	.31	.20
	Negative climate	.30	.05
	Teacher sensitivity	-.63*	.37
	Regard for student perspectives	.33	.12
<i>Classroom organization</i>	Behavior management	-.05	-.08
	Productivity	-.17	-.69*
	Instructional learning formats	-.02	-.17
<i>Instructional support</i>	Concept development	.35*	.34
	Quality of feedback	.21	.21
	Language modelling	.02	.52*

Discussion

The recent pandemic increase in the use of digital learning at different grade levels has made it possible to study a phenomenon that until a few years ago was still in its early stages. Today, the situation has normalized: The use of online learning is part of the different practices available for the implementation of educational programs and is perceived as an additional way to manage the teaching/learning process: This provides an opportunity to study and compare the specific modes of interaction of digital learning in comparison with those of face-to-face learning. In contrast, until a few years ago, it would not have been possible to study the effects of the two different modes of teaching (face-to-face vs. online) on the same individuals.

The results of the study suggest that online learning has a significant impact on the quality of teacher-student interactions compared to face-to-face instruction in elementary schools. The results show that online mode is associated with a more positive classroom climate: this finding helps to add to the sometimes contradictory statements in the literature.

For example, Ghaderi et al. (2022) report that college students are more likely to experience positive emotions (such as joy, hope, pride) in traditional face-to-face situations. In contrast, Yang et al.'s (2019) study shows that online learning situations can foster a positive collaborative climate by supporting mutual acceptance among students.

However, it should be kept in mind that classroom climate has been little studied in relation to online learning in the elementary school context. We can hypothesize that online learning is associated with a positive classroom climate because the virtual environment facilitates group management. However, teachers' sensitivity was higher in face-to-face contexts, suggesting that teachers may find it difficult to establish meaningful relationships

with their students online: This confirms the findings of several studies showing that the digital learning context hinders the development of meaningful interpersonal relationships.

Indeed, loneliness and social isolation have long been studied as relevant effects of online learning (Kraut et al., 1998; Ali & Smith, 2015); one of the most criticized aspects of online learning is precisely the difficulty of building authentic relationships between people (Niemi & Kousa, 2020). In addition, the online mode was found to be characterized by significantly higher levels of behavior management and instructional learning formats in the classroom organization domain. This could be due to the fact that in the virtual environment it is easier to track and monitor student behavior and technological tools are available to facilitate instructional learning. This is an original finding in relation to the elementary school context: recent studies have indeed shown a positive impact of online didactics on the organization of learning formats, but in relation to higher levels of education. For example, Reyes-Mercado et al. (2023) highlighted how online didactics support the ability to perform tasks, thus facilitating learning processes.

However, in the Instructional support domain, only the Quality of feedback dimension showed a significant difference, with higher mean scores in the face-to-face context. This suggests that online teaching may have some limitations in providing effective feedback to students: This finding is consistent with the literature. In this regard, Alawamleh and colleagues (2020) suggest that online teaching is associated with lower quality feedback and deterioration of communicative interactions.

Examination of the correlations between the dimensions of CLASS and student age reveals that age is significantly associated with different dimensions of student-teacher quality of interaction in the two studied educational settings: The negative correlation between teacher sensitivity and age in face-to-face classes suggests that teachers are less responsive to learners' needs in face-to-face classes with older students. This finding could be due to higher expectations of autonomy for older learners in a context such as face-to-face instruction to which they have long been accustomed. Teacher sensitivity in the elementary school context has been studied most frequently in the literature in relation to learners with special education needs (Koenen et al., 2019) and less frequently in relation to learner age. In relation to the area of classroom organization, a negative correlation between productivity and age is observed in the online context: As students age, less organization of activities and routines by teachers is observed. This result confirms what has already been highlighted in the literature in general in relation to the difficulties associated with online learning and deepens the phenomenon in relation to the age of the students (a factor that, however, has been less studied by the research). In the area of Instructional support, a positive correlation is found between concept development and age in the face-to-face context: The older students are, the more they can benefit from the subdimensions of instructional support in the face-to-face context. Finally, a positive correlation is found between language modelling and age in the online context: This result confirms our hypothesis regarding the language modelling dimension of the instructional support domain and shows that as learners age; teachers are more likely to facilitate and promote learners' language formats in the online learning context.

The findings indicate that age-appropriate inclusion of teaching practices in digital environments is warranted. As younger elementary-aged students can draw on school

experiences that require minimal autonomy and attention control, they would benefit from synchronous online learning that includes regular teacher check-in points for teacher-directed learning experiences that last a maximum of 20 minutes each, with significantly smaller stretches where cues or visual aids are used to guide attention (Acer & Yilmaz, 2020; Koivunoro et al., 2021).

Also, structuring the routine and providing guidance (e.g., shared tasks with the whole class) create opportunities to provide a supportive structure consistent with their prior skills and knowledge. For older elementary-aged students, break room discussions with 3–4 classmates are a good strategy to replicate classroom interaction and collaboration on a shared digital platform. More asynchronous lessons that allow for more flexible scheduling would also encourage their independence and autonomy in the learning process. With increasing autonomy and independence, primary school teachers need to recognize this trend and provide space for choice in task completion and increasing attempts at self-regulation (Sureyya, 2010). Overall, the findings presented in this study have improved teaching effectiveness and knowledge acquisition skills at all grade levels.

The implications of the findings are important for practitioners and educational researchers. In practice, teachers should pay particular attention to developing meaningful relationships with their learners in online learning contexts and translating these findings into explicit learning feedback.

The results also highlight the need to explore how the online space affects different factors that are features of online interaction between teachers and learners. Although the results of this study revealed relationships between knowledge acquisition skills and online teaching strategies, some markers overlap with the existing literature on teaching and learning in face-to-face environments. Supported by the results of this study and the literature, several suggestions can enhance online learning experiences in elementary classrooms.

The use of structured routines and visual schedules not only reduces cognitive load but also creates predictability in online learning experiences, which enhances learning for young learners who are more accustomed to structured environments in face-to-face learning (Hirsh-Pasek et al., 2020). The inclusion of interactive resources such as polls, shared whiteboards or quizzes encourages learner engagement and motivation in online learning contexts (Wang, 2015). To create and maintain an emotional connection with students, the teacher is encouraged to use student' names, provide feedback through digital means that are personalized by the teacher, and include brief informal moments for sharing personal connections, as all of these help to foster students' sense of belonging and emotional engagement in their learning process (Singh et al., 2022).

Ultimately, the use of multimodal instructional materials (text, video, images, etc.) supports better understanding and accommodates different cognitive and learning styles by providing access to visually engaging and diverse online resources and strategies within their learning process (Moreno & Mayer, 2007). As this study serves to enrich the examples of online and face-to-face interactions in an Italian educational context, future studies are important to replicate this study to better understand instructional practices in other educational contexts representative of non-Western or underrepresented cultural contexts. Cross-cultural comparisons could be used to determine which aspects of teacher-student

interaction are influenced by the contextual content of the pedagogy, as opposed to the commonalities that exist between the two modalities. This type of research will allow for additional generalizability and applicability of results to educational systems consistent with this study.

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

The findings of research question one demonstrate that adaptability significantly influences self-regulation, including intrinsic and extrinsic regulation factors. This aligns with several researchers who state that adaptability is part of self-regulation (Holliman et al., 2018; Martin et al., 2013), specifically related to coping with situational uncertainty and novelty. Thus, adaptability is useful for monitoring, directing, and managing thinking and behavior to lead to the goals to be achieved in diverse situations (Martin et al., 2013). This finding is further supported by Xu's (2022) research on the adaptation of online learning to students' self-regulation during the COVID-19 period. Xu (2022) emphasizes the importance of self-regulation in managing emotions, behaviors, and thoughts, highlighting that the shift to online learning necessitates a quick adaptation to self-regulation, particularly for students accustomed to traditional classroom settings.

Conclusion

The study highlighted the benefits of online instruction, including a more positive classroom climate, improved behavior management, and greater use of classroom learning formats. These findings suggest that the virtual learning environment can provide opportunities to promote a conducive and engaging learning atmosphere. On the other hand, face-to-face instruction showed strengths in terms of teacher sensitivity and quality of feedback. This underscores the importance of face-to-face interactions and tailored feedback in traditional classroom settings.

Correlations between subdimensions of CLASS and student age provided valuable insights into the dynamics of teacher-student interactions. The negative correlation between teacher sensitivity and age in face-to-face instruction suggests potential challenges in meeting the needs of older students. In addition, the negative correlation between productivity and age in the online context raises concerns about maintaining organizational aspects as students age.

On this basis, a number of recommendations emerge. First, online teachers should consider how to build meaningful and supportive relationships with their students while using various digital tools. It is important to experiment with different feedback strategies while

engaging students in learning outcomes through the effective use of digital tools.

Second, attention must be paid to the age gap in the design of online teaching practices, as well as the way in which senior students receive support by providing them with an appropriate level of decompression and organizational structure.

Third, further research is needed to investigate the relationship between different student characteristics (e.g., digital literacy, socio-economic situation) and the nature and quality of online interaction between teachers and students, as well as teachers' online teaching skills and their relationship with the quality of online interaction between teachers and student.

Fourth, research should be conducted to evaluate the reliability and validity of certain tools, including CLASS, to assess their use in different digital learning contexts in order to demonstrate the quality of mapping (i.e., to see the impact of online interactions compared to more traditional forms of interaction).

Fifth, there is a need for more comprehensive studies that examine the nature of online interactions in a range of educational systems and countries. Interactions can be examined by comparing one practice to another, taking into account the unique contextual variables that affect technology, socialization, pedagogy, and teacher training (e.g., computers and other technologies, including other strategies to support learning) that may have influenced or collectively changed the effectiveness of online teaching. These studies would improve the generalizability of findings and help to generate policy insights across a range of contexts.

In summary, this study provides valuable insights into the benefits and limitations of online instruction in the elementary school context. By understanding the nuances of teacher-student interactions in virtual environments, teachers can adapt instructional strategies to maximize student engagement and promote positive learning outcomes. Continued research in this area is essential to further improve the effectiveness of online instruction and advance educational practice in the digital age.

Limitations

This study compares the effects of online learning and face-to-face learning on the quality of student-teacher interactions in elementary school and presents original findings on this research question.

Previous research and this study have shown that CLASS (Pianta et al., 2008) is a viable tool to examine the constructs of the study; however, online learning environments are wild and have a high degree of heterogeneity in the way they are organized and delivered compared to traditional, face-to-face teaching. There are only a very small number of studies that have used CLASS as an observational tool to study interactions in online learning environments. Future studies should continue to investigate validity and reliability studies in other formats and contexts.

Furthermore, relying solely on direct observations does not adequately capture how participants experience and make sense of their lives. Future research might consider a mixed methods approach, where observational data is supplemented with qualitative data (i.e., interviews, focus groups, or participant self-report) to capitalize on the complex ecology of interactions that individuals embody in a classroom context.

The context of the COVID-19 pandemic should also be considered as an episodic context or a unique moment with unique conditions that influence the overall results. Although the sample was exclusively Italian schools and the transferability of the results is therefore questionable and influenced by COVID-19, the rapid and frenetic digital transformation meant that the online experiences introduced during the pandemic may have both adaptive and disruptive aspects for the quality of teaching. There were also contextual subtexts that were not systematically measured, such as equitable access to digital resources, differences in teachers' ICT skills, and differences in school infrastructure, all of which may contain important elements that influenced the quality of interactions as study variables. These potential influences should be reported and systematically evaluated in future studies to gain a greater understanding of contextual influences on teaching quality

References

- Ahel, O., & Schirmer, M. (2023). Education for sustainable development through research-based learning in an online environment. *International Journal of Sustainability in Higher Education*, 24(1), 118–140. <https://doi.org/10.1108/IJSHE-07-2021-0305>
- Alawamleh, M., Al-Twait, L. M., & Al-Saht, G. R. (2020). The effect of online learning on communication between instructors and students during Covid-19 pandemic. *Asian Education and Development Studies*, 11(2), 388–400. <https://doi.org/10.1108/AEDS-06-2020-0131>
- Ali, A., & Smith, D. (2015). Comparing social isolation effects on students' attrition in online versus face-to face courses in computer literacy. *Issues in Informing Science and Information Technology*, 12, 11–20. <https://doi.org/10.28945/2258>
- Alon, L., Sung, S., Cho, J., & Kizilcec, R. F. (2023). From emergency to sustainable online learning: Changes and disparities in undergraduate course grades and experiences in the context of COVID-19. *Computers & Education*, 203, 104870. <https://doi.org/10.1016/j.compedu.2023.104870>
- Ariffin, K., Darus, N. A., & Abdul Halim, N. (2022). Learning in the virtual environment: Instructors' strategies in enhancing interaction in ESL online classes. *LEARN Journal: Language Education and Acquisition Research Network*, 15(2), 412–435.
- Braad, E., Degens, N., & IJsselsteijn, W. A. (2020). Designing for metacognition in game-based learning: a qualitative review. *Translational Issues in Psychological Science*, 6(1), 53–69. <https://doi.org/10.1037/tps0000217>
- Chen, C.-P., & Wang, C.-H. (2015). Employing augmented-reality-embedded instruction to disperse the imparities of individual differences in earth science learning. *Journal of Science Education and Technology*, 24, 835–847. <https://doi.org/10.1007/s10956-015-9567-3>
- Choy, D., & Cheung, Y.L. (2022). Comparison of primary four students' perceptions towards self-directed learning and collaborative learning with technology in their English writing lessons. *Journal of Computers in Education*, 9, 783–806. <https://doi.org/10.1007/s40692-022-00220-4>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge. <https://doi.org/10.4324/9780203771587>
- Cole, A. W., Lennon, L., & Weber, N. L. (2021). Student perceptions of online active learning practices and online learning climate predict online course engagement. *Interactive Learning Environments*, 29(5), 866–880. <https://doi.org/10.1080/10494820.2019.1619593>
- Cormier, C., McGrew, J., Ruble, L., & Fischer, M. (2022). Socially distanced teaching: The mental health impact of the COVID-19 pandemic on special education

teachers. *Journal of Community Psychology*, 50(3), 1768–1772.
<https://doi.org/10.1002/jcop.22736>

- Decree of the President of the Council of Ministers. (2020, February 23). *Urgent measures for the containment and management of the epidemiological emergency from COVID-19*. <https://www.gazzettaufficiale.it/eli/id/2020/02/23/20A01228/sg>
- Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5–22.
<https://doi.org/10.1177/0047239520934018>
- Genlott, A. A., & Grönlund, Å. (2016). Closing the gaps—Improving literacy and mathematics by ict-enhanced collaboration. *Computers & Education*, 99, 68–80.
<https://doi.org/10.1016/j.compedu.2016.04.004>
- Ghaderi, E., Ali, K., & Neda, F. (2022). Achievement emotions of university students in on-campus and online education during the COVID-19 pandemic. *Tuning Journal for Higher Education* 10(1), 319–36. <https://doi.org/10.18543/tjhe.2346>
- Gherghel, C., Yasuda, S., & Kita, Y. (2023). Interaction during online classes fosters engagement with learning and self-directed study both in the first and second years of the COVID-19 pandemic. *Computers & Education*, 200, 104795.
<https://doi.org/10.1016/j.compedu.2023.104795>
- Goagoses, N., Suovuo, T., Winschiers-Theophilus, H., Suero Montero, C., Pope, N., Rötönen, E., & Sutinen, E. (2023). A systematic review of social classroom climate in online and technology-enhanced learning environments in primary and secondary school. *Education and Information Technologies*, 1–34.
<https://doi.org/10.1007/s10639-023-11705-9>
- Greenhow, C., Galvin, S. M., Brandon, D. L., & Askari, E. (2020). A decade of research on K–12 teaching and teacher learning with social media: Insights on the state of the field. *Teachers College Record*, 122(6), 1–72.
<https://doi.org/10.1177/016146812012200602>
- Greenhow, C., Graham, C. R., & Koehler, M. J. (2022). Foundations of online learning: Challenges and opportunities. *Educational Psychologist*, 57(3), 131–147.
<https://doi.org/10.1080/00461520.2022.2090364>
- Harris, L., Dargusch, J., Ames, K., & Bloomfield, C. (2020). Catering for ‘very different kids’: Distance education teachers’ understandings of and strategies for student engagement. *International Journal of Inclusive Education*, 1–17.
<https://doi.org/10.1080/13603116.2020.1735543>
- He, S., Shuai, L., Wang, Z., Qiu, M., Wilson, A., Xia, W., Cao, X., Lu, L., & Zhang, J. (2021). Online learning performances of children and adolescents with attention deficit hyperactivity disorder during the COVID-19 pandemic. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*.
<https://doi.org/10.1177/00469580211049065>

- Heo, J., & Han, S. (2018). Effects of motivation, academic stress and age in predicting self-directed learning readiness (SDLR): Focused on online college students. *Education and Information Technologies*, 23(1), 61–71. <https://doi.org/10.1007/s10639-017-9585-2>
- Hirsh-Pasek, K., Hadani, H. S., Blinkoff, E., & Golinkoff, R. M. (2020). A new path to education reform: playful learning promotes 21st century skills in school and beyond. *Policy Brief*, 1–25.
- Jamil, F. M., Sabol, T. J., Hamre, B. K., & Pianta, R. C. (2015). Assessing teachers' skills in detecting and identifying effective interactions in the classroom. Theory and Measurement. *The Elementary School Journal*, 115(3), 407–432. <https://doi.org/10.1086/680353>
- Khlaif, Z. N., Salha, S., & Kouraichi, B. (2021). Emergency remote learning during COVID-19 crisis: Students' engagement. *Education & Information Technology*, 26, 7033–7055. <https://doi.org/10.1007/s10639-021-10566-4>
- Kirk, G., Knaus, M., & Rogers, S. (2022). An appraisal of the CLASS instrument as an observational measurement tool for evaluation of student and teacher interactions in western Australian classrooms. *Australian Journal of Teacher Education (Online)*, 47(6), 85–104. <https://search.informit.org/doi/10.3316/informit.790703100283632>
- Koenen, A. K., Vervoort, E., Kelchtermans, G., Verschueren, K., & Spilt, J. L. (2019). Teacher sensitivity in interaction with individual students: The role of teachers' daily negative emotions. *European Journal of Special Needs Education*, 34(4), 514–529. <https://doi.org/10.1080/08856257.2018.1553876>
- Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T., & Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well-being? *American Psychologist*, 53(9), 1017–1031. <https://doi.org/10.1037/0003-066x.53.9.1017>
- Li, Q., Miao, Y., Zeng, X., Tarimo, C. S., Wu, C., & Wu, J. (2020). Prevalence and factors for anxiety during the coronavirus disease 2019 (COVID-19) epidemic among the teachers in China. *Journal of Affective Disorders*, 277, 153–158. <https://doi.org/10.1016/j.jad.2020.08.017>
- Li, S., & Zheng, J. (2018). The relationship between self-efficacy and self-regulated learning in one-to-one computing environment: the mediated role of task values. *The Asia-Pacific Education Researcher*, 27(6), 455–463. <https://doi.org/10.1007/s40299-018-0405-2>
- Marcus, J. (2022, October 6). With online learning, 'Let's take a breath and see what worked and didn't work.' *The New York Times*. <https://www.nytimes.com/2022/10/06/education/learning/online-learning-higher-education.html>
- Maryani, I., Prasetyo, Z. K., Wilujeng, I., & Purwanti, S. (2022). Promoting higher-order

- thinking skills during online learning: the integration of metacognition in science for higher education. *International Journal of Evaluation and Research in Education*, 11(4), 1980–1988. <https://doi.org/10.11591/ijere.v11i4.23129>
- Miller, K. E. (2021). A light in students' lives: K–12 teachers' experiences (re)building caring relationships during remote learning. *Online Learning*, 25(1), 115–134. <https://doi.org/10.24059/olj.v25i1.2486>
- Moon, J., Webster, C. A., Brian, A., Stodden, D. F., & Mulvey, K. L. (2023). Development of the system for observing virtual real time lessons in physical education (SOVRTL-PE): A tool to support preservice teachers' applied learning experiences. *Computers & Education*, 196, 104738. <https://doi.org/10.1016/j.compedu.2023.104738>
- Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments: Special issue on interactive learning environments: Contemporary issues and trends. *Educational Psychology Review*, 19(3), 309–326. <https://doi.org/10.1007/s10648-007-9047-2>
- Niemi, H. M., & Kousa, P. (2020). A case study of students' and teachers' perceptions in a Finnish high school during the COVID pandemic. *International Journal of Technology in Education and Science (IJTES)*, 4(4), 352–369. <https://doi.org/10.46328/ijtes.v4i4.167>
- Nygren, T., & Vikström, L. (2013). Treading old paths in new ways: Upper secondary students using a digital tool of the professional historian. *Education Science*, 3, 50–73. <https://doi.org/10.3390/educsci3010050>
- Pakarinen, E., Lerkkanen, M. K., Poikkeus, A. M., Kiuru, N., Siekkinen, M., Rasku-Puttonen, H., & Nurmi, J. E. (2010). A validation of the classroom assessment scoring system in Finnish kindergartens. *Early Education and Development*, 21(1), 95–124. <https://doi.org/10.1080/10409280902858764>
- Petchamé, J., Iriando, I., Villegas, E., Riu, D., & Fonseca, D. (2021). Comparing face-to-face, emergency remote teaching and smart classroom: A qualitative exploratory research based on students' experience during the COVID-19 pandemic. *Sustainability*, 13(12), 6625. <https://doi.org/10.3390/su13126625>
- Petillion, R., & McNeil, W. (2020). Student experiences of emergency remote teaching: impacts of instructor practice on student learning, engagement, and well-being. *Journal of Chemical Education*, 97(9), 2486–2493. <https://doi.org/10.1021/acs.jchemed.0c00733>
- Pianta, R. C., & Hamre, B. K. (2009). Conceptualization, measurement, and improvement of classroom processes: standardized observation can leverage capacity. *Educational Researcher*, 38(2), 109–119. <https://doi.org/10.3102/0013189X09332374>
- Pianta, R. C., Hamre, B. K., & Mintz, S. L. (2012). *The CLASS-secondary manual*. Teachstone.

- Pianta, R. C., La Paro, K. M., & Hamre, B. K. (2008). *The classroom assessment scoring system manual, K–3*. Brookes Publishing.
- Pianta, R. C., La Paro, K. M., Payne, C., Cox, M. J., & Bradley, R. (2002). The relation of kindergarten classroom environment to teacher, family, and school characteristics and child outcomes. *The Elementary School Journal*, 102(3), 225–238. <https://doi.org/10.1086/499701>
- Pirlott, A. G. (2022). Online versus face-to-face learning in an undergraduate psychology statistics course. *Scholarship of Teaching and Learning in Psychology*. Advance online publication. <https://doi.org/10.1037/stl0000340>
- Redpath, L. (2012). Confronting the bias against on-line learning in management education. *Academy of Management Learning & Education*, 11(1), 125–140. <https://doi.org/10.5465/amle.2010.0044>
- Repubblica Italiana. (2015). *Legge 13 luglio 2015, n. 107: Riforma del sistema nazionale di istruzione e formazione e delega per il riordino delle disposizioni legislative vigenti*. <https://www.gazzettaufficiale.it/eli/id/2015/07/15/15G00122/sg>
- Reyes-Mercado, P., Barajas-Portas, K., Kasuma, J., Almonacid-Duran, M., & Zamacona-Aboumrar, G. A. (2023). Adoption of digital learning environments during the COVID-19 pandemic: merging technology readiness index and UTAUT model. *Journal of International Education in Business*, 16(1), 91–114. <https://doi.org/10.1108/JIEB-10-2021-0097>
- Rif, S. C., Tan, K. H., & Khairuddin, K. F. (2023). Debriefing in online primary ESL Classrooms During the COVID-19 pandemic: a case study. *Journal of Language Teaching and Research*, 14(1), 224–230. <https://doi.org/10.17507/jltr.1401.23>
- Sahlin, J. S., Tsertsidis, A., & Islam, M. S. (2017). Usages and impacts of the integration of information and communication technologies (ICTs) in elementary classrooms: case study of Swedish municipality schools. *Interactive Learning Environments*, 25(5), 561–579. <https://doi.org/10.1080/10494820.2016.1170045>
- Salekdeh, S. H., & Hassaskhah, J. (2023). Learning activities in online EFL classrooms through the lens of learning theories. In *Proceedings of the 2023 10th International and 16th National Conference on E-Learning and E-Teaching (ICeLeT)* (pp. 1–6). IEEE.
- Shakina, B., Nur, S., & Sunra, L. (2022) An analysis of English teachers' online teaching strategies during Covid-19 pandemic. *Journal of Excellence in English Language Education (JoEELE)*, 1(2), 94–107.
- Siddiq, F., Gochyyev, P., & Wilson, M. (2017). Learning in digital networks–ICT literacy: A novel assessment of students' 21st century skills. *Computers & Education*, 109, 11–37. <https://doi.org/10.1016/j.compedu.2017.01.014>
- Singh, J., Singh, L., & Matthees, B. (2022). Establishing social, cognitive, and teaching presence in online learning—A panacea in COVID-19 pandemic, post vaccine and post pandemic times. *Journal of Educational Technology Systems*, 51(1), 28–

45. <https://doi.org/10.1177/00472395221095169>
- Skar, G. B. U., Graham, S., & Huebner, A. (2021). Learning loss during the COVID-19 pandemic and the impact of emergency remote instruction on first grade students' writing: A natural experiment. *Journal of Educational Psychology*. Advance online publication. <https://doi.org/10.1037/edu0000701>
- Sokal, L., Trudel, L. E., & Babb, J. (2020). Canadian teachers' attitudes toward change, efficacy, and burnout during the COVID-19 pandemic. *International Journal of Educational Research Open*, 1, 100016. <https://doi.org/10.1016/j.ijedro.2020.100016>
- Stuck, A., Kammermeyer, G., & Roux, S. (2016). The reliability and structure of the classroom assessment scoring system in German pre-schools. *European Early Childhood Education Research Journal*, 24(6), 873–894. <https://doi.org/10.1080/1350293X.2016.1239324>
- Thomas, R. C., Weywadt, C. R., Anderson, J. L., Martinez-Papponi, B., & McDaniel, M. A. (2018). Testing encourages transfer between factual and application questions in an online learning environment. *Journal of Applied Research in Memory and Cognition*, 7(2), 252–260. <https://doi.org/10.1016/j.jarmac.2018.03.007>
- Tomasik, M. J., Helbling, L. A., & Moser, U. (2021). Educational gains of in-person vs. distance learning in primary and secondary schools: A natural experiment during the COVID-19 pandemic school closures in Switzerland. *International Journal of Psychology*, 56(4), 566–576. <https://doi.org/10.1002/ijop.12728>
- Topçu, M. S., Foulk, J. A., Sadler, T. D., Pitiporntapin, S., & Atabey, N. (2018). The classroom observation protocol for socioscientific issue-based instruction: development and implementation of a new research tool. *Research in Science & Technological Education*, 36(3), 302–323.
- Tsai, C. W., Lin, M. Y. C., Cheng, Y. P., Lee, L. Y., Chyr, W. L., Lin, C. H., ... & Tsai, M. C. (2023). The effects of online peer-facilitated learning and distributed pair programming on students' learning. *Computers & Education*, 203, 104849. <https://doi.org/10.1016/j.compedu.2023.104849>
- UNESCO (2017). *A guide for ensuring inclusion and equity in education*. <https://unesdoc.unesco.org/ark:/48223/pf0000248254>
- Vagos, P., & Carvalhais, L. (2022). Online versus classroom teaching: Impact on teacher and student relationship quality and quality of life. *Frontiers in Psychology*, 13, 828774–828774. <https://doi.org/10.3389/fpsyg.2022.828774>
- Vaillancourt, T., Brittain, H., Krygsman, A., Farrell, A. H., Pepler, D., Landon, S., Saint-Georges, Z., & Vitoroulis, I. (2022). In-person versus online learning in relation to students' perceptions of mattering during COVID-19: A brief report. *Journal of Psychoeducational Assessment*, 40(1), 159–169. <https://doi.org/10.1177/07342829211053668>
- Wang, A. I. (2015). The wear out effect of a game-based student response system.

Computers & Education, 82, 217–227.
<https://doi.org/10.1016/j.compedu.2014.11.004>

- Wheeler, L. B., Navy, S. L., Maeng, J. L., & Whitworth, B. A. (2019). Development and validation of the classroom observation protocol for engineering design (COPED). *Journal of Research in Science Teaching*, 56(9), 1285–1305.
<https://doi.org/10.1002/tea.21557>
- Wu, Y.-C. J., Pan, C.-I., & Yuan, C.-H. (2017). Attitudes towards the use of information and communication technology in management education. *Behavior & Information Technology*, 36(3), 243–254.
<https://doi.org/10.1080/0144929X.2016.1212928>
- Yang, H. H., Feng, L., & MacLeod, J. (2019). Understanding college students' acceptance of cloud classrooms in flipped instruction: integrating UTAUT and connected classroom climate. *Journal of Educational Computing Research*, 56(8), 1258–1276. <https://doi.org/10.1177/0735633117746084>

Determinants of Job Satisfaction and Online Learning Continuation: A Study of Kazakhstani Educators During COVID-19

Saniya Nurgaliyeva

*Abai Kazakh National Pedagogical University, Almaty, Kazakhstan
Ataturk University, Erzurum, Turkey*

Aziya Zhumabayeva

Abai Kazakh National Pedagogical University, Almaty, Kazakhstan

Meiramgul Zhorokpayeva

Semey Medical University, Semey, Kazakhstan

Kalbike Yessenova

Abai Kazakh National Pedagogical University, Almaty, Kazakhstan

Saule Zeinolla

Kazakh-German University, Almaty, Kazakhstan

Aidos Bolatov

Shenzhen University Medical School, Shenzhen University, Shenzhen, China

Correspondence: Aidos Bolatov, Shenzhen University, Shenzhen, China. bolatovaidos@gmail.com

Abstract

The COVID-19 pandemic necessitated a rapid transition to online learning (OL), presenting significant challenges for teachers globally. This study aimed to provide a deeper understanding of the determinants of job satisfaction and the readiness of school teachers in Kazakhstan to continue online education after the pandemic. A cross-sectional study was conducted among 1,205 school teachers across Kazakhstan in May 2021. The vast majority of teachers (91.6%) reported technological challenges, and 53.4% faced communication difficulties with students. An increased workload was reported by 61.7% of respondents, with older and more experienced teachers being particularly affected. Age, changes in students' academic motivation, and satisfaction with the work of the Government were significant predictors of job satisfaction. Less than one-third (29.9%) of teachers expressed a willingness to continue OL after the pandemic. Mediation analysis revealed that job satisfaction indirectly influenced teachers' willingness to continue OL through communication challenges. Specifically, the indirect effect of job satisfaction on willingness to continue OL was significant both through communication challenges with colleagues and students. These findings underscore the need to address technological and communication barriers to enhance job satisfaction and ensure the sustainability of online learning in the post-pandemic period.

Keywords: Online learning, barriers, teacher challenges, job satisfaction, educational policy

Nurgaliyeva, S., Zhumabayeva, A., Zhorokpayeva, M., Yessenova, K., Zeinolla, S., & Bolatov, A. (2025) Determinants of job satisfaction and online learning continuation:

A study of Kazakhstani educators during COVID-19, *Online Learning*, 30(1), pp. 138-174. <https://doi.org.10.24059/olj.v30i1.4806>

Introduction

The COVID-19 pandemic profoundly affected societal structures worldwide (Hosseinzadeh et al., 2022). Governments were forced to implement unprecedented measures to mitigate the crisis, including prolonged isolation (Leach et al., 2021; Pietrabissa & Simpson, 2020). As a result, all societal institutions, including individuals, infrastructure, and technological systems, had to rapidly adapt to new conditions. Education was among the most vulnerable sectors, facing significant disruptions and requiring immediate adaptation to remote learning (Pokhrel & Chhetri, 2021; Du Plessis et al., 2024).

School closures affected over 94% of students globally (Birmingham et al., 2023; Miao et al., 2023), leading to substantial changes in educational delivery. Teachers encountered multiple challenges, including increased workloads, the need to master digital tools, and inadequate infrastructure to support remote learning (Dhawan, 2020; Goudarzi et al., 2023). In Kazakhstan, every school and teacher faced difficulties in maintaining instructional quality, making this issue persistently relevant (Burakanova et al., 2021; Burmistrova & Makoelle, 2023).

The transition to online learning revealed systemic weaknesses. There was no unified national strategy, clear guidelines, or a centralized educational platform to facilitate remote teaching. Schools lacked sufficient digital resources, including high-quality video lessons and effective online assessment tools (Bubb & Jones, 2020; Petek et al., 2023). Moreover, teachers had to adapt their instructional methods while developing new competencies in digital communication and student engagement (Paul & Jefferson, 2019; Brammer & Punyanunt-Carter, 2022; Williams, 2022).

In some schools, IT teachers or those with advanced digital skills provided peer support, helping colleagues navigate online tools. However, a shortage of specialists and training opportunities limited the effectiveness of this approach. Key barriers included (1) the inability to quickly train teachers in digital pedagogy (Avci, 2023; Carroll & Constantinou, 2023); (2) lack of experience with digital learning platforms (Adam & Metljak, 2022; Wallengren Lynch et al., 2023); and (3) low competition in the teaching profession, which reduced incentives for continuous professional development (Coman et al., 2020; Martin & Bolliger, 2018).

Kazakhstani policymakers encouraged teachers to develop their own materials and adapt to online formats, but often without sufficient support or training. Consequently, curricula originally designed for in-person instruction failed to translate effectively to remote settings (Durrani et al., 2023). Teachers struggled to deliver content, students faced technological and socioeconomic barriers, and many parents lacked the digital literacy needed to support their children's learning.

The shift to remote education also demanded significant changes in instructional formats, assessment methods, and student engagement strategies. Many teachers reported declining instructional quality in certain subjects and struggled to equate online teaching hours with traditional classroom time. Moreover, conventional assessment practices proved inadequate, increasing teachers' workload without reliably measuring student learning outcomes.

By spring 2020, online education in Kazakhstan had largely devolved into teachers assigning homework through electronic diaries, with students submitting tasks via social networks (Barrot et al., 2021; Kuhfeld et al., 2020). A lack of teacher motivation, digital competencies, technical resources, and systemic support exacerbated these challenges, leaving many unresolved (Blikstad-Balas et al., 2022; Lepp et al., 2021). The pandemic exposed deeper structural issues in Kazakhstan's education system, including chronic underfunding, inconsistent reforms, and ineffective management.

While previous studies have explored the challenges faced by teachers during the pandemic (Nugroho et al., 2020), limited research has specifically addressed job satisfaction and teachers' willingness to continue online education in Kazakhstan. This study seeks to fill this gap by using two complementary approaches to evaluate teachers' experiences and identify the factors influencing their satisfaction and readiness to continue online education post-pandemic. The findings will provide evidence-based insights to inform policymakers, educators, and stakeholders, aiding the development of strategies to enhance online teaching and contribute to Sustainable Development Goal 4 (Quality Education).

The study has two primary objectives: (1) to assess teachers' job satisfaction and willingness to continue online teaching and (2) to develop data-driven recommendations for improving online education policies and practices in Kazakhstan. While the present study focuses on Kazakhstan, its findings may hold broader relevance for other countries with similar socioeconomic and infrastructural challenges. Many post-Soviet and low-resource educational systems experienced parallel difficulties in transitioning to online learning, including limited digital infrastructure, uneven teacher training, and weak institutional support. By highlighting these systemic issues, our study contributes to a growing body of research aimed at developing sustainable and equitable approaches to online education in the post-pandemic era.

Problem Statement

The rapid transition to OL during the COVID-19 pandemic posed significant challenges for both students and teachers, especially in regions with limited technological infrastructure. To fully understand these challenges, it is essential to assess job satisfaction and the readiness of school teachers in Kazakhstan to continue online education beyond the pandemic. This study offers a comprehensive examination of these issues.

The research evaluates teachers' satisfaction with their professional activities and their willingness to continue online education using two complementary approaches. The first approach is structural, viewing job satisfaction as the relationship between teachers' expectations, requirements, and aspirations, and the degree to which these are met in terms of both content and working conditions. Teachers were asked to evaluate the importance of various aspects of their work, divided into two categories: (1) the conditions of their professional activity and (2) the teaching process.

The second approach focuses on job satisfaction as an emotional and evaluative attitude toward the teaching profession. This perspective includes an analysis of teachers' value orientations, which underpin their goal-setting, pedagogical design, and interactions with other participants in the educational process. Additionally, factors such as the perceived prestige of the teaching profession and teachers' social well-being – shaped by their social status – are considered key elements in understanding job satisfaction.

Overall, the study highlights a range of challenges faced by teachers in Kazakhstan during the pandemic, including technological readiness, communication difficulties, increased workload, and emotional well-being ([Amirova et al., 2023](#)).

Table 1 summarizes the key issues encountered by schoolteachers in Kazakhstan during the COVID-19 pandemic, based on data collected in the present study.

Table 1*Issues Faced by Teachers During the Transition to Online Learning in Kazakhstan (N=500)*

Issues Faced by Teachers During the Transition to OL		n	%
Internet and Technical Issues	Poor Internet Connection: Many teachers reported issues with the speed and stability of internet connections. Example: "Slow internet speed." "Weak internet in rural areas."	179	35.8
	Lack of Equipment: Issues with insufficient or inadequate hardware (computers, laptops, etc.) for both teachers and students. Example: "Lack of personal devices among students."	20	4.0
	Technical Difficulties: Problems with using online platforms and software. Example: "It was difficult to master the electronic platform." "Sometimes the platforms failed."	34	6.8
Student Engagement and Discipline	Low Students' Academic Motivation: Reduced motivation among students to participate in online classes. Example: "Students' interest in lessons decreased."	16	3.2
	Problems with partial feedback: reduced engagement and interest in the learning process among a certain number of students and, as a result, a decrease in their performance. Example: "The connection between teacher and student weakened", "Students do not attend lessons."	26	5.2
	Parental involvement challenges. Example: "Parents do homework for their children."	64	12.8
Workload and Time Management	Workload increase: The requirement to prepare and present online lessons has resulted in a notable increase in workload. Example: "The workload doubled."	36	7.2
	Time management: difficulties juggling the demands of distance learning with personal obligations. Example: "More time is spent on preparing and conducting lessons, and working with the Platform takes up a lot of time, I can't control it."	47	9.4
Health Concerns	Computer syndrome: prolonged time spent in front of a computer screen leads to eye muscle fatigue and discomfort. Example: "Eyesight deteriorated sharply", "a sedentary lifestyle has worsened health."	43	8.6%
	Professional stress and burnout among teachers due to online teaching. Example: "I felt psychological stress," "Sometimes, due to the lack of distinction between work and rest, I felt exhausted."	20	4.0
Communication and Relationship Challenges	Reduced student-teacher interaction. Example: "The connection between teacher and student weakened," "Lack of desire to participate in lessons with connected cameras, no visual contact."	25	5.0
	Difficulty in maintaining discipline. Example: "Students do not attend lessons."	15	3.0
Quality of Education	Reduced learning quality: questions about how well online instruction works and how well students comprehend the subject. Example: "The learning process declined," "Knowledge worsened."	29	5.8
	Accurately assessing students' performance and knowledge presents a challenge. Example: "Parents literally do the assignments for them and the grades they receive are undeserved," "It is impossible to assess the actual knowledge and skills of students."	8	1.6
Other Issues	Inequities, digital divide: Students from lower-income families struggled to access lessons due to a lack of devices and internet. Example: "Parents are at work, and children cannot join lessons."	15	3.0
	Inconsistent parental support: Some families deprioritized education, expecting to hire tutors later, leading to missed learning opportunities. Example: "Some parents completely neglected children's education."	15	3.0

Referring to Table 1, secondary school teachers demonstrated various problems in the transition to OL, including inequality of technical capabilities and imperfect technical equipment of secondary schools; the everyday capabilities of teachers, depending on their access to educational resources and the quality of the educational process turned out to be; digital literacy inequality among teachers; increased workload on teachers when teaching remotely, which negatively affected their socio-psychological well-being and health; and a lack of psychological support for teachers to ensure their well-being from the government during critical conditions ([Hajar & Karakus, 2024](#)).

Study Rationale

In the context of a severe epidemiological threat, education systems worldwide, including those of Kazakhstan, faced an unprecedented challenge ([Kolber, 2023](#)). The forced and rapid transition from traditional formats to online forms of education led to the emergence of the so-called “new reality” in teaching and learning ([Singh et al., 2022](#)). Amidst the widespread stress and uncertainty across all levels of education, it became evident that job satisfaction and the readiness of school teachers in Kazakhstan to continue online learning after the pandemic were among the most significant issues of this transition. ([Darmody et al., 2021](#)).

Despite the undeniable achievements of Kazakhstan’s educational system, several persistent challenges remain. In particular, the effective use of online teaching technologies has not been sufficiently addressed, further underscoring the relevance of this research. There is also a lack of studies in Kazakhstan exploring the role of online teaching in students’ learning and its impact on teachers’ professional development ([Berikkhanova et al., 2023](#); [Karstina, 2021](#)).

International researchers emphasize that integrating online teaching into the educational process can offer several benefits: (1) online learners gain access to a wide range of materials, including multimedia content, which enhances knowledge retention, while allowing students to work at their own pace ([Serrano et al., 2019](#)); (2) online learning contributes to higher attendance rates; and (3) it serves as an environmentally friendly option ([Panigrahi et al., 2018](#)).

Thus, online programs have the potential to deliver high-quality education in diverse formats. However, for online learning to be truly effective, careful planning, curriculum design, and technological support are essential ([Clark & Barbour, 2015](#); [Shumeiko et al., 2024](#)).

In the current epidemiologically unstable global context, the risk of declining motivation and professional engagement among teachers has increased significantly. The relevance and social significance of addressing this issue are underscored by the fact that, during the pandemic, teachers’ workload expanded considerably due to the need for rapid training and the subsequent organization of the educational process within a digital environment ([Chaleila et al., 2024](#)). However, teachers’ motivation has often been reduced to the formal acknowledgment of the social significance of their profession, which, in practice, does little to sustain their drive for efficiency and high-quality performance.

Moreover, assessing the impact of online teaching and the pandemic on teachers’ workload and job satisfaction is particularly challenging in Kazakhstan due to the lack of systematic research in this area. Therefore, a focused investigation into the challenges

encountered by teachers during the transition to online learning, specifically how the pandemic affected their workload and job satisfaction, is both timely and necessary.

While job satisfaction is a universal concern for teachers, the challenges in Kazakhstan may be more pronounced due to issues such as increased workload during the pandemic, limited resources, and the lack of widespread professional development opportunities in digital education. The literature on teacher burnout and satisfaction in countries with unstable economies, such as Kazakhstan, can shed light on how these global patterns manifest within the unique educational landscape of Kazakhstan (Bolatov et al., 2021).

This study offers a unique and original contribution to the existing body of literature on online learning by examining the underexplored context of Kazakhstan, a country characterized by specific structural, technological, and pedagogical challenges. While numerous studies have investigated online learning experiences in developed countries (e.g., Wiles et al., 2023; Bolliger & Martin, 2018; Bondie, 2023), there remains a significant research gap concerning teachers' job satisfaction and their willingness to continue online teaching in post-pandemic, resource-constrained environments.

This research is one of the first large-scale empirical studies to analyze the determinants of job satisfaction and readiness to continue online teaching among school teachers in Kazakhstan. Unlike previous studies conducted during the initial emergency remote teaching period, this study focuses on teachers' long-term readiness to continue online education after the pandemic, offering valuable insights into the sustainability of online teaching practices.

The study adopts both structural and emotional-evaluative approaches to examine job satisfaction and employs mediation analysis to explore how communication challenges influence the relationship between teachers' job satisfaction and their willingness to continue online teaching. The findings of this research provide practical recommendations not only for policymakers and stakeholders in Kazakhstan but also for other countries facing similar challenges related to the digital transformation of education. Thus, the study contributes to the broader discourse on the development of sustainable and equitable online learning systems.

Research Questions

Question 1: How has the shift to online instruction affected the workload and job satisfaction of teachers?

Question 2: How did the pandemic affect teachers' perceptions of the academic load and motivation of their students?

Question 3: What role did government support play in influencing teachers' job satisfaction and willingness to continue online learning format?

Objectives

The study examines job satisfaction and the willingness of school teachers in Kazakhstan to continue with OL post-pandemic.

Literature Review

The Effectiveness of Online Education

In a world characterized by constant change, the ability and willingness to pursue education and acquire new skills have become two of the most in-demand qualities for specialists in any field. According to [Jackson \(2015\)](#), employers today seek more than just professional qualifications; they value individuals who are familiar with online education, committed to continuous learning, and eager to enhance their skills. The rapidly growing digital economy is generating new employment opportunities for professionals with analytical and technical competencies, while simultaneously increasing competition among employers for talented individuals.

In such circumstances, online education is regarded as one of the most efficient and accessible ways to enhance one's value in the labor market ([Tripathy & Devarapalli, 2021](#)). As a result, the number of individuals obtaining academic credentials through online learning platforms is steadily increasing. [Hawkrige \(2022\)](#) and [Szymkowiak et al. \(2021\)](#), emphasize that the Internet and digital learning technologies provide numerous advantages in expanding access to quality education.

Globally, online learning has become an essential tool for improving access to education, particularly in remote areas. In Kazakhstan, this is especially relevant due to significant geographic and infrastructural challenges ([Durrani et al., 2024](#)). Rural regions often have limited access to traditional educational resources and qualified teachers. In these contexts, online learning offers an effective way to bridge educational gaps by providing access to quality content and instructors who might otherwise be unavailable. However, Kazakhstan faces challenges such as digital inequality and inconsistent internet access across regions, which can hinder the full effectiveness of online education ([Nagima et al., 2023](#)).

Moreover, studies worldwide have shown that online learning can enhance student engagement through interactive tools such as games, quizzes, and multimedia ([Abuhassna et al., 2020](#); [Stecula & Wolniak, 2022](#)). In Kazakhstan, similar advantages have been noted, particularly for students in urban areas where internet access is more reliable ([Apakhayev et al., 2024](#)). However, for students in rural areas, the lack of robust internet infrastructure remains a critical barrier to accessing these benefits. This digital divide limits the overall effectiveness of online education in Kazakhstan, making it imperative to explore strategies for improving connectivity and digital literacy ([Kerimbayeva et al., 2024](#)).

Moreover, the shift to online education during the COVID-19 pandemic has underscored the potential for online learning to provide a more flexible learning environment, enabling students to learn at their own pace ([Sato et al., 2023](#)). In Kazakhstan, where the educational system rapidly transitioned to online learning during the pandemic, this flexibility was crucial in maintaining educational continuity ([Helmer et al., 2024](#)). However, challenges such as teacher preparedness and the ability to effectively engage students in an online format were significant obstacles ([Darmody et al., 2021](#)). Understanding how these challenges were addressed, or exacerbated, in Kazakhstan is vital for improving the long-term sustainability of online education.

Additionally, online classes tend to be less formal, providing students with a more relaxed environment and reducing stress levels—an aspect that is especially important during tests and quizzes ([Awidi & Paynter, 2019](#)).

Online learning offers a solution for those who face barriers to traditional education, including illness, business trips, distance from educational institutions, or physical disabilities. In such cases, online education provides a viable alternative, enabling individuals to acquire new skills and even gain qualifications that may have otherwise been unattainable (Rhim & Han, 2020).

Quality educational platforms have the capacity to serve a large number of students globally, virtually eliminating the issue of class capacity. Furthermore, online learning platforms can invite experts and instructors from different cities and countries to conduct lectures or master classes, thereby enhancing the prestige and value of the education and diplomas they offer.

Students also benefit from the ability to contact experts in various fields in real time, allowing them to receive immediate responses to questions, which accelerates the learning process. Additionally, many students choose online education because it allows them to save time and money without compromising the quality of instruction or the knowledge gained (Boca, 2021; Guncaga et al., 2022).

Determinants of Job Satisfaction of Teachers

In recent years, the study of work attitudes and job satisfaction has become a central focus in many countries (Harrison et al., 2023; Lopes & Oliveira, 2020). This shift is driven by the recognition that, in modern work environments, job satisfaction is influenced not only by material factors but also by the growing impact of human factors. Job satisfaction is determined by an individual's alignment with the values of their profession, including interest in their work and favorable working conditions (Wartenberg et al., 2023).

Research into job satisfaction has only gained significant attention in recent years, and there is a notable gap in studies, especially in countries with unstable economies, such as Kazakhstan (Toropova et al., 2021; Tajibayeva et al., 2023).

Teaching is a “person-to-person” profession, characterized by emotional intensity and high levels of interpersonal interaction. As such, teachers are more vulnerable to the effects of professional burnout (Wang et al., 2020; Budhathoki, 2021).

The success of a teacher's professional activity is closely tied to their ability to manage various pedagogical challenges, including stressful and emotionally charged situations. It also depends on their flexibility in adapting to dynamic work environments, resilience to emotional and physiological stress, and the presence of effective adaptation and compensation mechanisms. Furthermore, the ability to uphold existential and humanistic values plays a crucial role in maintaining job satisfaction (Benevene et al., 2020; Hoque et al., 2023;).

As research shows, job satisfaction is one of the most crucial factors for enhancing efficiency and productivity. In Kazakhstan, a decrease in job satisfaction among teachers can have significant repercussions on their work performance, leading to negative outcomes such as poor labor discipline, increased turnover, absenteeism, and lack of engagement. These issues are particularly pronounced in a rapidly changing educational environment, where teachers must adapt to new technologies and teaching methods, as seen during the transition

to online education. Such conditions can cause heightened stress and emotional discomfort, limiting teachers' ability to perform effectively (Dicke et al., 2020; Baroudi et al., 2022).

Research has shown that social satisfaction is a vital indicator of quality of life in many countries, and Kazakhstan is no exception. The degree to which teachers feel supported and fulfilled in their work can influence their overall quality of life, which, in turn, impacts the effectiveness of the education system (Barauskaite & Streimikiene, 2021; Iwu et al., 2018).

Additionally, in Kazakhstan, data on teachers' satisfaction with their professional activities provides valuable insights into the challenges faced by the education system, especially in rural and underdeveloped areas (Nurgaliyeva et al., 2025). This information not only helps to identify personnel risks and transformation processes within the education sector but also provides a clearer understanding of teachers' readiness for professional development and their willingness to continue online teaching. Given the specific context of Kazakhstan, with its varying levels of technological infrastructure and regional disparities, monitoring teachers' satisfaction and their adaptation to online learning is crucial for ensuring the sustainability and equity of digital education in the country.

Impact of the Pandemic on Teachers' Perceptions of Student Motivation and Academic Performance

Studies have shown that, during remote learning, the lack of direct interaction and face-to-face communication with teachers often led to decreased motivation and engagement among students (Miethlich et al., 2023). In many regions, including Kazakhstan, access to reliable internet and appropriate devices was a significant issue. Such technological barriers hindered students' full engagement with the curriculum, raising concerns about disparities in academic performance. Teachers also struggled to effectively and accurately assess student progress through online assessments. In an online environment, teachers had to rely on limited data from digital platforms, making it difficult to track student engagement and academic progress (Crisci et al., 2019).

Motivating students during the pandemic became one of the most significant challenges teachers faced. Many teachers reported a considerable decline in students' intrinsic motivation, which is essential for academic success (Bright & Vogler, 2024). The pandemic exacerbated stress for both students and teachers, making it even more difficult to maintain high levels of motivation. Teachers observed that many students struggled with anxiety, both academically and personally. The uncertainty surrounding the pandemic and the challenges of remote learning further contributed to this stress. As a result, students' motivation levels decreased, making it harder for teachers to inspire them to keep up with their studies (Sengar & Pandey, 2024).

Classroom management in the online environment posed a significant challenge for teachers. Many teachers noted that the typical strategies they used in physical classrooms, such as keeping students engaged through group activities or offering individual assistance, were difficult to replicate online (Long et al., 2022). To maintain student engagement, teachers had to quickly adapt their strategies to the online format. However, effectively incorporating these tools into lessons proved challenging, especially for teachers who were less familiar with technology or lacked adequate resources (Ortan et al., 2021).

Government Policies and Support

During the pandemic, governments worldwide, including Kazakhstan, took measures to help teachers transition to online education. A key government initiative was improving technological infrastructure. In countries with large rural populations or underdeveloped regions, like Kazakhstan, limited internet access and outdated devices created major obstacles to online learning (Nurgaliyeva et al., 2024). In response, the government allocated funds to improve internet access, particularly in underserved areas, and to provide digital devices to schools and students. These efforts equipped teachers with essential tools and enabled students to attend online classes with fewer disruptions (Nguyen et al., 2024).

In addition to improving technological infrastructure, governments introduced financial incentives to encourage teachers' involvement in online education. These incentives included stipends, bonuses, and funding for extra hours spent converting traditional classroom content into digital formats. Teachers received compensation for extra time spent creating online materials, interacting with students, and mastering digital platforms. These financial measures helped ease teachers' financial stress during the pandemic and played a key role in maintaining morale (Martin et al., 2024).

Professional development programs were another key element of government support. Teachers had to rapidly adapt to online teaching by acquiring new skills and mastering various digital tools. In response, governments and educational institutions launched training programs and webinars to help teachers develop skills in online assessment, digital classroom management, and virtual pedagogy (Rivera-Vargas et al., 2021). In Kazakhstan, educational bodies offered free online courses to help teachers gain proficiency in virtual learning platforms like Moodle and Zoom (Tlepbergen et al., 2022). These programs eased teachers' technological anxiety and boosted their confidence in delivering effective online education (Schirmer & Lockman, 2022).

Moreover, ongoing professional development programs fostered teachers' professional growth and job satisfaction. Continuous learning opportunities made teachers feel supported and valued. Recognizing their efforts boosted morale and fostered a more positive attitude toward online teaching.

Government support directly influenced teachers' morale and job satisfaction. Despite the challenges of shifting to online learning, many teachers appreciated the tangible support they received. Research has shown that financial incentives, professional development, and improved access to resources can significantly enhance job satisfaction (Maqableh & Alia, 2021). Teachers who received additional training felt more prepared for online teaching and were more open to adopting it as a long-term option.

However, the effectiveness of government policies varied. Teachers with limited technology access or inadequate training often felt overwhelmed and unsupported (Mushtaha et al., 2022). Such disparities influenced teachers' attitudes toward online learning. Teachers lacking sufficient resources or training faced greater challenges transitioning to online education, resulting in higher stress and lower job satisfaction. Conversely, teachers with adequate resources and training were more likely to see online learning as a sustainable and effective approach (Tsai et al., 2021).

Teachers' willingness to continue online learning post-pandemic largely depends on the support they received. Studies show that teachers who felt well-supported by their governments were more likely to adopt online learning long-term (Trust & Whalen, 2021).

Financial incentives, professional development, and improved technology fostered a positive perception of online learning. Conversely, unsupported or unprepared teachers were less likely to continue online education, citing concerns about tool effectiveness and reduced student connection. Government policies, resources, and training were pivotal in shaping teachers' pandemic experiences (Williamson et al., 2020). Government support through technology, training, and financial incentives boosted teacher morale, job satisfaction, and willingness to continue online learning. However, uneven distribution of support influenced teachers' perceptions of online education and their post-pandemic motivation (Ali & Nath, 2023).

Despite extensive global research on online learning during the COVID-19 pandemic, limited evidence exists regarding the Kazakhstani context – particularly concerning how job satisfaction, communication challenges, and different forms of support (governmental, technological, and professional development) influence teachers' willingness to continue online teaching post-pandemic. Building on existing international findings, the present study addresses this gap by examining these relationships using a large sample of Kazakhstani educators. By doing so, it aims to contribute to a better understanding of the specific needs of teachers in Kazakhstan and to inform the development of targeted interventions to support online education in similar contexts. The following section outlines the methodology used to explore these factors in greater detail.

Methods

Study Design

To investigate the underexplored relationships between job satisfaction, communication challenges, and willingness to continue online learning (OL), we conducted a cross-sectional study with school teachers across Kazakhstan. The study aimed to examine the challenges and experiences faced by teachers during the transition to OL due to the COVID-19 pandemic, and to identify key predictors of both their job satisfaction and their intentions to continue using online teaching methods in the future (Maricuțoiu et al., 2023; Paudel et al., 2024). Data were collected using a structured questionnaire developed in Google Forms that was distributed online in May 2021.

Study Participants

The study population consisted of 1205 school teachers from different regions of Kazakhstan. The sample included a significant majority of female teachers (87.1%, $n=1050$). The age of the participants ranged from 19 to 85 years, with a mean age of 39.3 years ($SD=11.9$). The average work experience of participating teachers was 15.4 years ($SD = 11.6$), with values ranging from 0 to 49 years. Participants were recruited from various teaching levels, including primary, middle, and high schools, and represented diverse teaching subjects. Categorizing by teaching subjects, the largest group taught primary school subjects (25.2%), followed by linguistics (33.2%). Geographically, the majority of the participants were from Astana City (36.8%) and North Kazakhstan (29.0%). Regarding additional responsibilities, 59.0% ($n=711$) of the teachers were heads of their classes, while 41.0% ($n=494$) did not hold this position. In terms of family structure, nearly half of the teachers (47.2%) reported not having children under 18 years old. The socio-demographic data of the study participants are presented in Table 2.

Table 2

Study population (N=1,205)

Variable	n	%
Gender		
Male	155	12.9
Female	1,050	87.1
Teaching level		
Primary school	530	44.0
Middle school	392	32.5
High school	283	23.5
Teaching subject		
Primary school subjects	304	25.2
Math and ICT	144	12.0
STEM	123	10.2
Linguistics	400	33.2
History and Low	60	5.0
Sport	79	6.6
Psychology and related	30	2.5
Other	65	5.4
Residence		
Astana City	444	36.8
Almaty City	13	1.1
Central KZ	5	0.4
North KZ	349	29.0
East KZ	38	3.2
South KZ	138	11.5
West KZ	218	18.1
Head of the class		
No	494	41.0
Yes	711	59.0
Having children under 18 years of age		
No	569	47.2
1 child	222	18.4
2-3 children	334	27.7
4-5 children	69	5.7
≥6 children	11	0.9

Data Collection and Measures

Data were collected using a structured questionnaire that was distributed to the participants online. The questionnaire was designed to capture detailed information on the following variables:

- **Socio-demographic characteristics:** gender, age, work experience, teaching level, teaching subject, geographical residence, additional responsibilities (e.g., head of the class), and family structure (e.g., number of children under 18 years old).
- **Challenges faced during OL:** Participants were asked whether they experienced specific challenges in five key areas: technological support, communication with students, communication with colleagues, communication with school administration, and communication with family members. These items were presented as binary

(Yes/No) response options, allowing for the identification of the proportion of teachers who encountered each type of challenge during the transition to OL.

- **Previous experience with OL:** Participants were asked about their prior exposure to online learning before the COVID-19 pandemic. Specifically, they were asked three Yes/No questions regarding whether they had previous experience with OL as a student, as a teacher, and with using educational online resources (e.g., digital platforms, video lessons, or e-learning tools). These items were used to assess teachers' baseline familiarity with online education before the emergency shift to OL during the pandemic.
- **Impact of OL on academic load:** To evaluate how the transition to OL affected workload, participants were asked to assess perceived changes in both their own academic load and that of their students. The response options for each item were "Decreased," "Not changed," or "Increased." These items were designed to capture teachers' subjective experience of workload shifts during the pandemic, both from their perspective and in terms of the demands placed on students.
- **Impact of OL on student motivation:** Participants were asked to report their perceptions of how students' academic motivation changed following the shift to online learning. They were given three response options: "Decreased," "Not changed," or "Increased." This item aimed to capture teachers' observations of student engagement and enthusiasm during the remote learning period, reflecting one of the key factors influencing the effectiveness of online education.
- **Job satisfaction:** Overall job satisfaction and satisfaction with the work of the Ministry of Education and Science during the pandemic were calculated with 11-point satisfaction scale (from 0 – "not satisfied at all" to 10 – "very satisfied").

The questionnaire included both closed- and open-ended questions to allow for quantitative and qualitative analysis. In particular, participants were asked to describe the challenges they faced during the transition to OL in an open-ended format. These responses were then coded and categorized thematically to identify common issues such as internet connectivity problems, lack of equipment, increased workload, and communication difficulties. Out of the total 1,205 participants, 500 teachers provided responses to this open-ended question, which formed the basis for the qualitative analysis presented in Table 1.

Statistical Analysis

Descriptive statistics were used to summarize the socio-demographic characteristics of the participants. Means and standard deviations were calculated for continuous variables, while frequencies and percentages were reported for categorical variables. To explore preliminary associations between various online learning challenges and socio-demographic characteristics, bivariate analyses were conducted using chi-square tests and independent t-tests. These tests helped identify patterns that informed the selection of variables for multivariate analysis. To identify predictors of job satisfaction and willingness to continue with online learning post-pandemic, multiple regression models were applied. Linear regression was used for the continuous outcome variable (job satisfaction), while binomial logistic regression was used for the binary outcome (willingness to continue OL). These models allowed for simultaneous assessment of multiple predictors, controlling for potential confounding variables. Mediation analysis was conducted using the jAMM (jamovi

Advanced Mediation Models) module, which allows for robust estimation of direct and indirect effects (Gallucci, 2020). This module was used to test a parallel mediation model assessing whether challenges in communication with students and colleagues mediated the relationship between job satisfaction and willingness to continue online learning. The analysis was based on standard confidence intervals (CI) to evaluate the indirect effect. The level of significance was set at $p < 0.05$. To reduce the risk of Type I error due to multiple testing in regression models, a Bonferroni correction was applied. Given the inclusion of 33 predictors in the model, the threshold for statistical significance was adjusted from $p < 0.05$ to $p < 0.00152$. Confidence intervals (95%) were reported for all regression and Standard Error (SE) for all mediation estimates to indicate statistical precision. All statistical analyses were performed using Jamovi software (version 2.6.17).

Ethical Considerations

The study was approved by the Ethical Committee of the Academic Council at Abai Kazakh National Pedagogical University, Kazakhstan, on 12 September 2023 (Ref. No. 4). Informed consent was obtained from all participants before they completed the questionnaire. Participants were assured of the confidentiality of their responses and the voluntary nature of their participation.

Based on the methodology described above, the next section presents the key findings related to job satisfaction, communication challenges, and teachers' willingness to continue online learning.

Results

The study explored the challenges and experiences of school teachers during the transition to OL amid the COVID-19 pandemic. Study participants highlighted several key challenges and previous experiences with online education (Table 3).

Table 3

Challenges and Experience of School Teachers in Online Learning During the COVID-19 Pandemic

Challenges	n	%
Challenges in technological support	1104	91.6
Challenges in communication with students	644	53.4
Challenges in communication with colleagues	299	24.8
Challenges in communication with school administration	147	12.2
Challenges in communication with family	334	27.7
Previous experience with OL like a student	226	18.8
Previous experience with OL like a teacher	163	13.5
Previous experience with educational online-resources before pandemic	879	72.9
Probability of educational online-resources usage after pandemic	835	69.3
Agreement to continue work in online format	360	29.9

A vast majority of the teachers (91.6%) reported facing challenges with technological support. More than half of the respondents (53.4%) experienced challenges in communicating with their students during online learning. A substantial portion of teachers (75.2%) indicated they did not face difficulties in communicating with their colleagues, while 24.8% did encounter communication challenges. Moreover, the majority (87.8%) did not have issues

communicating with school administration, while 72.3% of the teachers did not report problems in communicating with their families.

A large majority (86.5%) had no prior experience with teaching online before the pandemic. Moreover, 81.2% of the teachers had no experience with online learning as students. This indicates that most of the teachers had no experience working in the OL format. At the same time, prior to the pandemic, 72.9% of the teachers had used educational online resources.

The study examined the impact of the COVID-19 pandemic on the academic load and motivation of both teachers and students during the switch to online learning (OL). The results are presented in Table 4.

Table 4

Academic Load and Student's Academic Motivation After Switching to Online Learning

Variable	Decreased		Not changed		Increased	
	n	%	n	%	n	%
Teacher's academic load	110	9.1	351	29.1	744	61.7
Student's academic load	493	40.9	373	31.0	339	28.1
Student's academic motivation	710	58.9	191	15.9	304	25.2

The majority of teachers (61.7%, n=744) reported an increase in their academic load after switching to online learning. Teachers who indicated an increased workload had an older age ($F=3.51$, $p=0.031$) and more work experience ($F=4.63$, $p=0.010$). STEM teachers (68.3%) and mathematics and ICT teachers (66.0%) indicated the largest increase in workload, while physical education teachers (46.8%) noted the least ($\chi^2=23.9$, $p=0.047$).

Around forty percent (40.9%) of teachers observed a decrease in their students' academic load, while 28.1% noted an increase in the students' academic load. Teachers of history and law (48.3%), languages (45.3%) and teachers of mathematics and ICT (43.1%) were more likely to note a decrease in the educational load for students. At the same time, an increase in the educational load for schoolchildren was more often noted by teachers-psychologists (43.3%) and STEM teachers (36.6%).

A significant portion of teachers (58.9%) perceived a decrease in students' academic motivation after switching to OL due to the COVID-19 pandemic. This perception was reported more frequently by middle school (63.3%) and primary school teachers (59.2%) than by high school teachers (52.3%; $\chi^2 = 11.0$, $p = 0.027$).

The level of job satisfaction of teachers during the pandemic varied; the average value was 8.23 ± 1.95 . At the same time, the level of satisfaction with the work of the Ministry of Education and Science during the pandemic was significantly lower – 7.52 ± 2.52 ($t=10.8$, $p<0.001$). Predictors of teacher's job satisfaction are presented in Table 5.

Table 5

Predictors of Teacher's Job Satisfaction During the COVID-19 Pandemic (linear regression: $R^2=0.315$, Adjusted $R^2=0.296$, $p<0.001$)

Predictor	Standardized Estimate	95% CI	p
Gender (Female – Male)	-0.042	-0.211 – 0.127	0.628
Age ^a	-0.202	-0.315 – -0.089	<0.001
Work experience	0.072	-0.042 – 0.187	0.214
Teaching subject			
Math & ICT – PSS	-0.239	-0.453 – -0.025	0.029
STEM – PSS	-0.227	-0.460 – 0.006	0.056
Linguistics – PSS	-0.173	-0.340 – -0.005	0.043
History and Low – PSS	-0.126	-0.408 – 0.155	0.379
Sport – PSS	-0.182	-0.448 – 0.084	0.180
Psychology and related – PSS	-0.138	-0.475 – 0.199	0.422
Other – PSS	-0.221	-0.487 – 0.045	0.104
Teaching level			
Middle school – Primary school	0.001	-0.149 – 0.151	0.989
High school – Primary school	-0.031	-0.195 – 0.133	0.711
Residence			
Almaty City – Astana City	0.394	-0.079 – 0.868	0.103
Central KZ – Astana City	0.275	-0.478 – 1.028	0.474
North KZ – Astana City	0.123	-0.002 – 0.248	0.054
East KZ – Astana City	-0.067	-0.351 – 0.217	0.645
South KZ – Astana City	0.081	-0.089 – 0.252	0.348
West KZ – Astana City	0.149	0.000 – 0.297	0.050
Having children <18 y.o.	-0.021	-0.071 – 0.029	0.412
Head of the class (Yes – No)	-0.030	-0.145 – 0.085	0.609
Challenges in technological support (Yes – No)	0.121	-0.054 – 0.297	0.173
Challenges in communication with students (Yes – No)	-0.023	-0.142 – 0.096	0.704
Challenges in communication with colleagues (Yes – No)	0.018	-0.120 – 0.156	0.800
Challenges in communication with school administration (Yes – No)	-0.046	-0.220 – 0.129	0.609
Challenges in communication with family (Yes – No)	-0.031	-0.160 – 0.097	0.631
Previous experience with OL like a student (Yes – No)	0.005	-0.139 – 0.150	0.944
Previous experience with OL like a teacher (Yes – No)	-0.008	-0.172 – 0.155	0.920
Previous experience with educational online-resources before pandemic (Yes – No)	0.004	-0.107 – 0.115	0.946
Probability of educational online-resources usage after pandemic (Yes – No)	-0.139	-0.249 – -0.028	0.014
Changes in the teacher's academic load	0.026	-0.025 – 0.077	0.321
Changes in the student's academic load	-0.012	-0.063 – 0.039	0.641
Changes in the student's academic motivation ^a	0.091	0.039 – 0.145	<0.001
Satisfaction with the work of the Government ^a	0.497	0.446 – 0.549	<0.001

Statistically significant after Bonferroni correction (adjusted alpha = 0.00152)

Note: PSS - Primary School Subjects; CI = Confidence Interval

The results of the linear regression analysis identify several predictors of job satisfaction among school teachers during the COVID-19 pandemic. The model explained a significant portion of the variance in job satisfaction, with $R^2=0.315$. After applying a Bonferroni correction to account for multiple comparisons (adjusted alpha = 0.00152 for 33 predictors), age, changes in students' academic motivation, and satisfaction with the work of the Government remained statistically significant. Thus, there was a significant negative association between age and job satisfaction, indicating that older teachers reported lower job satisfaction. There was a positive association between perceived increases in students' academic motivation and teacher job satisfaction. Moreover, satisfaction with the work of the Government was the strongest predictor of job satisfaction, with higher satisfaction with the government's response significantly associated with higher job satisfaction among teachers. Other predictors, including teaching subject (e.g., Math & ICT and Linguistics), and

probability of using educational online resources post-pandemic, showed nominal significance ($p < 0.05$) but did not remain significant after Bonferroni correction. These findings may still be of interest but should be interpreted with caution. Variables such as gender, work experience, teaching level, having children under 18 years old, being head of the class, challenges in technological support, communication with students, colleagues, school administration, and family, previous experience with online learning (as a student or teacher), and changes in teacher's academic load, were not significantly associated with job satisfaction.

Less than one-third (29.9%) of teachers agreed to continue the OL format after the end of the pandemic (Table 3).

The logistic regression model identified several predictors of teachers' willingness to continue using OL after the pandemic ($R^2_{McF} = 0.194$, $p < 0.001$). After applying a Bonferroni correction to account for multiple comparisons (adjusted $\alpha = 0.00152$), three variables remained statistically significant (Table 6). Teachers who reported fewer difficulties in communication with students were significantly more likely to support the continued use of OL, suggesting that effective student interaction plays a critical role in shaping positive attitudes toward remote education. An increase in students' academic motivation during the pandemic was also associated with a greater likelihood of teachers endorsing online learning post-pandemic. In addition, teachers who indicated a higher probability of using educational online resources in the future were more inclined to support the continuation of OL practices. Other factors, including the presence of children under the age of 18, difficulties in communicating with family members, and satisfaction with the government's response to the pandemic, showed nominal significance at the $p < 0.05$ level, but did not remain statistically significant after correction for multiple testing.

Table 6

Predictors of Teacher's Agreement to Continue Online Learning Format After Pandemic (Binominal Logistic Regression: $R^2_{mcf} = 0.194$, $P < 0.001$)

Predictor	OR	95% CI	p
Gender (Female – Male)	1.008	0.629 – 1.616	0.973
Age	0.993	0.965 – 1.021	0.610
Work experience	1.001	0.972 – 1.030	0.972
Teaching subject			
Math & ICT – PSS	1.045	0.545 – 2.003	0.894
STEM – PSS	1.886	0.958 – 3.712	0.066
Linguistics – PSS	2.135	1.301 – 3.504	0.003
History and Low– PSS	1.887	0.825 – 4.315	0.132
Sport – PSS	1.717	0.806 – 3.658	0.161
Psychology and related – PSS	2.010	0.785 – 5.152	0.146
Other – PSS	2.159	1.021 – 4.568	0.044
Teaching level			
Middle school – Primary school	0.711	0.465 – 1.085	0.114
High school – Primary school	0.881	0.557 – 1.394	0.588
Residence			
Almaty City – Astana City	0.627	0.147 – 2.671	0.528
Central KZ – Astana City	0.000	–	0.970
North KZ – Astana City	0.595	0.409 – 0.867	0.007
East KZ – Astana City	0.681	0.281 – 1.649	0.395
South KZ – Astana City	1.215	0.751 – 1.967	0.427
West KZ – Astana City	0.819	0.524 – 1.280	0.381
Having children <18 y.o.	1.160	1.006 – 1.338	0.041

Head of the class (Yes – No)	0.794	0.569 – 1.107	0.173
Challenges in technological support (Yes – No)	0.776	0.465 – 1.294	0.331
Challenges in communication with students (Yes – No) ^a	0.310	0.220 – 0.438	<0.001
Challenges in communication with colleagues (Yes – No)	0.720	0.449 – 1.153	0.172
Challenges in communication with school administration (Yes – No)	1.249	0.678 – 2.301	0.476
Challenges in communication with family (Yes – No)	0.618	0.401 – 0.952	0.029
Previous experience with OL like a student (Yes – No)	1.234	0.816 – 1.864	0.319
Previous experience with OL like a teacher (Yes – No)	1.297	0.814 – 2.065	0.274
Previous experience with educational online-resources before pandemic (Yes – No)	0.868	0.623 – 1.207	0.400
Probability of educational online-resources usage after pandemic (Yes – No) ^a	1.789	1.264 – 2.532	0.001
Changes in the teacher's academic load	0.899	0.715 – 1.131	0.364
Changes in the student's academic load	1.168	0.968 – 1.411	0.105
Changes in the student's academic motivation ^a	1.444	1.216 – 1.714	<0.001
Satisfaction with the work of the Government	1.085	1.006 – 1.169	0.034
Job Satisfaction during the COVID-19 Pandemic	1.007	0.918 – 1.104	0.885

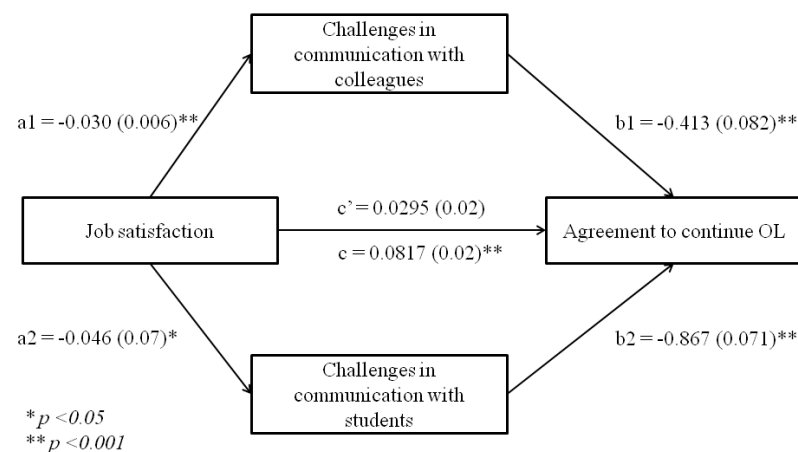
^aStatistically significant after Bonferroni correction (adjusted alpha = 0.00152)

Note: PSS - Primary School Subjects; OR = Odds Ratio; CI = Confidence Interval

Although the regression analysis did not show a link between job satisfaction and the agreement to continue the online learning format, the mediation model revealed a number of interesting results. Thus, the mediation analysis examined the indirect effects of job satisfaction on teachers' agreement to continue OL through challenges in communication with colleagues and students during the COVID-19 pandemic (Figure 1).

Figure 1

Mediation Model: Communication Challenges as a Mediator Between Job Satisfaction and Willingness to Continue Online Learning



The direct effect of job satisfaction on agreement to continue OL format was not significant. Indirect effect [Job satisfaction] → [Challenges in communication with colleagues] → [Agreement to continue OL] was 0.012 (SE = 0.004, 14.9%), $p < 0.001$. Moreover, indirect effect [Job satisfaction] → [Challenges in communication with students] → [Agreement to continue OL] was 0.040 (SE = 0.007, 49.0%), $p < 0.001$. These findings highlight the importance of effective communication in the context of online

learning. Even though job satisfaction did not directly affect teachers' willingness to continue with OL, it played a crucial role in mitigating communication challenges, which in turn influenced their agreement to continue with the online format. The results of the study reveal significant challenges in terms of technological readiness and emotional well-being, which are consistent with previous research ([Van der Spoel et al., 2020](#)). In the following section, these findings are discussed in relation to broader trends in online education during the pandemic, and recommendations for improving teacher satisfaction and readiness for continued online education are provided.

Discussion

The study aimed to understand the scope of the challenges caused by the emergency transition to online learning by examining data on job satisfaction and teachers' willingness to continue online education after the pandemic. A comprehensive analysis of job satisfaction and the readiness of school teachers in Kazakhstan to continue online education after the pandemic provided a holistic view of the issue. The study assessed teachers' satisfaction with their professional activities and their willingness to continue online education post-pandemic based on several factors. This approach allowed for an objective evaluation from teachers across different regions of Kazakhstan.

Key challenges associated with the shift to OL included technical difficulties, internet access issues, inadequate technical resources, a lack of skills among both teachers and students in using various platforms, and insufficient physical space for effective learning. The high percentage of teachers (91.6%) reporting challenges with technological support underscores the critical need for robust infrastructure and comprehensive training in digital tools and platforms. This finding aligns with previous research indicating that inadequate technological support is a significant barrier to effective online teaching ([Shrestha et al., 2022](#); [Yeh & Tsai, 2022](#); [Trust & Whalen, 2021](#)). Moreover, the lack of experience among both teachers and students, coupled with the teachers' unfamiliarity with strategies for engaging different categories of students in a virtual environment, further complicated the transition ([König et al., 2020](#); [Kovacs et al., 2021](#)). Correspondently, the lack of previous online teaching experience (86.5%) and learning experience (81.2%) before the pandemic further hindered the transition period, highlighting the need for continuous professional development in digital pedagogy.

Organizing educational activities in a virtual environment presents a significant challenge. This is due to technology serving as a new mediator of activities, which fundamentally alters the nature of interactions, including those between all participants in the educational process ([Blume, 2020](#); [Delcker & Ifenthaler, 2021](#)). In this study, more than half of the teachers reported difficulty communicating with their students.

Despite some emerging positive changes in learning conditions, the overall level of digital development and the infrastructure of schools likely does not meet either the current demands or the expectations of parents and teachers regarding the appropriate level of material and technical resources. One of the most pronounced issues in the digitalization of general education is the differentiation between institutions based on their access to digital equipment and software. This issue is particularly evident when comparing urban and rural schools, as well as gymnasiums (lyceums) and regular schools.

According to the data obtained, the vast majority of teachers view the pandemic and the shift to online teaching as stressful (DeCoito & Estaiteyeh, 2022; Klapproth, 2020; Lau et al., 2022). The increase in academic workload for teachers (61.7%) after transitioning to OL is concerning, suggesting that the digital shift may have added to the workload rather than reducing it. The transition to OL also had a negative impact on teachers' professional motivation. Many teachers expressed concern that, should education shift fully or partially online in the future, they would prefer to avoid such a scenario.

Naturally, this stressful situation affected the quality of education. Many teachers lacked the necessary technical and pedagogical skills to effectively integrate digital technologies into their teaching practices. To address this, universities quickly organized training sessions for both teachers and students on how to effectively use the university's electronic educational environment, work with the MOODLE system, and utilize other online platforms for learning. However, the online education system was essentially rebuilt "on the fly," which meant that methods for implementing courses were not fully developed. Not all educational materials could be adapted to the online format in such a short time, and opportunities for conducting practical classes were significantly reduced and had to be implemented in alternative formats. These challenges had a negative impact on the overall quality of education (Bergdahl & Nouri, 2021; Mankki, 2022; Kupers et al., 2022).

The issue of professional stress among teachers in OL is not new to psychology. According to a meta-analysis of contemporary international studies, teachers are more susceptible to stress compared to professionals in other fields. Longitudinal studies examining the relationship between professional stress factors and their symptomatic responses, conducted in Australia, Sweden, Finland, the United Kingdom, Israel, and the United States, found that long-term stress in teachers' workplaces is linked to a wide range of affective disorders. This stress lowers self-esteem and job satisfaction, can trigger psychosomatic symptoms, and may even lead to various forms of deviant behavior (Baker et al., 2021; Folkman et al., 2023; Pressley et al., 2021; Robinson et al., 2023).

Several studies have also examined the prevalence and nature of distress and burnout among teachers during specific timeframes, such as the first two months of quarantine restrictions or the initial month after returning to teaching following a lockdown during the COVID-19 pandemic (Birkelund & Karlson, 2023; Engzell et al., 2021). Interestingly, the results of these studies are inconsistent. For instance, a study by American researchers indicated that the majority of teachers did not experience emotional disturbances or increased anxiety after returning to their regular work schedules (DornViruleg et al., 2020; Redding & Nguyen, 2024).

Other data, obtained by Finnish scientists, showed that after returning to normal working conditions during the first few months of the COVID-19 pandemic, teachers experienced high levels of professional stress (Oksanen et al., 2022; Salmela-Aro & Lavonen, 2023;). In a comparative American study examining the impact of changes in working conditions before and during the pandemic (2019–2020, 2020–2021) on school and higher education teachers, it was found that teachers displayed a strong sense of belonging to the professional community and a relatively low level of isolation (Gicheva, 2022; Kraft et al., 2020). The absence of emotional burnout (or its low level) was observed both before and after the pandemic.

Job satisfaction among teachers during emergency situations can be improved by making appropriate adjustments (Dicks et al., 2022). The current study identified several predictors of job satisfaction among teachers during the pandemic, with age, teaching subject, and satisfaction with the government's response being significant factors. The negative association between age and job satisfaction suggests that older teachers may have found the transition more challenging, possibly due to less familiarity with digital tools. The lower satisfaction reported by teachers of Math & ICT and Linguistics compared to those teaching primary school subjects highlights subject-specific challenges in online learning. Satisfaction with the government's response emerged as the strongest predictor of job satisfaction, emphasizing the importance of effective government support and communication during crises. For instance, a study conducted among German teachers found that resource support from colleagues was particularly positively associated with job satisfaction (Stang-Rabrig et al., 2022). Moreover, teachers who perceived an increase in students' academic motivation also reported higher job satisfaction, suggesting that student engagement plays a crucial role in teachers' professional fulfillment, which may also be linked to their sense of self-efficacy (Zakariya & Wardat, 2023).

Less than one-third (29.9%) of teachers expressed a willingness to continue with OL post-pandemic. Significant predictors of this willingness included having children under 18 years of age, challenges in communication with students and families, changes in students' academic motivation, and satisfaction with the government's response. Mediation analysis revealed that job satisfaction, mediated by effective communication, significantly influenced teachers' willingness to continue OL.

Study Limitations

This study has several limitations that should be considered when interpreting the findings. First, the use of a cross-sectional design restricts the ability to make causal inferences. While the statistical methods used, such as regression and mediation analysis, are appropriate for examining associations, they cannot establish temporal relationships between variables. Future research using longitudinal or experimental designs could provide deeper insights into the directionality and long-term impact of the observed relationships. Second, the study relied on self-reported data, which introduces the possibility of several response biases, including social desirability bias, recall bias, and non-response bias. Although the survey was anonymous and pilot-tested to enhance clarity, responses may still reflect participants' perceptions rather than objective realities. Additionally, the lack of triangulation with administrative data or observational methods may limit the reliability of some measures. Third, while the study controlled for a wide range of demographic and professional factors, there may be unmeasured confounding variables, such as school leadership quality, local education policy, or individual personality traits, that could influence both job satisfaction and willingness to continue online learning. The decision to use standard confidence intervals rather than bootstrapped estimates in the mediation analysis may also limit the robustness of those particular findings.

Despite these limitations, the study offers valuable insights into the online teaching experiences of school teachers in Kazakhstan, a context underrepresented in the global literature. The findings underscore the importance of continued investment in technological infrastructure, targeted professional development, peer collaboration, and transparent government support. Future research should consider mixed-methods approaches to capture both the measurable outcomes and lived experiences of teachers. Exploring the impact of online learning on student outcomes, as well as differences across subjects, grade levels, and

school environments, would further enrich the understanding needed for effective policy development.

Recommendations

To address the challenges faced by teachers in Kazakhstan during the transition to online learning (OL) and to inform the development of more sustainable online education practices, several interconnected strategies should be considered. These recommendations draw on the correlational findings of the present study and are supported by relevant literature.

First, enhancing technological infrastructure and providing ongoing training are crucial steps. Given that a large proportion of teachers (91.6%) reported technological difficulties, improving internet connectivity, particularly in rural regions, is essential to reducing barriers to participation in online education (Bhandari, 2020). In parallel, ensuring that teachers have access to necessary digital devices and timely technical support can help address common challenges related to digital equity (Ezra et al., 2021). Furthermore, as the majority of teachers in this study (86.5%) had limited prior experience with online learning, continuous professional development focused on digital pedagogy would likely be beneficial, supporting teachers' confidence and competence in virtual environments (Ramli et al., 2024).

Supporting communication and collaboration is another important focus area. More than half of the teachers reported difficulties in communicating with students, suggesting a need for strategies such as regular check-ins and virtual office hours to strengthen teacher-student interaction (McTigue et al., 2023). In addition, developing structured peer support networks can foster collaboration among teachers, which has been shown to enhance well-being and job satisfaction (Wu et al., 2025).

Addressing increased workload and emotional stress is also essential. Our study identified associations between age, increased workload, and job satisfaction, with 61.7% of teachers reporting an increased workload. While causality cannot be inferred, monitoring and managing workload expectations could help alleviate stress, particularly among older educators (Hongsa & Polyong, 2024). In line with this, providing mental health support through counseling services or stress-reduction programs may help mitigate the emotional strain some teachers experienced during the pandemic (Beames et al., 2023).

Fostering student motivation and engagement should also be prioritized. Teachers in this study perceived a decline in student motivation (58.9%), suggesting the need to incorporate more interactive teaching methods, such as gamification and collaborative learning approaches, to maintain student interest and participation (Nadeem et al., 2023). Additionally, involving parents more actively in the online learning process, despite not being a primary focus of this study, has been highlighted in previous research as a valuable strategy to support student engagement and learning outcomes (Ilmanto et al., 2021).

Finally, improving government support and educational policies appears to be a critical factor. Satisfaction with the government's pandemic response emerged as the strongest predictor of teacher job satisfaction in our model, highlighting the importance of transparent and supportive policies to promote teacher morale and trust (Glaveli et al., 2024). Moreover, as only 29.9% of teachers expressed willingness to continue online learning after the pandemic, introducing financial incentives or career development opportunities may

encourage greater adoption and integration of online learning into future teaching practice (Najjar et al., 2025).

These recommendations are based on correlational findings and should be interpreted with caution, as no causal relationships can be inferred from this study. Nonetheless, they provide a foundation for further research, discussion, and policy development aimed at supporting teachers and enhancing the sustainability of online education in Kazakhstan.

Conclusion

This study highlights the multifaceted challenges faced by school teachers in Kazakhstan during the transition to OL amid the COVID-19 pandemic. Addressing technological and communication barriers, managing increased workloads, and enhancing job satisfaction are critical for improving the effectiveness and sustainability of OL. Policymakers and educational leaders must consider these factors when designing support systems and professional development programs for teachers to better prepare for potential future disruptions.

Although this study is situated within the context of Kazakhstan, its implications extend beyond national borders. Many education systems in resource-constrained or post-Soviet settings face comparable challenges, particularly in terms of digital readiness, teacher support, and policy gaps. The patterns identified in this study, such as the role of job satisfaction, communication barriers, and government support, may inform cross-national efforts to strengthen the sustainability of online learning.

Declarations

Ethics approval consent to participate: The study was approved by the Ethical Committee of the Academic Council, Abai Kazakh National Pedagogical University, Kazakhstan (Ref. No. 1, 12 February 2021).

Availability of data and materials: All data available by request to corresponding author.

Competition and conflicts: The authors declare that they have neither competing interests nor conflicts of interest related to this study.

Funding: This research has been funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19677837).

References

- Abuhassna, H., Al-Rahmi, W. M., Yahya, N., Zakaria, M. A. Z. M., Kosnin, A. B. M., & Darwish, M. (2020). Development of a new model on utilizing online learning platforms to improve students' academic achievements and satisfaction. *International Journal of Educational Technology in Higher Education*, 17, 1-23. <https://doi.org/10.1186/s41239-020-00216-z>
- Adam, T. B., & Metljak, M. (2022). Experiences in distance education and practical use of ICT during the COVID-19 epidemic of Slovenian primary school music teachers with different professional experiences. *Social Sciences & Humanities Open*, 5(1), 100246. <https://doi.org/10.1016/j.ssaho.2021.100246>
- Ali, R., & Nath, S. (2023). Pre-service teachers' experiences of remote online learning: Reimagining teacher education post-pandemic. *Educational Research*, 65(3), 337-356. <https://doi.org/10.1080/00131881.2023.2223645>
- Amirova, A., Nurumov, K., Kasa, R., Akhmetzhanova, A., & Kuzekova, A. (2023). The impact of the digital divide on synchronous online teaching in Kazakhstan during COVID-19 school closures. *In Frontiers in Education*, 7, 1083651. <https://doi.org/10.3389/educ.2022.1083651>
- Apakhayev, N., Mussabekova, I., Bugybay, D., Kuandykov, K., & Koishybaiuly, K. (2024). Distance learning technologies and their legal regulation in the Republic of Kazakhstan. *E-Learning and Digital Media*, 20427530241231842. <https://doi.org/10.1177/20427530241231>
- Avci, N. (2023). Is there anybody out there? Insights into teachers' emergency remote teaching experiences. *Journal of Qualitative Research in Education*, (34). <https://doi.org/10.14689/enad.34.807>
- Awidi, I. T., & Paynter, M. (2019). The impact of a flipped classroom approach on student learning experience. *Computers & Education*, 128, 269-283. <https://doi.org/10.1016/j.compedu.2018.09.013>
- Baker, C. N., Peele, H., Daniels, M., Saybe, M., Whalen, K., Overstreet, S., & The New Orleans, T. I. S. L. C. (2021). The experience of COVID-19 and its impact on teachers' mental health, coping, and teaching. *School Psychology Review*, 50(4), 491-504. <https://doi.org/10.1080/2372966X.2020.1855473>
- Barrot, J. S., Llenares, I. I., & Del Rosario, L. S. (2021). Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. *Education and Information Technologies*, 26(6), 7321-7338. <https://doi.org/10.1007/s10639-021-10589-x>
- Baroudi, S., Tamim, R., & Hojeij, Z. (2022). A quantitative investigation of intrinsic and extrinsic factors influencing teachers' job satisfaction in Lebanon. *Leadership and Policy in Schools*, 21(2), 127-146. <https://doi.org/10.1080/15700763.2020.1734210>
- Barauskaite, G., & Streimikiene, D. (2021). Corporate social responsibility and financial performance of companies: The puzzle of concepts, definitions and assessment

- methods. *Corporate Social Responsibility and Environmental Management*, 28(1), 278-287. <https://doi.org/10.1002/csr.2048>
- Beames, J. R., Spanos, S., Roberts, A., McGillivray, L., Li, S., Newby, J. M., ... & Werner-Seidler, A. (2023). Intervention programs targeting the mental health, professional burnout, and/or wellbeing of school teachers: Systematic review and meta-analyses. *Educational Psychology Review*, 35(1), 26. <https://doi.org/10.1007/s10648-023-09720-w>
- Benevene, P., De Stasio, S., & Fiorilli, C. (2020). Well-being of school teachers in their work environment. *Frontiers in Psychology*, 11, 1239. <https://doi.org/10.3389/fpsyg.2020.01239>
- Bergdahl, N., & Nouri, J. (2021). Covid-19 and crisis-prompted distance education in Sweden. *Technology, Knowledge and Learning*, 26(3), 443-459. <https://doi.org/10.1007/s10758-020-09470-6>
- Berikkhanova, A., Sapargaliyeva, B., Ibraimova, Z., Sarsenbayeva, L., Assilbayeva, F., Baidildinova, D., & Wilson, E. (2023). Conceptualising the integration of action research into the practice of teacher education universities in Kazakhstan. *Education Sciences*, 13(10), 1034. <https://doi.org/10.3390/educsci13101034>
- Bhandari, V. (2020). Improving internet connectivity during COVID-19. *Digital pathways at Oxford paper series*, 4. <https://doi.org/10.2139/ssrn.3688762>
- Birkelund, J. F., & Karlson, K. B. (2023). No evidence of a major learning slide 14 months into the COVID-19 pandemic in Denmark. *European Societies*, 25(3), 468-488. <https://doi.org/10.1080/14616696.2022.2129085>
- Birmingham, W. C., Wadsworth, L. L., Lassetter, J. H., Graff, T. C., Lauren, E., & Hung, M. (2023). COVID-19 lockdown: Impact on college students' lives. *Journal of American College Health*, 71(3), 879-893. <https://doi.org/10.1080/07448481.2021.1909041>
- Blikstad-Balas, M., Roe, A., Dalland, C. P., & Klette, K. (2022). Homeschooling in Norway during the pandemic-digital learning with unequal access to qualified help at home and unequal learning opportunities provided by the school. *Primary and secondary education during COVID-19: Disruptions to educational opportunity during a pandemic*, 177-201. https://doi.org/10.1007/978-3-030-81500-4_7
- Blume, C. (2020). German teachers' digital habitus and their pandemic pedagogy. *Postdigital Science and Education*, 2(3), 879-905. <https://doi.org/10.1007/s42438-020-00174-9>
- Boca, G. D. (2021). Factors influencing students' behavior and attitude towards online education during COVID-19. *Sustainability*, 13(13), 7469. <https://doi.org/10.3390/su13137469>
- Bolatov, A. K., Seisembekov, T. Z., Askarova, A. Z., Baikanova, R. K., Smailova, D. S., & Fabbro, E. (2021). Online-learning due to COVID-19 improved mental health among medical students. *Medical Science Educator*, 31(1), 183-192. <https://doi.org/10.1007/s40670-020-01165-y>

- Bolliger, D. U., & Martin, F. (2018). Instructor and student perceptions of online student engagement strategies. *Distance Education*, 39(4), 568-583. <https://doi.org/10.1080/01587919.2018.1520041>
- Bondie, R. (2023). Exploring personalized learning and open education pedagogy in multilingual learner teacher preparation. *Online Learning*, 27(4), 315-347. <https://doi.org/10.24059/olj.v27i4.4018>
- Brammer, S. E., & Punyanunt-Carter, N. M. (2022). Getting the attention of online learners. *Communication Education*, 71(2), 155-157. <https://doi.org/10.1080/03634523.2021.2022732>
- Bright, K., & Vogler, J. S. (2024). Learning online vs. learning in person: A mixed-methods approach to understanding how student preferences and perceptions have evolved since the pandemic. *Online Learning*, 28(4), 56-78. DOI: <https://doi.org/10.24059/olj.v28i4.4565>
- Bubb, S., & Jones, M.-A. (2020). Learning from the COVID-19 home-schooling experience: Listening to pupils, parents/carers and teachers. *Improving Schools*, 23(3), 209-222. <https://doi.org/10.1177/1365480220958797>
- Budhathoki, J. K. (2021). Teachers' satisfaction: Implications for job performance. *Interdisciplinary Research in Education*, 6(2), 79-88. <https://doi.org/10.3126/ire.v6i2.43540>
- Burakanova, G. M., Orazgaliyeva, A. G., & Pinaev, S. M. (2021). Psychological, pedagogical, and digital aspects of distance learning in Kazakhstan in the context of the COVID-19 pandemic. In *SHS Web of Conferences*, 113, 00021. <https://doi.org/10.1051/shsconf/202111300021>
- Burmistrova, V., & Makoelle, T. M. (2023). Change from face-to-face teaching and learning to online learning: A case of a cross-sectional study in a Kazakhstani medical University. *Cogent Education*, 10(2), 2282800. <https://doi.org/10.1080/2331186X.2023.2282800>
- Carroll, M., & Constantinou, F. (2023). Teachers' experiences of teaching during the COVID-19 pandemic. *Research Report. Cambridge University Press & Assessment*. <https://www.cambridge.org/>
- Chaleila, W. A., Qadan, I., Abu Touma, L., Habayeb, H., Assaly, I., Atamna, U., Massarwe, A. (2024). Online learning anxiety and academic self-efficacy during COVID-19 crisis. *Online Learning*, 28(2), 1–21. <https://doi.org/10.24059/olj.v28i2.3428>
- Clark, T., & Barbour, M. K. (2015). Online, blended, and distance education in schools: An introduction. In *Online, blended, and distance education in schools*, 3-10. Routledge. <https://doi.org/10.4324/9781003446194>
- Coman, C., Țîru, L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: Students' perspective. *Sustainability*, 12(24), 10367. <https://doi.org/10.3390/su122410367>

- Crisci, A., Sepe, E., & Malafronte, P. (2019). What influences teachers' job satisfaction and how to improve, develop and reorganize the school activities associated with them. *Quality & Quantity*, 53(5), 2403-2419. <https://doi.org/10.1007/s11135-018-0749-y>
- Darmody, M., Smyth, E., & Russell, H. (2021). Impacts of the COVID-19 control measures on widening educational inequalities. *YOUNG*, 29(4), 366-380. <https://doi.org/10.1177/11033088>
- DeCoito, I., & Estaiteyeh, M. (2022). Transitioning to online teaching during the COVID-19 pandemic: An exploration of STEM teachers' views, successes, and challenges. *Journal of Science Education and Technology*, 31(3), 340-356. <https://doi.org/10.1007/s10956-022-09958-z>
- Delcker, J., & Ifenthaler, D. (2021). Teachers' perspective on school development at German vocational schools during the Covid-19 pandemic. *Technology, Pedagogy and education*, 30(1), 125-139. <https://doi.org/10.1080/1475939X.2020.1857826>
- Dicke, T., Marsh, H. W., Parker, P. D., Guo, J., Riley, P., & Waldeyer, J. (2020). Job satisfaction of teachers and their principals in relation to climate and student achievement. *Journal of Educational Psychology*, 112(5), 1061-1073. <https://doi.org/10.1037/edu0000409>
- Dicks, T., Eggert, V., Köstner, C., Beutel, T., Kalo, K., Zähme, C., ... & Dietz, P. (2022). Predictors of job satisfaction among German teachers during the SARS-CoV-2 pandemic. *European Journal of Public Health*, 32, 131-272. <https://doi.org/10.1093/eurpub/ckac131.272>
- Dhawan, S. (2020). Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems*, 49(1), 5-22. <https://doi.org/10.1177/0047239520934018>
- Dorn, E., Hancock, B., Sarakatsannis, J., & Viruleg, E. (2020). COVID-19 and student learning in the United States: The hurt could last a lifetime. *McKinsey & Company*, 1, 1-9. https://www.childrensinstitute.net/sites/default/files/documents/COVID-19-and-student-learning-in-the-United-States_FINAL.pdf
- Du Plessis, A. E., Küng, E., & du Plessis, E. (2024). Challenges for pedagogical effectiveness in an ever-changing education landscape: Conceptualisation of pedagogical mobility and flexibility as a context-consciousness. *Education Sciences*, 14(4), 349. <https://doi.org/10.3390/educsci14040349>
- Durrani, N., Makhmetova, Z., Kadyr, Y., & Karimova, N. (2024). Leading schools during a global crisis: Kazakhstani school leaders' perspectives and practices. *Sage Open*, 14(2), 21582440241251606. <https://doi.org/10.1177/21582440241251606>
- Durrani, N., Qanay, G., Mir, G., Helmer, J., Polat, F., Karimova, N., & Temirbekova, A. (2023). Achieving SDG 4, Equitable quality education after COVID-19: Global evidence and a case study of Kazakhstan. *Sustainability*, 15(20), 14725. <https://doi.org/10.3390/su152014725>
- Engzell, P., Frey, A., & Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences*, 118(17), e2022376118. <https://doi.org/10.1073/pnas.2022376118>

- Ezra, O., Cohen, A., Bronshtein, A., Gabbay, H., & Baruth, O. (2021). Equity factors during the COVID-19 pandemic: Difficulties in emergency remote teaching (ert) through online learning. *Education and Information Technologies*, 26(6), 7657-7681. <https://doi.org/10.1007/s10639-021-10632-x>
- Folkman, A. K., Josefsson, K. A., & Fjetland, K. J. (2023). Norwegian teachers' experiences with distance teaching and online schooling during the COVID-19 pandemic. *Scandinavian Journal of Educational Research*, 67(3), 447-462. <https://doi.org/10.1080/00313831.2021.2021445>
- Gallucci, M. (2020). jAMM: jamovi Advanced Mediation Models. [jamovi module]. <https://jamovi-amm.github.io/>.
- Gicheva, D. (2022). Teachers' working hours during the COVID-19 pandemic. *Educational Researcher*, 51(1), 85-87. <https://doi.org/10.3102/0013189X211056897>
- Glaveli, N., Manolitzas, P., Tsourou, E., & Grigoroudis, E. (2024). Unlocking teacher job satisfaction during the COVID-19 pandemic: a multi-criteria satisfaction analysis. *Journal of the Knowledge Economy*, 15(1), 1264-1285. <https://doi.org/10.1007/s13132-023-01124-z>
- Goudarzi, E., Hasanvand, S., Raoufi, S., & Amini, M. (2023). The sudden transition to online learning: Teachers' experiences of teaching during the COVID-19 pandemic. *PloS One*, 18(11), e0287520. <https://doi.org/10.1371/journal.pone.0287520>
- Guncaga, J., Lopuchova, J., Ferdianova, V., Zacek, M., & Ashimov, Y. (2022). Survey on online learning at universities of Slovakia, Czech Republic and Kazakhstan during the COVID-19 pandemic. *Education Sciences*, 12(7), 458. <https://doi.org/10.3390/educsci12070458>
- Harrison, M. G., King, R. B., & Wang, H. (2023). Satisfied teachers are good teachers: The association between teacher job satisfaction and instructional quality. *British Educational Research Journal*, 49(3), 476-498. <https://doi.org/10.1002/berj.3851>
- Hawkrigde, D. (2022). *New information technology in education*. Routledge. <https://doi.org/10.4324/9781003312826>
- Hajar, A., & Karakus, M. (2024). Throwing light on fee-charging tutoring during the global pandemic in Kazakhstan: Implications for the future of higher education. *Asia Pacific Education Review*, 25(2), 313-325. <https://doi.org/10.1007/s12564-023-09831-7>
- Helmer, J., Durrani, N., Mir, G., Polat, F., Karimova, N., & Qanay, G. (2024). Navigating homeschooling, parenting, and work during an educational emergency: Insights from Kazakhstan. *Sage Open*, 14(4). <https://doi.org/10.1177/2158244024130744>
- Hoque, K. E., Wang, X., Qi, Y., & Norzan, N. (2023). The factors associated with teachers' job satisfaction and their impacts on students' achievement: A review (2010–2021). *Humanities and Social Sciences Communications*, 10(1), 1-7. <https://doi.org/10.1057/s41599-023-01645-7>
- Hongsa, T., & Polyong, C. P. (2024). Prevalence and factors associated with sickness presenteeism among Thai and foreign teachers following the end of COVID-19 public

- health emergency of international concern. *Korean Journal of Family Medicine*, 45(6), 337–345. <https://doi.org/10.4082/kjfm.23.0224>
- Hosseinzadeh, P., Zareipour, M., Baljani, E., & Moradali, M. R. (2022). Social consequences of the COVID-19 pandemic. A systematic review. *Investigacion y educacion en enfermeria*, 40(1), e10. <https://doi.org/10.17533/udea.iee.v40n1e10>
- Ilmanto, A. H., Fahyuni, E. F., & Harahap, A. (2021). The problems of online learning: The role of parents during the Covid-19 pandemic. *Nazhruna: Jurnal Pendidikan Islam*, 4(2), 284-293. <https://doi.org/10.31538/nzh.v4i2.1471>
- Jackson, D. (2015). Employability skill development in work-integrated learning: Barriers and best practice. *Studies in Higher education*, 40(2), 350-367. <https://doi.org/10.1080/03075079.2013.842221>
- Karstina, S. G. (2021). Educators training in the context of socio-economic and technological trends of Kazakhstan. In *Educating Engineers for Future Industrial Revolutions: Proceedings of the 23rd International Conference on Interactive Collaborative Learning (ICL2020)*, 2 (23), 68-75. Springer, Cham. https://doi.org/10.1007/978-3-030-68201-9_7
- Kerimbayeva, B. T., Niyazova, G. Z., Meirbekov, A. K., Kibishov, A. T., & Usembayeva, I. B. (2024). A network communicative culture for future teachers: development of digital literacy and communicative competence. *Cogent Education*, 11(1), 2363678. <https://doi.org/10.1080/2331186X.2024.2363678>
- Klapproth, F., Federkeil, L., Heinschke, F., & Jungmann, T. (2020). Teachers' experiences of stress and their coping strategies during COVID-19-induced distance teaching. *Journal of Pedagogical Research*, 4(4), 444-452. <https://doi.org/10.33902/JPR.2020062805>
- Kolber, M. (2023). Learned helplessness of secondary-school students learning English during COVID-19 distance education: A research report. *Multidisciplinary Journal of School Education*, 12(2 (24), 105-123. <https://doi.org/10.35765/mjse.2023.1224.05>
- König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education*, 43(4), 608-622. <https://doi.org/10.1080/02619768.2020.1809650>
- Kovacs, H., Pulfrey, C., & Monnier, E. C. (2021). Surviving but not thriving: Comparing primary, vocational and higher education teachers' experiences during the COVID-19 lockdown. *Education and Information Technologies*, 26(6), 7543-7567. <https://doi.org/10.1007/s10639-021-10616-x>
- Kraft, M. A., Simon, N. S., & Lyon, M. A. (2020). *Sustaining a sense of success: The importance of teacher working conditions during the COVID-19 pandemic* (EdWorkingPaper No. 20-279). Annenberg Institute for School Reform at Brown University. <https://doi.org/10.26300/35nj-v890>
- Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020). Projecting the potential impact of COVID-19 school closures on academic achievement. *Educational Researcher*, 49(8), 549-565. <https://doi.org/10.3102/0013189X20965918>

- Kupers, E., Mouw, J. M., & Fokkens-Bruinsma, M. (2022). Teaching in times of COVID-19: A mixed-method study into teachers' teaching practices, psychological needs, stress, and well-being. *Teaching and Teacher Education*, 115, 103724. <https://doi.org/10.1016/j.tate.2022.103724>
- Lau, S. S. S., Shum, E. N. Y., Man, J. O. T., Cheung, E. T. H., Amoah, P. A., Leung, A. Y. M., Okan, O., & Dadaczynski, K. (2022). Teachers' well-being and associated factors during the COVID-19 pandemic: A cross-sectional study in Hong Kong, China. *International Journal of Environmental Research and Public Health*, 19(22), 14661. <https://doi.org/10.3390/ijerph>
- Leach, M., MacGregor, H., Scoones, I., & Wilkinson, A. (2021). Post-pandemic transformations: How and why COVID-19 requires us to rethink development. *World Development*, 138, 105233. <https://doi.org/10.1016/j.worlddev.2020.105233>
- Lepp, L., Aaviku, T., Leijen, Ä., Pedaste, M., & Saks, K. (2021). Teaching during COVID-19: The decisions made in teaching. *Education Sciences*, 11(2), 47. <https://doi.org/10.3390/educsci11020047>
- Long, E., Patterson, S., Maxwell, K., Blake, C., Pérez, R. B., Lewis, R., ... & Mitchell, K. R. (2022). COVID-19 pandemic and its impact on social relationships and health. *J Epidemiol Community Health*, 76(2), 128-132. <https://doi.org/10.1136/jech-2021-216690>
- Lopes, J., & Oliveira, C. (2020). Teacher and school determinants of teacher job satisfaction: A multilevel analysis. *School Effectiveness and School Improvement*, 31(4), 641-659. <https://doi.org/10.1080/09243453.2020.1764593>
- Iwu, C. G., Ezeuduji, I. O., Iwu, I. C., Ikebuaku, K., & Tengeh, R. K. (2018). Achieving quality education by understanding teacher job satisfaction determinants. *Social Sciences*, 7(2), 25. <https://doi.org/10.3390/socsci7020025>
- Maqableh, M., & Alia, M. (2021). Evaluation online learning of undergraduate students under lockdown amidst COVID-19 Pandemic: The online learning experience and students' satisfaction. *Children and Youth Services Review*, 128, 106160. <https://doi.org/10.1016/j.childyouth.2021.106160>
- Mankki, V. (2022). Primary teachers' principles for high-quality distance teaching during covid-19. *Scandinavian Journal of Educational Research*, 66(5), 852-864. <https://doi.org/10.1080/00313831.2021.1939141>
- Maricuțoiu, L. P., Pap, Z., Ștefancu, E., Mladenovici, V., Valache, D. G., Popescu, B. D., ... & Virgă, D. (2023). Is teachers' well-being associated with students' school experience? A meta-analysis of cross-sectional evidence. *Educational Psychology Review*, 35(1), 1. <https://doi.org/10.1007/s10648-023-09721-9>
- Martin, F., & Bolliger, D. U. (2018P). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning Journal*, 22(1), 205–222. <https://doi.org/10.24059/olj.v22i1.1092>
- Martin, F., Kumar, S., Ritzhaupt, A., & Polly, D. (2024). Bichronous online learning: Perspectives, best practices, benefits, and challenges from award-winning online instructors. *Online Learning*, 28(2), n2. <https://doi.org/10.24059/olj.v28i2.3945>

- McTigue, E. M., Gourvennec, A. F., Solheim, O. J., & Jensen, M. T. (2023). Co-teaching implementation: How do school leaders support teachers? *Education Sciences*, 13(12), 1197. <https://doi.org/10.3390/educsci13121197>
- Miao, D., Zhu, M., Zhou, Z., & Zhang, N. (2023). How school closures affected learning and the physical and mental health of Chinese university students during the COVID-19 pandemic?. *Building and Environment*, 242, 110582. <https://doi.org/10.1016/j.buildenv.2023.110582>
- Miethlich, B., Beliakova, M., Voropaeva, L., Ustyuzhina, O., & Yurieva, T. (2023). Internal corporate policy: CSR and employee satisfaction. *Employee Responsibilities and Rights Journal*, 35(1), 127-141. <https://doi.org/10.1007/s10672-022-09406-5>
- Mushtaha, E., Dabous, S. A., Alsyounf, I., Ahmed, A., & Abdraboh, N. R. (2022). The challenges and opportunities of online learning and teaching at engineering and theoretical colleges during the pandemic. *Ain Shams Engineering Journal*, 13(6), 101770. <https://doi.org/10.1016/j.asej.2022.101770>
- Nadeem, M., Oroszlanyova, M., & Farag, W. (2023). Effect of digital game-based learning on student engagement and motivation. *Computers*, 12(9), 177. <https://doi.org/10.3390/computers12090177>
- Nagima, B., Saniya, N., Gulden, Y., Saule, Z., Aisulu, S., & Nazigul, M. (2022). Influence of special learning technology on the effectiveness of pedagogical ethics formation in future teachers. *Journal of Education and E-Learning Research*, 10(1), 1-6. <https://doi.org/10.20448/jeelr.v10i1.4313>
- Najjar, N., Roupheal, M., Bitar, T., & Hleihel, W. (2025). The rise and drop of online learning: adaptability and future prospects. *Frontiers in Education*, 10, 1522905. <https://doi.org/10.3389/educ.2025.1522905>
- Nurgaliyeva, S., Bolatov, A., Abildina, S., Zeinolla, S., Kurbonova, B., & Kyyakbayeva, U. (2024). COVID-19 online learning challenges: Kazakhstan secondary schools case study. *Frontiers in Education*, 9, p. 1448594. <https://doi.org/10.3389/educ.2024.1448594>
- Nurgaliyeva, S., Zeinolla, S., Aben, A., Iskenderova, S., Ismukhanova, G. (2025). Kazakhstan's universities: global challenges and local duties improving education quality. *International Journal of Evaluation and Research in Education*, 14(1), 768–776. <http://doi.org/10.11591/ijere.v14i1.31852>
- Nugroho, A., Ilmiani, D., & Rekha, A. (2020). EFL teachers' challenges and insights of online teaching amidst global pandemic. *Metathesis: Journal of English Language, Literature, and Teaching*, 4(3), 277-291. <https://doi.org/10.31002/metathesis.v4i3.3195>
- Nguyen, T. T. T., Vilppu, H., Södervik, I., & Murtonen, M. (2024). The effect of a short online pedagogical course on university teachers' conceptions of learning and engaging students during lectures. *Online Learning*, 28(2). <https://doi.org/10.24059/olj.v28i2.3695>
- Oksanen, A., Oksa, R., Celuch, M., Cvetkovic, A., & Savolainen, I. (2022). COVID-19 anxiety and wellbeing at work in Finland during 2020-2022: A 5-wave longitudinal

- survey study. *International Journal of Environmental Research and Public Health*, 20(1), 680. <https://doi.org/10.3390/ijerph20010680>
- Ortan, F., Simut, C., & Simut, R. (2021). Self-efficacy, job satisfaction and teacher well-being in the K-12 educational system. *International Journal of Environmental Research and Public Health*, 18(23), 12763. <https://doi.org/10.3390/ijerph182312763>
- Panigrahi, R., Srivastava, P. R., & Sharma, D. (2018). Online learning: Adoption, continuance, and learning outcome—A review of literature. *International Journal of Information Management*, 43, 1-14. <https://doi.org/10.1016/j.ijinfomgt.2018.05.005>
- Paul, J., & Jefferson, F. (2019). A comparative analysis of student performance in an online vs. face-to-face environmental science course from 2009 to 2016. *Frontiers in Computer Science*, 1, 472525. <https://doi.org/10.3389/fcomp.2019.00007>
- Paudel, N. R., Kc, P., Ghimire, R., Nygård, C. H., & Neupane, S. (2024). Occupational burnout and their determinants among schoolteachers in Nepal: A cross-sectional study. *BMC psychiatry*, 24(1), 472. <https://doi.org/10.1186/s12888-024-05923-9>
- Pawan, F., Sankaranarayanan, R., Myers, R., & Miao, D. (2021). Learning presence and the reconceptualization of language and literacy teachers' online professional development. *Online Learning*, 25(4), 49-73. DOI: <https://doi.org/10.24059/olj.v25i4.2888>
- Petek, D., Zakarija-Grković, I., Stepanović, A., Tomićić, M., Adžić, Z. O., Cerovečki, V., Švab, I., & Homar, V. (2023). Transitioning from face-to-face to distance education. Part 2: A qualitative study in the former Yugoslavia during COVID-19. *European Journal of General Practice*, 29(1), 2283834. <https://doi.org/10.1080/13814788.2023.2283834>
- Pietrabissa, G., & Simpson, S. G. (2020). Psychological consequences of social isolation during COVID-19 outbreak. *Frontiers in Psychology*, 11, 2201. <https://doi.org/10.3389/fpsyg.2020.02201>
- Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, 8(1), 133-141. <https://doi.org/10.1177/23476311209834>
- Pressley, T., Ha, C., & Learn, E. (2021). Teacher stress and anxiety during COVID-19: An empirical study. *School Psychology*, 36(5), 367-376. <https://doi.org/10.1037/spq0000468>
- Ramli, A. F., Rasul, M. S., & Omar, M. (2024). Issues and challenges in the implementation of professional development programs for design and technology teachers. *International Journal of Learning, Teaching and Educational Research*, 23(7), 64-83. <https://doi.org/10.26803/ijlter.23.7.4>
- Redding, C., & Nguyen, T. D. (2024). Teacher working conditions and dissatisfaction before and during the COVID-19 pandemic. *Educational Researcher*, 53(4), 233-244. <https://doi.org/10.3102/0013189X241232657>
- Rivera-Vargas, P., Anderson, T., & Cano, C. A. (2021). Exploring students' learning experience in online education: Analysis and improvement proposals based on the

- case of a Spanish open learning university. *Educational Technology Research and Development*, 69(6), 3367-3389. <https://doi.org/10.1007/s11423-021-10045-0>
- Rhim, H. C., & Han, H. (2020). Teaching online: Foundational concepts of online learning and practical guidelines. *Korean Journal of Medical Education*, 32(3), 175–183. <https://doi.org/10.3946/kjme.2020.171>
- Robinson, L. E., Valido, A., Drescher, A., Woolweaver, A. B., Espelage, D. L., LoMurray, S., Long, A. C. J., Wright, A. A., & Dailey, M. M. (2023). Teachers, stress, and the COVID-19 pandemic: A qualitative analysis. *School Mental Health*, 15(1), 78–89. <https://doi.org/10.1007/s12310-022-09533-2>
- Salmela-Aro, K., & Lavonen, J. (2023). The switch to distance teaching and learning in Finland during the COVID-19 pandemic (2020–2022) went technically well but was emotionally challenging. In: Reimers, F.M. (eds) *Schools and Society During The Covid-19 Pandemic: How Education Systems Changed And The Road Ahead*, 63-83. Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-42671-1_4
- Sato, S. N., Condes Moreno, E., Rubio-Zarapuz, A., Dalamitros, A. A., Yañez-Sepulveda, R., Tornero-Aguilera, J. F., & Clemente-Suárez, V. J. (2023). Navigating the new normal: Adapting online and distance learning in the post-pandemic era. *Education Sciences*, 14(1), 19. <https://doi.org/10.3390/educsci14010019>
- Sengar, S., & Pandey, M. (2024). To study the effect of job satisfaction on the performance of academic faculties working in private colleges and private universities in Indore. *International Journal for Global Academic & Scientific Research*, 3(1), 13-24. <https://doi.org/10.55938/ijgasr.v3i1.69>
- Serrano, D. R., Dea-Ayuela, M. A., Gonzalez-Burgos, E., Serrano-Gil, A., & Lalatsa, A. (2019). Technology-enhanced learning in higher education: How to enhance student engagement through blended learning. *European Journal of Education*, 54(2), 273-286. <https://doi.org/10.1111/ejed.12330>
- Schirmer, B. R., & Lockman, A. S. (2022). Culturally responsive teaching in an undergraduate online general education course. *Online Learning*, 26(3), 132-148. DOI: <https://doi.org/10.24059/olj.v26i3.2805>
- Shrestha, S., Haque, S., Dawadi, S., & Giri, R. A. (2022). Preparations for and practices of online education during the COVID-19 pandemic: A study of Bangladesh and Nepal. *Education and Information Technologies*, 27(1), 243–265. <https://doi.org/10.1007/s10639-021-10659-0>
- Shumeiko, T., Bezhina, V., Zhiyenbayeva, A., Bozhevolnaya, N., & Zubko, N. (2024). Improving the readiness of teachers for using distance technologies in supplementary technical education: A case study in Kazakhstan. *International Journal of Innovative Research and Scientific Studies*, 7(1), 92-106. <https://doi.org/10.53894/ijirss.v7i1.2506>
- Singh, J., Evans, E., Reed, A., Karch, L., Qualey, K., Singh, L., & Wiersma, H. (2022). Online, hybrid, and face-to-face learning through the eyes of faculty, students, administrators, and instructional designers: Lessons learned and directions for the post-vaccine and post-pandemic/COVID-19 world. *Journal of Educational Technology Systems*, 50(3), 301-326. <https://doi.org/10.1177/00472395211063754>

- Stang-Rabrig, J., Brüggemann, T., Lorenz, R., & McElvany, N. (2022). Teachers' occupational well-being during the COVID-19 pandemic: The role of resources and demands. *Teaching and Teacher Education*, 117, 103803.
<https://doi.org/10.1016/j.tate.2022.103803>
- Stecula, K., & Wolniak, R. (2022). Influence of COVID-19 pandemic on dissemination of innovative e-learning tools in higher education in Poland. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(2), 89.
<https://doi.org/10.3390/joitmc8020089>
- Szymkowiak, A., Melović, B., Dabić, M., Jeganathan, K., & Kundi, G. S. (2021). Information technology and Gen Z: The role of teachers, the internet, and technology in the education of young people. *Technology in Society*, 65, 101565.
<https://doi.org/10.1016/j.techsoc.2021.101565>
- Tajibayeva, Z., Nurgaliyeva, S., Aubakirova, K., Ladzina, N., Shaushekova, B., Yespolova, G., Taurbekova, A. (2023). Investigation of the psychological, pedagogical and technological adaptation levels of repatriated university students. *International Journal of Education in Mathematics, Science, and Technology*, 11(3), 755-774.
<https://doi.org/10.46328/ijemst.3336>
- Tlepbergen, D., Akzhigitova, A., & Zabrodskaia, A. (2022). Language-in-education policy of Kazakhstan: Post-pandemic technology enhances language learning. *Education Sciences*, 12(5), 311.
- Tsai, C. L., Ku, H. Y., & Campbell, A. (2021). Impacts of course activities on student perceptions of engagement and learning online. *Distance Education*, 42(1), 106-125.
<https://doi.org/10.1080/01587919.2020.1869525>
- Toropova, A., Myrberg, E., & Johansson, S. (2021). Teacher job satisfaction: the importance of school working conditions and teacher characteristics. *Educational Review*, 73(1), 71-97. <https://doi.org/10.1080/00131911.2019.1705247>
- Trust, T., & Whalen, J. (2021). Emergency remote teaching with technology during the COVID-19 pandemic: Using the whole teacher lens to examine educator's experiences and insights. *Educational Media International*, 58(2), 145-160.
<https://doi.org/10.1080/09523987.2021.>
- Tripathy, S., & Devarapalli, S. (2021). Emerging trend set by a start-ups on Indian online education system: A case of Byju's. *Journal of Public Affairs*, 21(1), e2128.
<https://doi.org/10.1002/pa.2128>
- Van der Spoel, I., Noroozi, O., Schuurink, E., & van Ginkel, S. (2020). Teachers' online teaching expectations and experiences during the Covid19-pandemic in the Netherlands. *European Journal of Teacher Education*, 43(4), 623-638.
<https://doi.org/10.1080/02619768.2020.1821185>
- Wallengren Lynch, M., Dominelli, L., & Cuadra, C. (2023). Information communication technology during COVID-19. *Social Work Education*, 42(1), 1-13.
<https://doi.org/10.1080/02615479.2022.2040977>

- Wang, K., Li, Y., Luo, W., & Zhang, S. (2020). Selected factors contributing to teacher job satisfaction: A quantitative investigation using 2013 TALIS data. *Leadership and Policy in Schools*, 19(3), 512-532. <https://doi.org/10.1080/15700763.2019.1586963>
- Wartenberg, G., Aldrup, K., Grund, S., & Klusmann, U. (2023). Satisfied and high performing? A meta-analysis and systematic review of the correlates of teachers' job satisfaction. *Educational Psychology Review*, 35(4), 114. <https://doi.org/10.1007/s10648-023-09831-4>
- Williams, G. (2022). Broadening our perspective yields good outcomes, pedagogically and otherwise. *Communication Education*, 71(2), 149-151. <https://doi.org/10.1080/03634523.2021.2022729>
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency. *Learning, Media and Technology*, 45(2), 107-114. <https://doi.org/10.1080/17439884.2020.1761641>
- Wiles, D., Morrison, A., Smart, J., Bennett, L., & Peters, S. (2023). The Online Teaching Motivation Scale (OTMS): Development and validation of a survey instrument. *Online Learning*, 27(4), 6-25. DOI: <https://doi.org/10.24059/olj.v27i4.4035>
- Wu, M., Mohammadi, M., & Izadpanah, S. (2025). Investigating the mediating role of job commitment and job satisfaction in the relationship between social support and job motivation among English language teachers. *European Journal of Education*, 60(2), e70069. <https://doi.org/10.1111/ejed.70069>
- Yeh, C. Y., & Tsai, C. C. (2022). Massive distance education: barriers and challenges in shifting to a complete online learning environment. *Frontiers in Psychology*, 13, 928717. <https://doi.org/10.3389/fpsyg.2022.928717>
- Zakariya, Y. F., & Wardat, Y. (2023). Job satisfaction of mathematics teachers: an empirical investigation to quantify the contributions of teacher self-efficacy and teacher motivation to teach. *Mathematics Education Research Journal*, 1-23. <https://doi.org/10.1007/s13394-023-00475-9>

Hot-fit Model on E-Learning Success: Innovation and Quality Consciousness

Muhammad Sofwan

Fakultas Keguruan dan Ilmu Pendidikan, Universitas Jambi, Indonesia

Akhmad Habibi

Graduate School of Education, Korea University, Seoul, Korea

Fakultas Keguruan dan Ilmu Pendidikan, Universitas Jambi, Indonesia

Faculty of Business and Management, Universiti Sultan Zainal Abidin, Malaysia

Robin Pratama

Fakultas Keguruan dan Ilmu Pendidikan, Universitas Jambi, Indonesia

Mohd Sofian Omar Fauzee

Faculty of Education and Liberal Arts, INTI International University, Nilai, Malaysia

Hamdy Abdullah

Faculty of Business and Management, Universiti Sultan Zainal Abidin, Malaysia

Abstract

The current research elaborates on the effect of the human organization technology fit model, which consists of human, organizational, and technological dimensions, on e-learning readiness in an elementary school teacher education program. The main dataset, comprising 416 student teachers, was analyzed using partial least squares structural equation modelling procedures. The study tested hypotheses linking various factors to e-learning readiness and usage. Statistically significant results demonstrated that knowledge ($p = .008$), relative advantage ($p < .05$), compatibility ($p < .05$), complexity ($p < .001$), quality ($p < .05$), and innovation awareness ($p < .05$) significantly affect e-learning readiness and actual use of e-learning. Specifically, knowledge, relative advantage, compatibility, quality, and innovation awareness exhibit positive impacts, whereas complexity exerts a negative influence. Conversely, the findings indicated no significant relationships ($p > .05$) between certain correlations, such as computer self-efficacy and e-learning readiness, innovation and actual use of e-learning, and quality and actual use of e-learning. The findings contribute to the development of e-learning, providing practical and theoretical recommendations for its improvement regarding sustainable development goal 4, quality education.

Keywords: Hot-fit; readiness; e-learning implementation; innovation awareness; quality awareness

Sofwan, M., Habibi, A., Pratama, R., Fauzee, M. S. O., & Abdullah, H. (2026). Hot-fit model on e-learning success: Innovation and quality consciousness, *Online Learning*, 30(1), pp. 175-198. <https://doi.org/10.24059/olj.v30i1.4861>

Introduction

E-learning in education represents a novel paradigm in education, driving significant changes in the field. E-learning possesses potential in developing countries when obstacles can be overcome (Qoriawan & Apriliyanti, 2023). Universities in developing countries are often unable and unprepared to implement e-learning programs effectively due to limited facilities (Eze et al., 2020). E-learning integration requires additional funds, especially in government institutions and state universities (Qoriawan & Apriliyanti, 2023). The situations cause an additional financial burden. Countries typically favor conventional learning styles due to the need for more financial and human resources. Currently, e-learning in the teaching process at university levels has become a trend in educational technology, along with students' widespread use of the Internet and smartphones. Higher education institutions (HEIs) continue to make efforts to update their educational services, one of which is the implementation of e-learning (Maphalala & Adigun, 2020; Turnbull et al., 2021). For the system at Indonesian HEIs, the e-Learning management system is used, which is an online site that aims to make it easier for lecturers and students to do distance learning whose activities include sharing teaching materials, videos, synchronous or asynchronous learning, evaluation, and other online activities (Aman et al., 2020). These e-learning programs help lecturers and students enhance the quality of lectures, including in the school teacher education program (ESTEP) (Apriani et al., 2021; Ayu, 2020).

Human organization technology fit (Hot-fit) is an extended model established by merging DeLone and McLean's model of success in information systems practice with the information technology organizational fit model (DeLone & McLean, 2003). The model is ideal and flexible to be applied in various contexts for a system's improvement cycle (Maswadi et al., 2022; Mirabolghasemi et al., 2019). Integrating human and technological elements in organizational systems is crucial for enhancing performance and adaptability. This hybrid approach brings together the best of human decision-making and advanced technology to build a more effective framework. It highlights how crucial it is to make sure that system design matches what users need, so that technology helps instead of getting in the way of what people are trying to do. Hot-fit model uses feedback loops, which help organizations continually improve and adapt quickly to changes in their environment. This approach is highly flexible, which means it can work effectively in various environments, including educational settings. Additionally, it promotes teamwork among everyone involved, making sure that the system develops in a way that helps all parties.

Human factors include computer self-efficacy and subjective norms, and organizational factors include knowledge and management support. On the other hand, technological factors offer optional benefits, including flexibility and efficiency in education. Besides the core variables of Hot-fit, this study included two moderating variables: innovation awareness and quality awareness, which are crucial in an educational system for bridging the gap between e-learning readiness and implementation (Polat et al., 2022). Thus, a constant exploration of the factors enabling improved e-learning implementation at ESTEP is required to contribute as significant determinants to reduce the e-learning readiness and implementation gap. Especially, the context of this study aims to empirically analyze the effects of the Hot-fit model, which consists of human, organizational, and technological dimensions, on the readiness of e-learning at ESTEP. The e-learning readiness influences implementation with awareness and innovation quality as moderator effects. These dimensions were developed by proposing research indicators that partially and simultaneously impact the readiness and implementation of e-learning among ESTEP

students. This study attempts to understand several factors that influence college students' readiness and implementation of e-learning practices.

Literature Review

Hot-Fit in HEIs

The Hot-fit model places important components in information systems. The Hot-fit evaluation includes (1) organizational factors and dimensions: structure and environment; (2) conformity between technological, human, and organizational factors; and (3) the two-way relationship between information quality and system usage, user satisfaction, structure and environment, structure and net benefits, and net environmental benefits (Mirabolghasemi et al., 2019; Polat et al., 2022). The human component assesses the information system based on its use, considering the frequency and breadth of functions and information systems. System use is associated with whoever uses the system, user level, training, knowledge, expectations, and acceptance or rejection of the system (Mirabolghasemi et al., 2019; Polat et al., 2022).

E-learning Readiness and Usage Among Student Teachers

Student teachers must be e-learning ready and use technology to teach successfully. Digital learning readiness encompasses technical skills, access to technology, self-efficacy, and motivation. Student teachers must be ready to model technology-enhanced teaching in their future classes. This indicates the extent to which these teachers use e-learning tools, such as learning management systems (LMS), virtual simulations, and collaborative platforms, during training (Eze et al., 2020). Research indicates that technical proficiency and institutional support have a significant impact on the preparation of student teachers. Reliable infrastructure and training enhance student teachers' confidence in e-learning. Low digital literacy or e-learning exposure might impair preparation, especially in under-resourced settings (Apriani et al., 2021; Ayu, 2020). Some student teachers use Moodle or Google Classroom for collaborative learning, while others use them sparingly due to unfamiliarity or pedagogical integration. Attitude toward e-learning matters too. Positive technological attitudes increase the use of e-learning among student teachers. Institutions play a crucial role in providing hands-on training and integrating e-learning with teacher goals. E-learning must be integrated into teacher education programs to promote practical and reflective practice. Progress is, nevertheless, hindered by unequal access to devices, internet connectivity, and academic support. Teacher education programs should include digital literacy, equitable resource distribution, and mentorship to improve preparation and use. Creating a culture of technological flexibility helps student teachers prepare for tech-driven classrooms.

Moderating Variables

A moderating factor is an interacting variable used when the correlations between independent and dependent factors are less strong, consistent, or sometimes non-existent (Maswadi et al., 2022). The greater the power of the moderating influence of innovation and quality awareness, the smaller the readiness-implementation gap. The term of awareness is vital for the current research, implying subjective or phenomenal feeling, option, memory, thinking, language, voluntary behavioral control, and internally generated patterns in the human brain (Liljenström, 2022; Sattin et al., 2021). The current study evaluated awareness of conceptual measures of self-esteem, knowledge, and voluntary behavioral control for implementing e-learning, as well as the sense of innovation and quality brought about by e-learning as an integral part of the education system. Innovation and quality awareness initiatives were introduced to bridge the acceptance-readiness gaps.

Innovation Awareness

Innovation awareness in this study refers to psychological awareness and intentional behavior that emerges from the human brain, whereas innovation is defined as the degree to which an individual or group of people accepts new ideas compared to other members of the social system (Panigrahi et al., 2021). Innovative students are eager to quickly explore current technologies, adopt, and use them efficiently in instructional activities. Many previous studies have emphasized that e-learning is an innovation that supports the teaching and learning process (Chang et al., 2021; Ifinedo et al., 2020). A strong correlation exists between technology integration and computer innovation (Ifinedo et al., 2020). Furthermore, students' degree of e-learning innovation significantly influences their integration behavior. A robust link exists between students' perceptions of the innovative attributes of e-learning websites and their use behavior (Panigrahi et al., 2021).

Quality Awareness

Quality awareness refers to one of the most important effects of the implementation success of e-learning in education (Al-Fraihat et al., 2020). Therefore, in e-learning implementation, quality awareness is the awareness of the main values related to e-learning implementation. The quality of the educational activities is one of the determinants for student learning (Mahoney et al., 2021; Santos et al., 2020). The challenge of improving the quality of education is part of quality assurance as a goal of sustainable education development (Onyekwere & Enamul Hoquei, 2023; Şimşek & Ateş, 2022). Students' need for e-learning skills and knowledge facilitates quality education and improves academic achievement. Implementing e-learning can enhance education quality and effectiveness at a low cost. Students agree that using e-learning in teaching and learning can improve the quality of education (Onyekwere & Enamul Hoquei, 2023; Şimşek & Ateş, 2022).

Core Variables

Computer self-efficacy refers to an individual's assessment of their ability to use e-learning. Self-efficacy refers to an individual's belief in their ability to perform various tasks within a system (Prifti, 2022). Self-efficacy determines individual choices about which technology to adopt and how strong the effort is to survive in the face of challenges. The decision of students to use e-learning is related to their ability to use the technology and the advantages they can obtain through the use of the system (Al-Fraihat et al., 2020). Positive experiences using e-learning systems can increase student self-efficacy (Prifti, 2022). Students will use e-learning if they feel capable of using the system.

Subjective norm is the perception that most individuals think certain behaviors and attitudes should be carried out, conceptualized as normative beliefs (Habibi et al., 2020). Subjective norm is defined as the social influence on how the perception of technological tool users is affected by a person close to them (Rejón-Guardia et al., 2020). When individuals perceive that the primary reference system of thinking must be used, they incorporate the reference beliefs into their own belief systems. Students' perceptions of e-learning readiness are a collaborative effort between organizations and instructors.

For the effective utilization of e-learning systems, users must possess relevant technological skills and knowledge. Organizations with limited expertise in Information and Communication Technologies (ICT) may want to refrain from using new technology, so they must fully master the technology (Habibi et al., 2020). The interest and supporting policies of leaders at every level are the most important factors for the success of e-learning (Basir et al., 2021). Management's commitment to implementing decision-making processes in e-learning practices is crucial because it guarantees adequate resources to support implementation. For ICT integration to become efficient and effective, institution management should be skillful

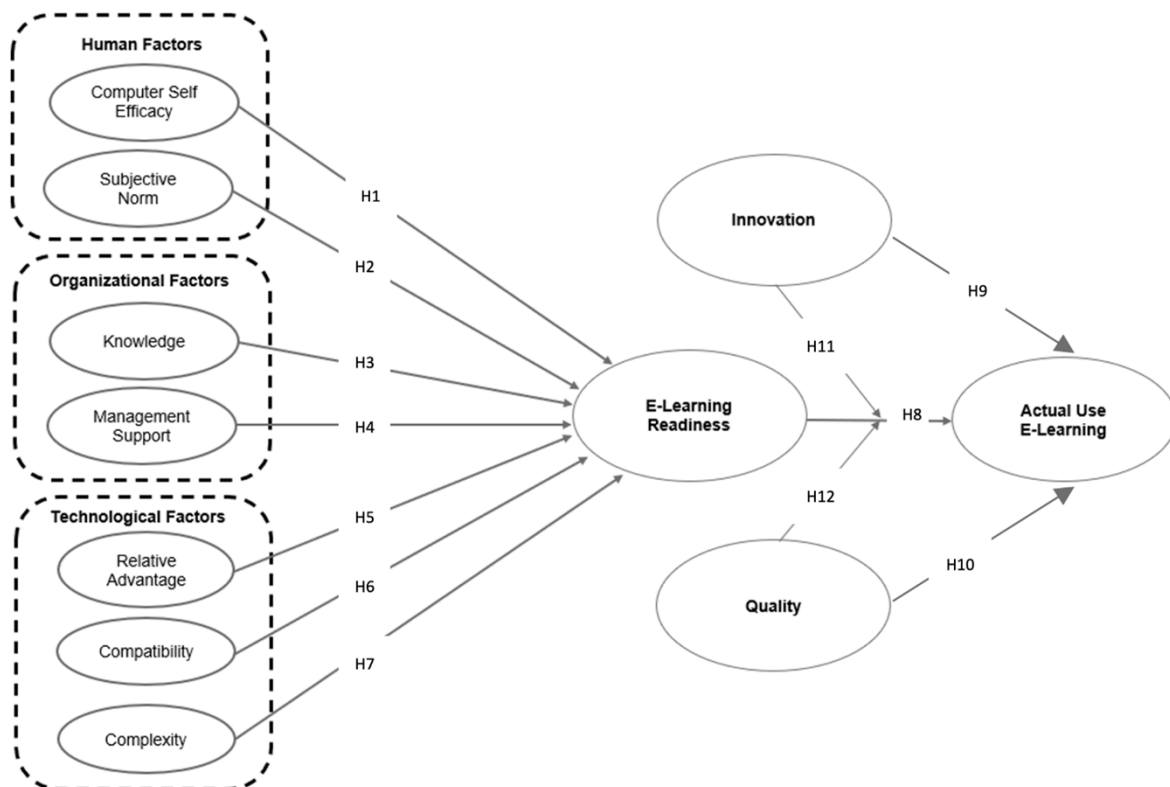
and knowledgeable in the technology implementation and obtain a good understanding of the whole pedagogical, technological, financial, institutional, and cohesive perspectives.

Relative advantage refers to the extent to which e-learning tools in tertiary institutions are considered to provide significant benefits in helping to achieve their goals (Mustafa et al., 2021; Wang et al., 2022). The relative advantage of e-learning benefits a system that is perceived as beneficial (Mustafa et al., 2021; Wang et al., 2022). Relative advantage is defined as the level to which an innovation is considered more significant than the innovation it replaces, such as reducing costs and increasing performance. If the e-learning relative advantage is high, universities are more likely to provide significant resources to implement a novel system.

Compatibility or suitability refers to the extent to which an innovation aligns with users' existing experiences, values, and potential means of use (Al-Fraihat et al., 2020). Regarding profit organizations, the need for compatibility makes many companies hesitant about the potential of innovation related to the situation happening in education (Choi et al., 2020; Rocca et al., 2023). The success rate of e-learning use increases if compatibility is more significant (Al-Fraihat et al., 2020). Educational institutions are more likely to apply technology that is compatible with their processes, requirements, technological infrastructure, and value systems.

Complexity refers to the difficulties organizations encounter when using and understanding new technology (Benbya et al., 2020; Toufaily et al., 2021). If organizations perceive technology as complex, they use it because they need more confidence in implementing and understanding the new system (Goh & Sigala, 2020). The complexity of e-learning systems can improve the perceived risk related to the readiness and implementation. In the context of this research, twelve hypotheses are proposed:

- H1: Computer self-efficacy has a significant positive effect on e-learning readiness
- H2: Subjective norms have a positive effect on e-learning readiness
- H3: Knowledge has a positive effect on e-learning readiness
- H4: Management support has a positive effect on e-learning readiness
- H5: Relative advantage has a positive effect on e-learning readiness
- H6: Compatibility has a positive effect on e-learning readiness
- H7: Complexity has a positive effect on e-learning readiness
- H8: e-learning readiness has a significant positive correlation with actual use of e-learning.
- H9: Innovation awareness has a significant positive correlation with the actual use of e-learning.
- H10: Quality awareness has a significant positive correlation with actual use of e-learning.
- H11: Innovation awareness positively moderates the relationship between e-learning readiness, acceptance, and the implementation of e-learning.
- H12: Quality awareness positively moderates the relationship between e-learning readiness, acceptance, and e-learning Implementation.

Figure 1*Proposed Model***Methods*****Data Collection***

For the data collection, we use probability sampling, a sampling technique in which each member of the population has the same chance of being selected for the sample. In other words, all population members have a non-zero probability (Tabandeh et al., 2022; Sivagurunathan et al., 2024). The samples used in this study were 416 ESTEP student teachers. Based on gender, 253 samples were females, and 163 respondents were males. Regarding the year in university, 167 were in the first year, 228 in the second year, and the rest were in the third year or above. A survey was distributed online via Google Forms to all eligible participants, following approval from the Institutional Review Board (IRB) to ensure the waiver of ethical compliance. Of the 500 surveys sent, 416 were completed, yielding a response rate of 94.2%.

Instrumentation

The questionnaire used in this study was a closed-ended questionnaire that provided a choice of answers. Questions for each construct were adapted from previously validated instruments (Benbya et al., 2020; DeLone & McLean, 2003; Rahman et al., 2017; Toufaily et al., 2021). All quantitative questionnaire items were measured using a seven-point Likert scale; strongly disagree (1) to strongly agree (7) (Sofwan et al., 2024). The first step in preparing the questionnaire is to translate the questionnaire through back translation (Habibi et al., 2023). Three English-Indonesian professional translators were involved in this process. We compared the questionnaire to see the relevance of the translation results in the context of ESTEP. All items for the current study were listed in Appendix A.

Data Analysis

This study's hypotheses were tested using the partial least squares structural equation model (PLS-SEM), a well-established method (Hair et al., 2022; Yuanjue et al., 2025). PLS-SEM was used to study human attitudes, actions, and intentions in e-learning adoption because it can handle complex models with latent constructs (Hair et al., 2022). First, the measurement model was tested for reliability and validity. E-learning preparedness and use were examined for internal consistency using composite reliability. Average variance extracted (AVE) values confirmed convergence. The Heterotrait-Monotrait (HTMT) ratio was calculated to confirm construct distinction and discriminant validity (Habibi et al., 2024; Sofwan et al., 2024).

The structural model was evaluated to test the hypothesized relationships in the second step. Path coefficients were estimated to identify the degree and direction of correlations between variables, such as technological self-efficacy and e-learning utilization. The results were robustly tested using bootstrapping with 5,000 subsamples to determine significance. This approach provided stable p-value and confidence interval estimates, enhancing reliability. The main tool for this research was SmartPLS, which has a simple interface for model estimation, visualization, and interpretation (Hair et al., 2022; Huang, 2020). All variance inflation factor (VIF) readings indicated concerns about multicollinearity. This thorough method guaranteed that the results accurately reflected student teachers' preparation and use of e-learning resources, supporting the study's conclusions.

Findings

Measurement Model

Convergent validity is defined as the extent to which a measurement item of the exact factor in the context of the model is assumed to be comparable to other measurement items of the same factor (Habibi et al., 2023). Each survey item included in a factor should have a value of .700 or more to fulfill the validity threshold. Convergent validity is assessed by the average variance extracted (AVE). To meet the standard of the convergent validity, the AVE value must be $> .500$. Convergent validity was assessed using the Partial Least Squares (PLS) technique. Table 1 displays the results of the analysis. Most indicator values are reported to be greater than 0.708. The internal consistency reliability is measured between 0 and 1; the higher the value, the better the validity. Alpha and CR must be higher than .700 (Hair et al., 2022). The alpha and CR values generated for all constructs are stable with acceptable reliability, from .710 to .878. Convergent validity is established through the AVE value. The minimum acceptable AVE is $> .500$ or higher, meaning that all construct variable variances explain 50% or more of the item variance. All factors meet the threshold, with an AVE value greater than .500, ranging from .592 (complexity) to .847 (compatibility).

Table 1

Measurement Model

Construct	Item	Load	alpha	CR	AVE
Actual use e-learning	ACT1	.852	.678	.861	.756
	ACT2	.886			
Compatibility	CMPI1	.919	.909	.943	.847
	CMPI2	.937			
	CMPI3	.905			
Complexity	CMPX1	.816	.665	.813	.592
	CMPX2	.701			

	CMPX3	.788			
Computer Self-efficacy	CSE2	.714	.531	.800	.670
	CSE3	.911			
E-learning readiness	ELR1	.832	.678	.819	.602
	ELR2	.760			
	ELR3	.731			
Innovation	INO1	.849	.710	.872	.773
	INO2	.908			
Knowledge	KNW1	.738	.786	.877	.705
	KNW2	.887			
	KNW3	.884			
Management support	MS1	.865	.861	.915	.782
	MS2	.911			
	MS3	.878			
Quality	QUA1	.839	.643	.848	.736
	QUA2	.876			
Relative advantage	RA1	.741	.751	.857	.667
	RA2	.819			
	RA3	.883			
Subjective norm	SN1	.885	.735	.883	.791
	SN2	.893			

Discriminant Validity

The first discriminant validity criterion within this study was the Fornell-Larcker assessment, where the limit value of AVE is $\geq .500$ (Hair et al., 2022). All the square roots of AVEs and correlation values for $> .500$. In addition, the square root value of AVE shows a high discriminant validity value. Discriminant validity was also evaluated through the Heterotrait-Monotrait Ratio (HTMT) as the most robust evaluation (Hair et al., 2022). From the results of the PLS-SEM, all HTMT values (Table 2) are lower than .900 (Hair et al., 2022). HTMT showed that all values differ from 1. The discriminant validity, as per Fornell and Larcker (1981), indicates that the limit value of AVE is $\geq .500$. The results show all the Squared Root of AVEs and correlation values for are ($> .500$) (Table 3). Thus, the results meet the criteria for discriminant validity.

Table 2

Heterotrait-Monotrait Ratio

	ACT	CMPL	COMPL	CSE	ELR	INO	KNO	MS	QUA	RA
	I		X				W			
Compatibility	.047									
Complexity	.156	.760								
Computer self-efficacy	.127	.365	.511							
E-Learning readiness	.075	.807	.908	.547						
Innovation	.364	.065	.097	.047	.056					
Knowledge	.088	.638	.812	.386	.709	.110				

Management support	.116	.614	.736	.337	.585	.080	.618			
Quality	.421	.142	.104	.093	.131	.785	.057	.041		
Relative advantage	.083	.832	.692	.401	.851	.044	.465	.471	.060	
Subjective norm	.087	.752	.729	.508	.710	.069	.520	.668	.079	.603

Table 3*Fornell-Larcker*

	ACT	CMP	COM	CSE	ELR	INO	KNO	MS	QUA	RA	SN
			LX								
Actual Use E Learning	.869										
Compatibility	-.009	.920									
Complexity	-.087	.605	.770								
Computer Self-efficacy	.056	.262	.298	.818							
E-Learning Readiness	.012	.655	.660	.320	.776						
Innovation	.254	-.003	-.061	.018	.002	.879					
Knowledge	-.019	.539	.599	.248	.541	-.057	.840				
Management Support	-.091	.545	.557	.248	.461	-.059	.512	.885			
Quality	.277	.107	.071	.021	.095	.535	.040	.001	.858		
Relative Advantage	-.056	.703	.536	.265	.636	-.005	.375	.382	-.011	.817	
Subjective Norm	-.062	.615	.512	.347	.511	-.047	.393	.530	.040	.459	.889

Structural Model

Measurement model supports the validity of the structural model's correlation between the two variables (Fauzee et al., 2026; Hair et al., 2022). We employed a bootstrapping approach with 5,000 subsamples to obtain a meaningful path coefficient (β) and t-value for the hypothesis's significance. The hypothesis testing results provide a detailed analysis of the factors influencing e-learning readiness and the actual use of e-learning systems (Table 4). The study examined twelve hypotheses, each exploring different predictors of e-learning readiness and their subsequent impact on actual e-learning use. The

findings suggest a nuanced understanding of how various factors contribute to these two outcomes, with some expected predictors showing significant influence while others do not. Firstly, the effect of computer self-efficacy (H1) on e-learning readiness is found to be non-significant ($\beta = .064$, $p = .246$). Similarly, subjective norm (H2), which measures the influence of perceived social pressure to use e-learning, also shows a non-significant relationship with e-learning readiness ($\beta = .071$, $p = .202$).

On the other hand, knowledge (H3) about e-learning significantly influences readiness ($\beta = .148$, $p = .008$), indicating that individuals who are more informed about e-learning are more likely to be ready to adopt it. Relative advantage (H5) and compatibility (H6), which reflect the perceived benefits of e-learning and its fit with existing practices, are also significant predictors ($\beta = .272$, $p = .000$; $\beta = .164$, $p = .041$, respectively). These factors suggest that when individuals see e-learning as advantageous and compatible with their current ways of working or learning, they are more likely to be ready to adopt it. Additionally, complexity (H7), which typically would have a negative connotation, interestingly shows a positive and significant relationship with readiness ($\beta = .281$, $p = .000$). When it comes to the actual use of e-learning, the results are mixed. The direct impact of e-learning readiness (H8) on actual use is non-significant ($\beta = .014$, $p = .781$). However, quality (H10) and innovation awareness (H12) emerge as significant factors influencing the actual use of e-learning ($\beta = .190$, $p = .008$; $\beta = .190$, $p = .022$, respectively). These findings highlight that the perceived quality of the e-learning system and awareness of innovations within the system are crucial in translating readiness into actual use. In contrast, the direct effects of innovation (H9) and the mediating role of quality awareness (H11) on e-learning readiness and its subsequent use are found to be non-significant, suggesting that these factors might not independently drive e-learning adoption.

Table 4

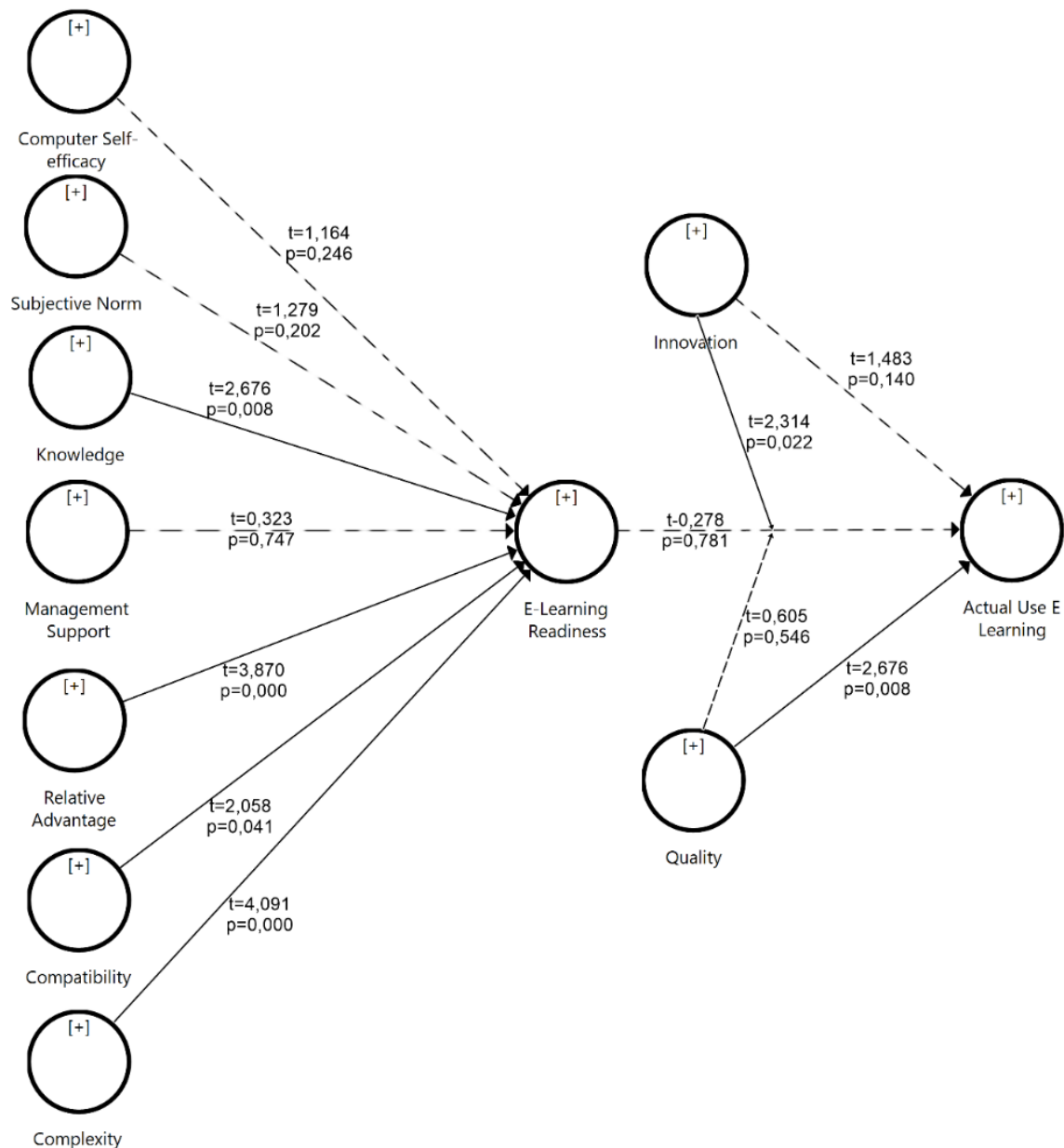
Structural Model

	Path	β	t value	p value	Sig.
H1	Computer self-efficacy -> e-learning readiness	.064	1.164	.246	No
H2	Subjective norm -> e-learning readiness	.071	1.279	.202	No
H3	Knowledge -> e-learning readiness	.148	2.676	.008	Yes
H4	Management support -> e-learning readiness	-.018	.323	.747	No
H5	Relative advantage -> e-learning readiness	.272	3.870	.000	Yes
H6	Compatibility -> e-learning readiness	.164	2.058	.041	Yes
H7	Complexity -> e-learning readiness	.281	4.091	.000	Yes
H8	e-learning readiness -> actual use of e-learning	.014	.278	.781	No
H9	Innovation awareness-> actual use e-learning	.132	1.483	.140	No
H10	Quality awareness -> actual use of e-learning	.190	2.676	.008	Yes

H11	Quality awareness. -> e-learning readiness - > actual use of e-learning	.042	.605	.546	No
H12	Innovation awareness -> e-learning readiness -> actual use of e-learning	.190	2.314	.022	Yes

Coefficient of Determination (R^2) and Predictive Relevance (Q^2)

R^2 is one of the main measurements used to evaluate paths in the PLS-SEM. The R^2 value for the actual use of e-learning is .136, representing the amount of variance explained by each endogenous latent variable and indicating the model's quality in the moderate category. E-learning readiness produces a value in the medium category, .594 (Hair et al., 2022). The proposed model exhibits sufficient predictive relevance for endogenous constructs when Q^2 exceeds zero; however, when Q^2 values are less than zero, the model fails to meet predictive relevance for endogenous constructs. Based on the table above, the model has sufficient predictive relevance. Q^2 value for actual use e-learning ($Q^2 = .072$), small effect category, e-learning readiness ($Q^2 = .321$), large effect category.

Figure 2*Final Model*

Discussion

The discussions of ESTEP student teachers about e-learning, based on the statistical findings of the current study, reveal how awareness of innovation affects the usage of digital tools in teaching. The findings confirm six hypotheses while rejecting six others. This study examines the relationships between computer self-efficacy, subjective norms, knowledge, management support, relative advantage, compatibility, quality awareness, and e-learning use. Innovation awareness has a significant impact on ESTEP student teachers' readiness to integrate e-learning into their teaching. Innovation awareness refers to the extent to which individuals understand and accept innovative educational technology (Chang et al., 2021; Ifinedo et al., 2020). Awareness of novel tools, such as e-learning platforms, can greatly

influence student teachers' adoption of these tools, especially those in the ESTEP program (Chang et al., 2021). This awareness might inspire Indonesian student teachers to explore how digital tools can enhance teaching, student engagement, and learning outcomes.

High computer self-efficacy should help student teachers experiment with e-learning platforms, create digital content, and fix technical issues during lessons (Al-Fraihat et al., 2020; Prifti, 2022). However, e-learning readiness is not significantly influenced by computer self-efficacy or confidence in computer and technology skills, as indicated by the current study's findings. Additionally, subjective norms—student instructors' social pressures and expectations regarding technology use in education—also do not affect e-learning readiness, arguing against previous studies' findings (Habibi et al., 2020; Rejón-Guardia et al., 2020). This emphasizes the necessity of creating a conducive school atmosphere where practicing instructors model the use of digital tools. The study highlights that while computer self-efficacy aids e-learning engagement, it doesn't significantly impact readiness. Social pressures from instructors and expectations around tech use in education also have minimal effect.

Readiness also depends on e-learning knowledge. ESTEP student teachers must grasp e-learning platforms, their classroom uses, and their effects on student engagement, supporting prior reports (Basir et al., 2021; Habibi et al., 2020). Even the most tech-savvy people may fail to recognize the value of e-learning or apply it effectively without this expertise. This emphasizes the need for comprehensive training that extends beyond technical skills and focuses on pedagogical practices that use e-learning to enhance teaching and learning (Basir et al., 2021). This expertise is crucial for student teachers, who must employ e-learning resources to provide hands-on, inquiry-based learning experiences that match scientific instruction. However, management support is not crucial to e-learning readiness. The findings argue that educational institutions must actively facilitate technology integration to give student instructors the tools and assistance. Further studies on the correlation should be conducted in the future.

E-learning's perceived relative advantages over traditional teaching techniques can affect readiness. E-learning allows ESTEP student teachers to offer more dynamic and flexible learning experiences for various students. Digital platforms can provide asynchronous learning opportunities or online discussion rooms to enhance student engagement. As virtual labs, simulations, and data visualization tools improve science education, e-learning benefits Indonesian student teachers (Habibi et al., 2020). If these benefits are not clearly explained or experienced, student instructors may not perceive the value in e-learning and prefer familiar techniques. E-learning compatibility with teaching methods and beliefs is also vital. Student teachers must integrate e-learning into their teaching style and curriculum (Benbya et al., 2020; Toufaily et al., 2021). If e-learning tools seem too complicated or incompatible with their teaching approach, they may reject their use. E-learning platforms should be user-friendly and versatile, allowing student teachers to personalize their use. Compatible tools are crucial for student teachers, who need them for hands-on, experimental science education.

Quality awareness, or recognition of high-quality e-learning tools and activities, affects preparedness and utilization. Student teachers who understand what makes a good e-learning platform—intuitive navigation, compelling content, and reliable performance—are more inclined to use it. This knowledge establishes a standard for e-learning and encourages individuals to seek resources that meet it, thereby enhancing their readiness. Quality awareness is essential for Indonesian student teachers, who require tools that effectively explain scientific concepts and engage students (Mahoney et al., 2021; Santos et al., 2020).

These criteria culminate in the effective use of e-learning, demonstrating preparedness. ESTEP student instructors must move from awareness and preparation to implementation. By incorporating e-learning into their classes, they may recognize its benefits and reinforce their commitment to digital integration. E-learning is used by student teachers to develop dynamic, student-centered lessons that encourage scientific curiosity and critical thinking.

For moderating variables, innovation awareness has a significant influence on the actual use of e-learning, particularly in terms of the readiness of ESTEP student teachers to integrate e-learning, rather than quality awareness, which has no significant effects on actual use. The positive results show that the correlation between readiness and integration use is greater for those who believe innovation awareness strengthens their intention than for ESTEP student teachers who believe quality awareness reinforces their actual use of e-learning to integrate e-learning. These results are consistent with previous research on ICT innovations in teaching and learning (Chang et al., 2021; Pratama et al., 2020; Purwanto & Tannady, 2020). Innovation offers student teachers opportunities to integrate e-learning into the teaching and learning process. Thus, the results of this study imply that ESTEP students are aware of the innovations that e-learning brings to education. Innovation awareness has a strong influence on ESTEP student teachers' openness to using e-learning, especially they who appreciate such improvements. A prior study on the role of ICT in education suggests that awareness promotes the integration of digital tools. These findings underscore the need for specialized training programs to enhance technological adoption, enabling ESTEP students to effectively use e-learning to enhance their education. More elaboration on the insignificant relationship between quality awareness and actual use of e-learning through readiness should be conducted in the future.

Conclusion

Overall, the study highlights the importance of prioritizing quality and innovation in e-learning systems to encourage actual usage, even among users who are already ready. The perceived benefits, compatibility, and knowledge about e-learning play crucial roles in preparing users for adoption, but ensuring that these systems are perceived as high quality and innovative is key to translating readiness into actual use. The study faces significant obstacles due to its reliance on self-reported data, which may introduce biases and errors. Participants may inaccurately describe activities or events due to social desirability or memory lapses, distorting the results. The sample size significantly constrains the study's trustworthiness. A restricted participant pool may inadequately represent the diversity of the larger community, hence diminishing the generalizability of the findings. Demographic characteristics, including age, socioeconomic level, and cultural background, may be insufficiently represented, resulting in incomplete insights. The methodology varies across study domains, as emphasized in the text. In disciplines such as psychology, researchers frequently use surveys or interviews to collect subjective data, which may be susceptible to interpretative inaccuracies. In contrast, in fields like biology, objective metrics such as laboratory testing yield more definitive results, although they may still be constrained by the representativeness of the sample. The study underscores the significance of "general method variance," a phenomenon wherein methodological discrepancies among studies result in conflicting conclusions. This variability hinders the ability to compare or reproduce results, as the methodologies and instruments employed in one study may not correspond with those in another. The paper recommends using methodologies such as PLS-SEM to tackle these challenges. This statistical method efficiently manages smaller sample sizes compared to conventional approaches, enabling the investigation of intricate correlations between variables with enhanced precision. Nonetheless, despite employing such methodologies, the

outcomes remain context-dependent and cannot be universally applied without prudence. The research includes ESTEP students, signifying an emphasis on educational or developmental data gathered at a specific time. Conducting this research over a prolonged duration may uncover trends and transformations, yielding profound insights into the issue and augmenting the study's overall validity.

The current study reported the determining effects of behavioral intention on the e-learning use of ESTEP students. The primary objective of the current study was to investigate the moderating effects of innovation and quality awareness on the relationship between intention and e-learning use among ESTEP students. The innovation awareness factor proved to have a moderating influence on the relationship between intention and actual use. In addition, innovation and quality awareness are independent factors predicting e-learning use. Upcoming studies are suggested to confirm the justification of these factors as predictors of e-learning use and examine the pathways of the correlational analyses. In addition, the study's reports provide new insights into factual information regarding e-learning and how this situation can influence students, teachers, and lecturers' decisions about integrating e-learning. Additionally, the study could enhance its findings by incorporating mixed-method approaches that merge qualitative interviews with quantitative data. The integration of technology, such as real-time data tracking applications, may diminish dependence on self-reporting. Collaborating with various institutions may expand the participation base. These measures would augment the study's profundity and relevance.

Conflict of Interest

No potential competing interest was reported by the authors.

Ethic Statement

Given the nature of the study and after a thorough review, the ethical approval requirement can be waived. This decision aligns with the guidelines established by Universitas Jambi for social science research, which require obtaining appropriate waivers from Institutional Review Boards (IRB) or equivalent authorities to ensure ethical compliance.

References

- Al-Fraihat, D., Joy, M., Masa'deh, R., & Sinclair, J. (2020). Evaluating e-learning systems' success: An empirical study. *Computers in Human Behavior*, 102, 67-86. <https://doi.org/10.1016/j.chb.2019.08.004>
- Ali, B. J., & Anwar, G. (2021). Implementation of e-learning system readiness: The effect of the cost readiness on implementing e-learning. *International Journal of Electrical, Electronics and Computers*, 6(3), 27–37. <https://doi.org/10.22161/eec.63.4>
- Aman, L. D. P., Sofwan, M., Mukminin, A., Habibi, A., & Yaqin, L. N. (2020). Factors affecting Indonesian pre-service teachers' use of m-LMS: A mix method study. *International Journal of Interactive Mobile Technologies*, 14(6), 137–147. <https://doi.org/10.3991/ijim.v14i06.12035>
- Apriani, E., Syafradin, Inderawati, R., Arianti, A., Wati, S., Hakim, I. N., & Noermanzah. (2021). Implementing e-learning training toward English virtual lecturers: The process, perspectives, challenges and solutions. *International Journal of Emerging Technologies in Learning*, 16(4), 240–255. <https://doi.org/10.3991/ijet.v16i04.14125>
- Ayu, M. (2020). Online learning: Leading e-learning at higher education. *The Journal of English Literacy Education: The Teaching and Learning of English as a Foreign Language*, 7(1), 47–54. <https://doi.org/10.36706/jele.v7i1.11515>
- Basir, M., Ali, S., & Gulliver, S. R. (2021). Validating learner-based e-learning barriers: developing an instrument to aid e-learning implementation management and leadership. *International Journal of Educational Management*, 35(6), 1277–1296. <https://doi.org/10.1108/IJEM-12-2020-0563>
- Benbya, H., Nan, N., Tanriverdi, H., & Yoo, Y. (2020). Complexity and information systems research in the emerging digital world. *MIS Quarterly: Management Information Systems*, 44(1), 1–17. <https://doi.org/10.25300/MISQ/2020/13304>
- Chang, H., Varvello, M., Hao, F., & Mukherjee, S. (2021). Can you see me now?: A measurement study of Zoom, Webex, and Meet. *Proceedings of the ACM SIGCOMM Internet Measurement Conference, IMC*. <https://doi.org/10.1145/3487552.3487847>
- Choi, D., Chung, C. Y., Seyha, T., & Young, J. (2020). Factors affecting organizations' resistance to the adoption of blockchain technology in supply networks. *Sustainability (Switzerland)*, 12(21), 8882–8895. <https://doi.org/10.3390/su12218882>
- DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *Journal of Management Information Systems*, 19(4), 9–30. <https://doi.org/10.1080/07421222.2003.11045748>
- Eze, S. C., Chinedu-Eze, V. C. A., Okike, C. K., & Bello, A. O. (2020). Factors influencing the use of e-learning facilities by students in a private Higher Education Institution (HEI) in a developing economy. *Humanities and Social Sciences Communications*, 7(1), 1–15. <https://doi.org/10.1057/s41599-020-00624-6>
- Fauzee, M. S. O., Zhang, S., Ishak, M., Ma, L., Hou, M., Zhang, W., Abdullah, M. N. H., Habibi, A., Singh, D. S. G., Yasin, M. H. M., & Nik, W. S. W. (2026). Enhancing academic resilience through motivation and strategy: Evidence from Malaysian boarding

- schools using SDT. *International Journal of Evaluation and Research in Education*, 15(1), 238–257. <https://doi.org/10.11591/ijere.v15i1.35494>
- Goh, E., & Sigala, M. (2020). Integrating information & communication technologies (ICT) into classroom instruction: Teaching tips for hospitality educators from a diffusion of innovation approach. *Journal of Teaching in Travel and Tourism*, 20(2), 156–165. <https://doi.org/10.1080/15313220.2020.1740636>
- Habibi, A., Mukminin, A., Octavia, A., Wahyuni, S., Danibao, B. K., & Wibowo, Y. G. (2024). ChatGPT acceptance and use through UTAUT and TPB: A big survey in five Indonesian Universities. *Social Sciences & Humanities Open*, 10 (101136), 1–11. <https://doi.org/10.1016/j.ssaho.2024.101136>
- Habibi, A., Mukminin, A., & Sofyan, S. (2024). Access to the digital technology of urban and suburban vocational schools. *Education and Information Technologies*, 29(4). <https://doi.org/10.1007/s10639-023-12006-x>
- Habibi, A., Sofyan, S., & Mukminin, A. (2023). Factors affecting digital technology access in vocational education. *Scientific Reports*, 13(1), 5682. <https://doi.org/10.1038/s41598-023-32755-6>
- Habibi, A., Yusop, F. D., & Razak, R. A. (2020). The role of TPACK in affecting pre-service language teachers' ICT integration during teaching practices: Indonesian context. *Education and Information Technologies*, 25(3), 1929–1949. <https://doi.org/10.1007/s10639-019-10040-2>
- Hair, J., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *PLS-SEM book: A Primer on PLS-SEM* (3rd ed.). Sage.
- Huang, T., Hochbein, C., & Simons, J. (2020). The relationship among school contexts, principal time use, school climate, and student achievement. *Educational Management Administration & Leadership*, 48(2), 305–323. <https://doi.org/10.1177/1741143218802595>
- Ifinedo, E., Rikala, J., & Hämäläinen, T. (2020). Factors affecting Nigerian teacher educators' technology integration: Considering characteristics, knowledge constructs, ICT practices and beliefs. *Computers and Education*, 146, 1–17. <https://doi.org/10.1016/j.compedu.2019.103760>
- Liljenström, H. (2022). Consciousness, decision making, and volition: Freedom beyond chance and necessity. *Theory in Biosciences*, 141(2), 125–140. <https://doi.org/10.1007/s12064-021-00346-6>
- Mahoney, J. L., Weissberg, R. P., Greenberg, M. T., Dusenbury, L., Jagers, R. J., Niemi, K., Schlinger, M., Schlund, J., Shriver, T. P., VanAusdal, K., & Yoder, N. (2021). Systemic social and emotional learning: Promoting educational success for all preschool to high school students. *American Psychologist*, 76(7), 1128–1142. <https://doi.org/10.1037/amp0000701>
- Maphalala, M. C., & Adigun, O. T. (2020). Academics' experience of implementing e-learning in a South African higher education institution. *International Journal of Higher Education*, 10(1), 1–13. <https://doi.org/10.5430/ijhe.v10n1p1>

- Maswadi, K., Ghani, N. A., & Hamid, S. (2022). Factors influencing the elderly's behavioural intention to use smart home technologies in Saudi Arabia. *PLoS ONE*, 17(8Au), 1–30. <https://doi.org/10.1371/journal.pone.0272525>
- Mirabolghasemi, M., Choshaly, S. H., & Iahad, N. A. (2019). Using the HOT-fit model to predict the determinants of E-learning readiness in higher education: A developing Country's perspective. *Education and Information Technologies*, 24, 3555–3576.
- Mustafa, M. H., Ahmad, M. B., Shaari, Z. H., & Jannat, T. (2021). Integration of TAM, TPB, and TSR in understanding library user behavioral utilization intention of physical vs. E-book format. *Journal of Academic Librarianship*, 47(5), 1–11. <https://doi.org/10.1016/j.acalib.2021.102399>
- Olugbara, C. T., Imenda, S. N., Olugbara, O. O., & Khuzwayo, H. B. (2020). Moderating effect of innovation consciousness and quality consciousness on intention-behavior relationship in E-learning integration. *Education and Information Technologies*, 25(1), 329–350. <https://doi.org/10.1007/s10639-019-09960-w>
- Onyekwere, J., & Enamul Hoquei, K. (2023). Relationship between technological change, digitization, and students' attitudes toward distance learning in Lagos Higher Education institutes. *Innoeduca. International Journal of Technology and Educational Innovation*, 9(1), 126–142. <https://doi.org/10.24310/innoeduca.2023.v9i1.15286>
- Panigrahi, R., Srivastava, P. R., & Panigrahi, P. K. (2021). Effectiveness of e-learning: the mediating role of student engagement on perceived learning effectiveness. *Information Technology and People*, 34(7), 1840–1862. <https://doi.org/10.1108/ITP-07-2019-0380>
- Polat, E., Hopcan, S., & Yahşi, Ö. (2022). Are K-12 teachers ready for e-learning? *International Review of Research in Open and Distance Learning*, 23(2), 214–241. <https://doi.org/10.19173/irrodl.v23i2.6082>
- Pratama, H., Azman, M. N. A., Kassymova, G. K., & Duisenbayeva, S. S. (2020). The trend in using online meeting applications for learning during the period of pandemic Covid-19: A literature review. *Journal of Innovation in Educational and Cultural Research*, 1(2), 28–68. <https://doi.org/10.46843/jiecr.v1i2.15>
- Prifti, R. (2022). Self-efficacy and student satisfaction in the context of blended learning courses. *Open Learning*, 37(2), 111–125. <https://doi.org/10.1080/02680513.2020.1755642>
- Purwanto, E., & Tannady, H. (2020). The factors affecting intention to use Google Meet amid online meeting platform competition in Indonesia. *Technology Reports of Kansai University*, 62(6), 2829–2839.
- Qoriawan, T., & Apriliyanti, I. D. (2023). Exploring connections within the technology-based entrepreneurial ecosystem (EE) in emerging economies: understanding the entrepreneurship struggle in the Indonesian EE. *Journal of Entrepreneurship in Emerging Economies*, 15(2), 301–332. <https://doi.org/10.1108/JEEE-02-2021-0079>
- Rahman, M. M., Lesch, M. F., Horrey, W. J., & Strawderman, L. (2017). Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. *Accident Analysis and Prevention*, 108, 361–372. <https://doi.org/10.1016/j.aap.2017.09.011>

- Ramadiani, Azainil, Hidayanto, A. N., Khairina, D. M., & Jundillah, M. L. (2020). Teacher and student readiness using e-learning and m-learning. *Bulletin of Electrical Engineering and Informatics*, 9(3), 1176–1182. <https://doi.org/10.11591/eei.v9i3.2006>
- Rejón-Guardia, F., Polo-Peña, A. I., & Maraver-Tarifa, G. (2020). The acceptance of a personal learning environment based on Google apps: The role of subjective norms and social image. *Journal of Computing in Higher Education*, 32(2), 2023–233. <https://doi.org/10.1007/s12528-019-09206-1>
- Rocca, L., Veneziani, M., & Carini, C. (2023). Mapping the diffusion of circular economy good practices: Success factors and sustainable challenges. *Business Strategy and the Environment*, 32(4), 2035–2048. <https://doi.org/10.1002/bse.3235>
- Santos, G., Marques, C. S., Justino, E., & Mendes, L. (2020). Understanding social responsibility's influence on service quality and student satisfaction in higher education. *Journal of Cleaner Production*, 256, 1–10. <https://doi.org/10.1016/j.jclepro.2020.120597>
- Sattin, D., Magnani, F. G., Bartesaghi, L., Caputo, M., Fittipaldo, A. V., Cacciatore, M., Picozzi, M., & Leonardi, M. (2021). Theoretical models of consciousness: A scoping review. *Brain Sciences*, 11(5), 1–58. <https://doi.org/10.3390/brainsci11050535>
- Şimşek, A. S., & Ateş, H. (2022). The extended technology acceptance model for Web 2.0 technologies in teaching. *Innoeduca. International Journal of Technology and Educational Innovation*, 8(2). <https://doi.org/10.24310/innoeduca.2022.v8i2.15413>
- Sivagurunathan, R., Senathirajah, A. R. B. S., Ramasamy, G., Isa, M. B. M., Haque, R., Chanjin, Y., & Sivagurunathan, L. (2024). A study on development of educational leadership program using equine assisted experiential learning. *Eurasian Journal of Educational Research*, (112), 1–14. <https://doi.org/10.14689/ejer.2024.112.01>
- Sofwan, M., Habibi, A., Attar, R. W., Alqahtani, T. M., Alahmari, S. A., & Alhazmi, A. H. (2024). Factors affecting teachers' behavior of innovative teaching with technology: Structural equation modelling. *Sustainability*, 16(19), 8496–8509. <https://doi.org/10.3390/su16198496>
- Sofwan, M., Yaakob, M. F. M., & Habibi, A. (2024). Technological, pedagogical, and content knowledge for technology integration: A systematic literature review. *International Journal of Evaluation and Research in Education (IJERE)*, 13(1), 212–222. <https://doi.org/10.11591/ijere.v13i1.26643>
- Tabandeh, A., Jia, G., & Gardoni, P. (2022). A review and assessment of importance sampling methods for reliability analysis. *Structural Safety*, 97, 1–18. <https://doi.org/10.1016/j.strusafe.2022.102216>
- Toufaily, E., Zalan, T., & Dhaou, S. Ben. (2021). A framework of blockchain technology adoption: An investigation of challenges and expected value. *Information and Management*, 58(3), 1–17. <https://doi.org/10.1016/j.im.2021.103444>
- Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-Learning during the COVID-19 pandemic: How have higher education institutions responded to the challenge? *Education and Information Technologies*, 26(5), 6401–6419. <https://doi.org/10.1007/s10639-021-10633-w>

- Yuanjue, Y., Senathirajah, A. R. B. S., Ramasamy, G., Qazi, S. Z., Fauzee, M. S. O., Haque, R., & Lertatthakornkit, T. (2025). Sports products and services: Technological acceptance and psychological factors influencing online purchase behavior amongst university students. *WSEAS Transactions on Business and Economics*, 22, 2444–2455. <https://doi.org/10.37394/23207.2025.22.192>
- Wang, G., Tan, G. W. H., Yuan, Y., Ooi, K. B., & Dwivedi, Y. K. (2022). Revisiting TAM2 in behavioral targeting advertising: A deep learning-based dual-stage SEM-ANN analysis. *Technological Forecasting and Social Change*, 175, 1–15. <https://doi.org/10.1016/j.techfore.2021.121345>

Appendix A

Items

Indonesian
Jenis Kelamin
Semester:
Umur

Computer Self-Efficacy

1. Saya bisa menyelesaikan tugas menggunakan e-learning jika saya hanya memiliki petunjuk manual.
2. Saya merasa percaya diri dalam menggunakan e-learning jika ada orang lain yang membantu saya untuk memulai.
3. Saya bisa menyelesaikan tugas menggunakan e-learning jika saya memiliki banyak waktu untuk menyelesaikannya.
4. Saya merasa nyaman menggunakan e-learning jika saya memiliki akses ke petunjuk manual.

Subjective Norm

1. Orang-orang yang berpengaruh dalam hidup saya berpikir bahwa saya harus menggunakan e-learning.
2. E-learning adalah kebiasaan yang umum di lingkungan saya.
3. Orang-orang yang penting bagi saya berpikir bahwa saya harus menggunakan e-learning.
4. Saya merasa diharapkan untuk menggunakan e-learning oleh orang-orang di sekitar saya.

Knowledge

1. E-learning memungkinkan saya untuk mengelola pengetahuan secara efektif.
2. Saya menggunakan e-learning untuk berbagi pengetahuan dengan orang lain.
3. E-learning memungkinkan saya untuk menyimpan dan mengakses pengetahuan kapan saja.
4. Saya menggunakan e-learning untuk memperbarui pengetahuan saya secara rutin.

Relative Advantage

1. E-learning memberikan keuntungan lebih dibandingkan metode pembelajaran tradisional.
2. Menggunakan e-learning membuat saya lebih produktif dalam belajar.
3. E-learning memungkinkan saya untuk belajar dengan cara yang lebih fleksibel.
4. Saya merasa e-learning memberikan manfaat yang lebih besar dibandingkan metode lain.

Compatibility

1. E-learning kompatibel dengan gaya belajar saya.
2. Saya merasa e-learning sesuai dengan cara saya belajar.
3. E-learning cocok dengan kebutuhan saya dalam belajar.

Complexity

1. Saya merasa e-learning sulit untuk digunakan.
2. E-learning membutuhkan usaha ekstra untuk memahami cara kerjanya.
3. Saya merasa e-learning terlalu rumit untuk digunakan secara rutin.

Management support

1. Manajer tertarik pada penggunaan layanan e-learning.

2. Manajer bersedia berinvestasi pada sumber daya yang diperlukan.
3. Manajer bersedia mengambil risiko yang terlibat dalam penggunaan elearning.

Innovation

1. Saya sadar bahwa penggunaan e-learning membawa inovasi dalam pengajaran dan pembelajaran
2. Saya menyadari penggunaan e-learning membawa inovasi dalam pengajaran dan pembelajaran

Quality

1. Saya merasa kualitas e-learning yang saya gunakan sangat baik.
2. E-learning yang saya gunakan memiliki kualitas yang konsisten.

E-learning readiness

1. Saya memiliki keyakinan positif terhadap efisiensi e-learning dalam studi saya.
2. Saya seorang pelopor dalam menggunakan e-learning dalam studi saya.
3. Jika saya ingin menggunakan e-learning dalam studi saya, saya lebih suka menggunakan fitur dasar.
4. Saya tidak percaya menggunakan e-learning dalam penelitian saya.

Actual use of e-learning

1. Saya benar-benar menggunakan e-learning untuk belajar.
2. Saya sering menggunakan e-learning dalam kegiatan belajar saya.
3. Saya menggunakan e-learning secara teratur untuk berkolaborasi.

Indonesian

Gender

Semester:

Age

Computer Self-Efficacy

1. I can complete the task using e-learning if I only have manual instructions.
2. I feel confident in using e-learning if someone else helps me to get started.
3. I can complete the task using e-learning if I have plenty of time to complete it.
4. I feel comfortable using e-learning if I have access to manual instructions.

Subjective Norm

1. Influential people in my life think that I should use e-learning.
2. E-learning is a common habit in my environment.
3. People who are important to me think that I should use e-learning.
4. I feel expected to use e-learning by those around me.

Knowledge

1. E-learning allows me to manage knowledge effectively.
2. I use e-learning to share knowledge with others.
3. E-learning allows me to store and access knowledge at any time.
4. I use e-learning to update my knowledge regularly.

Relative Advantage

1. E-learning provides more advantages over traditional learning methods.
2. Using e-learning makes me more productive in learning.

3. E-learning allows me to learn in a more flexible way.
4. I feel e-learning provides greater benefits compared to other methods.

Compatibility

1. E-learning is compatible with my learning style.
2. I believe e-learning suits my learning style.
3. E-learning suits my needs in learning.

Complexity

1. I find e-learning difficult to use.
2. E-learning requires extra effort to understand how it works.
3. I find e-learning too complicated to use regularly.

Management support

1. Managers are interested in the use of e-learning services.
2. The manager is willing to invest in the necessary resources.
3. Managers are willing to take the risks involved in the use of e-learning.

Innovation

1. I am aware that the use of e-learning brings innovation in teaching and learning
2. I realize the use of e-learning brings innovation in teaching and learning

Quality

1. I feel the quality of the e-learning I use is excellent.
2. The e-learning I use is of consistent quality.

E-learning readiness

1. I have a positive belief in the efficiency of e-learning in my study.
2. I am a pioneer in using e-learning in studies death.
3. If I want to use e-learning in my studies, I am more like to use basic features.
4. I do not believe in using e-learning in my research.

Actual use of e-learning

1. I actually use e-learning for learning.
2. I often use e-learning in my learning activities.
3. I use e-learning regularly to collaborate.

Collaborative Online International Learning: Scale Validation and Reliability

Hugo Alexander Rozo-García

Universidad de La Sabana, Chia, Colombia

María Soledad Ramirez-Montoya

*Department of Research, Benemérita Escuela Normal de Coahuila, MEXICO/Research
Department, University of Design, Innovation and Technology (UDIT), Madrid, Spain*

Carolina Alcantar Nieblas

Institute for the Future of Education, Tecnológico de Monterrey, Monterrey, México

Abstract

Collaborative Online International Learning (COIL) is a powerful tool for improving higher education by fostering intercultural competencies, broadening access to international experiences, and preparing students for an increasingly globalized and digitized world. The measurement of COIL experiences in students is fundamental to know the impact it has on learning and the student experience, as well as to make decisions with scientific evidence. The field of COIL measurement is a little explored area, so there is an important gap in the literature to consider. The study presents the psychometric properties of construct validity and reliability of the scale to measure the COIL experiences of higher education students. The sample included 100 students from Colombia, Venezuela, Spain, China, and Mexico; 66 were female (66%), 34 were male (34%), and their ages ranged from 17 to 27. The calculated indices confirmed the fit of the data to the Collaborative Online International Learning measurement model, highlighting three dimensions: digital interaction, multicultural collaborative work in teams, and reflection during collaborative activity. This article represents a contribution to the field of COIL by showing adequate psychometric properties that ensure the correct measurement of the construct. It is a valid tool for educational bodies responsible for the internationalization of the curriculum.

Keywords: Collaborative online international learning, higher education, measurement, validity, reliability, educational innovation

Rozo-García, H., Ramirez-Montoya, M., Nieblas, C. (2025) Collaborative online international learning: Scale validation and reliability. *Online Learning* 30(1), pp. 199-212.
<https://doi.org.10.24059/olj.v30i1.4770>

Collaborative Online International Learning (COIL) is recognized as a pedagogical approach or strategy that thrives on collaboration. It involves the exchange of learning experiences between two or more educational institutions in different geographical areas or that present significant cultural variations. The professors of these institutions decide to partner bilaterally by proposing activities for their students to develop joint projects in a period averaging between 5 and 8 weeks (Rubin & Guth, 2023). SUNY (2015) describes COIL as a teaching tool or learning paradigm that fosters intercultural competency using Internet tools and innovative online pedagogies through meaningful exchanges that last from 5 to 15 weeks. It also defines it as an approach that brings students and faculty from different cultures to discuss, learn, and collaborate in a classroom setting (SUNY, 2023). Similarly, it has been conceived as an international virtual mobility experience, where two teachers collaboratively design and implement a course, aligning learning outcomes, activities, and modules that emphasize the intercultural and transnational dimensions (Helm, 2020; Naicker et al., 2021). The intercultural dimension derives from two courses usually located in different geographical locations but are synchronized by the institutions to address global content or problems.

The proposal of creating or co-designing a collaborative online learning experience among colleagues from different universities and geographical areas is quite attractive to participating faculty and students. The idea is not new; it is based on Vygotsky's (1978) theory of social constructivism, where students, as active subjects, use social skills to work, discuss, and complete group tasks. In Vygotsky's time, the activities occurred in a presential (face-to-face) classroom. Now, integrated digital technologies allow synchronous and asynchronous deliveries, enriching the learning process and breaking the barriers of the traditional classroom (Otchie, 2018).

Moreover, COILs respond to an imminent need in universities to train students for a multicultural world with global problems or needs and discussions of global citizenship and education (O'Dowd, 2017; Woodley et al., 2023). These activities are possible thanks to the internationalization of the curriculum, which also enhances the intercultural dimension through student-centered content that develops global competencies through multidisciplinary teamwork and strengthens complex thinking, creativity, and appreciation for diversity, among other competencies (Leask, 2015; Romero-Rodríguez et al., 2022). For these and other reasons, COIL courses comprise a pedagogy that responds to the current demands of education and society.

Literature Review

Few documented studies on COIL courses exist. They first appeared in the early 2000s, although some literature has unveiled the underlying perspectives of their applications, intentions, and nuances in the last five years. Some studies are presented below, emphasizing the results that impact the evidence.

Some universities worldwide have tried to introduce their professors to this innovative educational alternative and support it through two initiatives: a) COIL Connect, an initiative of the COIL Virtual Exchange Foundation, and b) the SUNY COIL Center (State University of New York). These initiatives provide access to a bank of institutions, classes, and professors interested in connecting and co-designing a COIL experience and other services, such as training, workshops, and support. These valuable actions have intrigued teachers to investigate

these experiences for various reasons, such as Anderson & Or (2023), who examined the intercultural effectiveness of a COIL on adult students in the United States and Brazil, in line with the brief discussion in our introduction and perhaps representative of COIL's genesis.

Membrillo-Hernández et al. (2023) sought to identify how the global classroom facilitates developing disciplinary and transversal competencies in sustainability, plant physiology, and SDG compliance through collaborative work, critical thinking, and problem-solving. Notably, their proposed COIL centered on challenge-based learning, resolving a real-world challenge remotely using digital communication tools.

Measurement of Collaborative Online International Learning (COIL)

Several elements configuring a COIL experience can be evaluated and measured, including its formulation and planning, which spotlight the primary intention of a COIL course, which, in some cases, may be developed to favor or privilege internationalization, learning, motivation, and interculturality, among other purposes. Mestre-Segarra & Ruiz-Garrido (2022) used a questionnaire applied before and after the experience to measure participant perception and semi-structured interviews that inquired about expectations and perceptions. They concluded that the COIL course improved language learning, which is linked to both intercultural and interdisciplinary skills.

The above aligns with the claim that COILs are a pedagogical approach to enrich learning and positively impact students' cultural awareness. Davis et al. (2023) concluded this through perception surveys applied before and after the experience to measure the growth of knowledge and behavior.

In the same sense, the research by Naicker et al. (2022) inquired about barriers and facilitators through focus groups. Regarding obstacles, the study highlighted digital skills, language, and dynamics among colleagues to overcome them. Again, the facilitators indicated that COIL could comprise an effective learning system, depending upon the structure of the courses and the academic self-efficacy of the participants. As observed, each research study used different measuring instruments to assess the COIL experience's success in meeting the proposed course's intention. Likert-type questionnaires and open methods such as interviews and focus groups were used to measure participants' perceptions.

Other studies assessing the competencies developed through COIL courses rely on a variety of instruments, aligned with the intended goals of the specific COIL design. Online COIL courses are significantly challenging, requiring discussion and dialogue about working on a joint project remotely and how to evaluate the personal, social, and cognitive competencies of the participants through various collection instruments, including online surveys, in-depth interviews, focus groups, review of teaching diaries, field notes, and others (Ballesteros-Sola & Magomedova, 2023). House et al. (2022) demonstrated a strong relationship between participation in COIL initiatives and the development of cultural competence, mediated by gains in cultural knowledge resulting from COIL-oriented discussions. Their findings and conclusions were obtained after applying a survey with closed and open questions to students.

On the other hand, the research of Marconi et al. (2023) in the Tuning Project assured that the COIL allowed the development of several transversal competencies for professional

development, including interculturality, collaboration, disciplinary professional learning, and self-efficacy. Their research was based on an empirical phenomenological design using opinion surveys applied in each session.

The above results related to implementing COIL in universities suggest a promising panorama for learning and developing competencies necessary for contemporary society. University research on COIL is increasingly present. However, an aspect that must be addressed is the development of objective measurement instruments to assess understanding of phenomena, evaluate results, and support informed decision-making. Adequate measurement allows comparing data from different studies and generalizing the findings, which contributes to advancing and consolidating knowledge in a specific area. In this sense, the measurement of COIL experiences is in its infancy. An example is the scarcity of measurement tools for COIL experiences that provide evidence of validity and reliability. Therefore, the present study addresses this gap in the literature with a measurement scale for COIL experiences among university students, exploring the construct validity of the scale and its reliability.

Method

The analysis of COIL literature led to delimiting the scale's dimensions and items in its first version, which was submitted to experts who evaluated the clarity, coherence, relevance, and sufficiency of the scale's items. After affirming the content validity, we applied the scale to higher education students participating in a COIL course (an inclusion criterion). The sample consisted of 100 students from Colombia, Venezuela, Spain, China, and Mexico, of which 66 (66%) were women and 34 (34%) were men. The ages ranged from 17 to 27.

Instrument

The instrument aims to measure students' experiences in COIL courses. According to the definition of COIL, these courses should foster the development of intercultural competencies by providing students with international experiences and preparing them for an increasingly globalized and digitized society.

In this context, the instrument titled "Perception of Experiences in Collaborative Online International Learning," designed based on a review of the literature (Appiah-Kubi & Nichwitz, 2020; Tecnológico de Monterrey, 2023; Roza et al., 2024) evaluates experiences in COIL courses through three main dimensions. This instrument consists of 19 items distributed across the following dimensions:

1. **Student interaction in digital environments:** This dimension includes seven items that assess interaction between students in digital platforms. An example is: "I respect my peers' opinions in the online course, even if I disagree with them."
2. **Collaborative work in multicultural teams to achieve objectives:** This dimension comprises six items that measure collaboration to achieve common goals in multicultural teams. An example is: "Working collaboratively with peers from other cultures helped me develop my communication skills."

3. **Reflection on differences and similarities with peers during collaboration:** This dimension includes six items that explore how students reflect on differences and similarities with their peers during collaboration. An example is: “Working with peers from different cultures helped me realize the importance of respect.”

The scale uses a Likert-type response format with values ranging from 1 (“Strongly disagree”) to 7 (“Strongly agree”).

Procedure

Before administering the instrument, we requested the voluntary participation of students who had previously participated in a COIL. The students who agreed to participate gave informed consent, and we explained ethical considerations such as confidentiality and data handling. The Google Forms instrument administered electronically took approximately 15 minutes to answer.

For data analysis, the instrument’s descriptive and univariate normality measures were calculated first using the SPSS 25 statistical package for social sciences. Normality values between 3 and -3 standard deviations were the reference for skewness and kurtosis.

Second, a Confirmatory Factor Analysis (CFA) was performed to examine the scale’s internal structure; the CFA was calculated using the maximum likelihood (ML) estimation method. A bootstrap of 500 replicates with a 95% confidence interval was used to ensure that multivariate normality issues did not affect the calculations. The χ^2 is sensitive to sample size, so we used the fit indices proposed by Blunch (2013) and Byrne (2013): χ^2 , p (Chi-square and associated probability), TLI (Tucker-Lewis Index), SRMR (Standardized Root Mean Square Residual), CFI (Comparative Fit Index) and RMSEA (Root Mean Square Error Approximation with its confidence interval). The indicators of data model fit were χ^2 values with $p > .001$; TLI, CFI, AGFI $\geq .95$; RMSEA and SRMR $\leq .08$ (Byrne, 2013; Sharma et al., 2005). Finally, Cronbach’s Alpha and McDonald’s Omega index were used to examine the reliability of the measurement model. Cronbach’s Alpha and McDonald’s Omega values $> .70$ were acceptable (Green & Yang, 2015).

Results

Table 1 presents the results of the means, standard deviations, range, and normality of the items that comprise the scale “Perceptions of Experience in Collaborative Online International Learning.” The results indicate that the students had a favorable opinion about their experiences as participants in COIL courses. Regarding the normality of the items, the values obtained do not exceed the values suggested in the literature, except for items 3 and 16, which presented kurtosis values slightly above three standard deviations.

Table 1

Means, Standard Deviations, Minimum, Maximum, and Normality of the Scale “Perceptions of Experience in Collaborative Online International Learning.”

Item	M	SD	Min	Max	Asymmetry	Kurtosis
Item 1	5.06	1.44	1	7	-.52	-.40
Item 2	5.37	1.37	1	7	-.88	.12
Item 3	6.34	.91	1	7	-1.79	3.39
Item 4	5.89	1.34	1	7	-1.61	2.52
Item 5	5.54	1.42	1	7	-.83	.10
Item 6	5.82	1.35	1	7	-1.17	.62
Item 7	5.01	1.88	1	7	-.75	-.57
Item 8	5.73	1.46	1	7	-1.33	1.12
Item 9	5.57	1.52	1	7	-1.15	.56
Item 10	5.65	1.29	1	7	-.81	-.12
Item 11	5.89	1.18	1	7	-.92	.16
Item 12	5.96	1.18	1	7	-1.06	.40
Item 13	5.89	1.05	1	7	-1.45	2.10
Item 14	5.96	1.18	1	7	-1.28	.51
Item 15	6.15	1.46	1	7	-.96	-.17
Item 16	5.99	1.00	1	7	-.91	3.50
Item 17	6.06	1.16	1	7	-1.65	1.29
Item 18	6.02	1.26	1	7	-1.17	1.29
Item 19	5.81	1.45	1	7	-1.09	.68

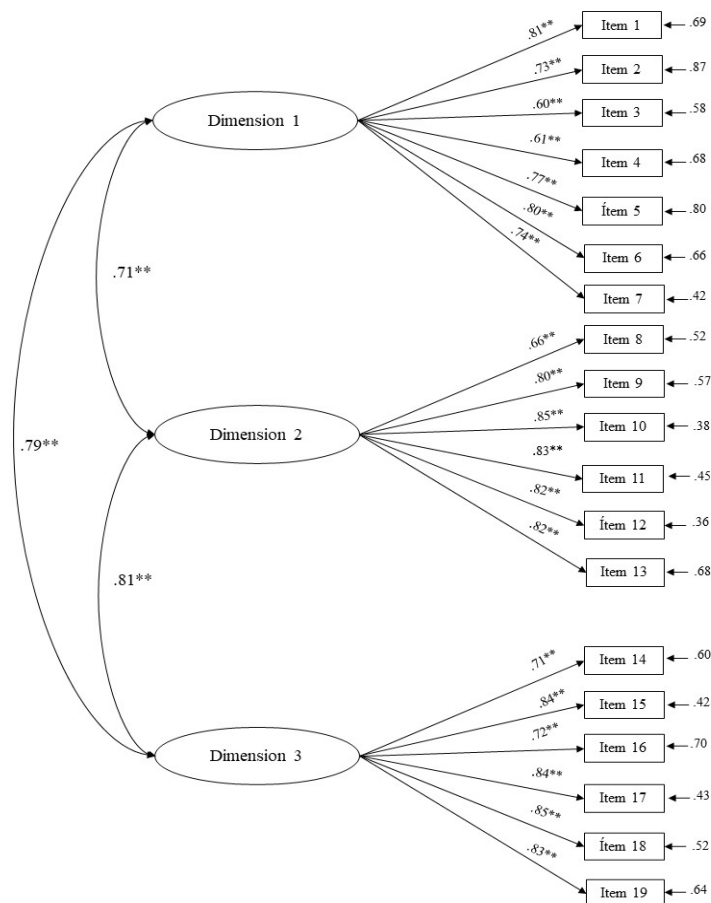
Note: Min: minimum, Max: maximum

Construct Validity

The factor loadings of the items in the measurement model were significant, with values between .63 and .92 (see Figure 1). The indices obtained confirm the fit of the data to the measurement model for Collaborative Online International Learning in three dimensions: interaction among students in digital environments, collaborative work in multicultural teams to achieve goals, and reflection on differences and similarities with peers during collaboration ($\chi^2 = 162.06$; $gl = 96$; $p = < .000$; $SRMR = .05$; $TLI = .92$, $CFI = .94$; $RMSEA = .07$, IC 90% [.06, .08]).

Figure 1

Results of the Confirmatory Factor Analysis of the Scale “Perceptions of Experience in Collaborative Online International Learning.”



Note: Dimension 1: Interaction among students in digital environments; Dimension 2: Collaborative work in multicultural teams to achieve goals; and Dimension 3: Reflection on differences and similarities with peers during collaboration.

Reliability Analysis

Table 2 reports the reliability analysis results calculated by the omega coefficient (ω) and Cronbach's alpha (α). The values of both coefficients range between 0.84 and 0.89, suggesting good reliability of the items in measuring the variables they represent. Thus, the items are consistent with each other and reliably measure the dimension corresponding to the interaction between students in digital environments.

Table 2

McDonald's (?) Omega and Cronbach's Alphas of the Dimension "Interaction Between Students in Digital Environments."

Items	ω	α	Magnitude
1. Learning with my peers through interaction in digital environments was easy.	.86	.84	Good
2. I can communicate adequately with peers from other countries through tools in digital environments.	.87	.85	Good
3. I respected the views of my peers in the online course, even if I disagreed with them.	.89	.88	Good
4. My classmates considered my opinions, even if they differed from theirs.	.89	.87	Good
5. Interaction with my peers in digital environments favored my learning.	.86	.84	Good
6. The online course professor promoted a collaborative environment among classmates.	.87	.84	Good
7. I perceived a cooperative environment enjoyed by most classmates during the online course.	.86	.84	Good

Note: McDonald's ω , Cronbach's α

Table 3 reports the reliability of the dimension of collaborative work in multicultural teams to achieve objectives. The values of both coefficients range between 0.82 and 0.87, suggesting good item reliability in measuring the variables they represent; thus, the items are consistent with each other and reliably measure the construct.

Table 3

McDonald's Omega and Cronbach's Alpha of the Dimension "Collaborative Work in Multicultural Teams to Achieve Objectives."

Items	ω	α	Magnitude

8. My online coursemates and I were able to guide each other to meet the objectives despite language barriers.	.86	.86	Good
9. The collaborative work with my teammates let me know their organizational forms.	.87	.86	Good
10. Working collaboratively with colleagues from other cultures helped me develop my practical communication skills.	.82	.82	Good
11. Working collaboratively with my teammates from other cultures helped me to develop my leadership skills.	.83	.82	Good
12. Collaborative work with peers from other cultures made me commit to my tasks.	.84	.84	Good
14. I felt satisfied that I successfully achieved the course objectives.	.85	.85	Good

Table 4 reports the reliability of the dimension “Reflection on differences and similarities with peers during collaboration.” The values of both coefficients range between 0.85 and 0.89, suggesting good item reliability for the measurement of the variables they represent; thus, the items are consistent with each other and reliably measure the construct.

Table 4

McDonald’s Omega and Cronbach’s Alpha of the Dimension “Reflection on Differences and Similarities with Peers During Collaboration.”

Items	ω	α	Magnitude
15. Working with peers from different cultures helped me remember that everyone is different and must be considered when working in a group.	0.88	0.87	Good
16. Working with peers from different cultures helped me learn about new digital tools.	0.86	0.86	Good
17. Working with peers from different cultures helped me realize the importance of respect.	0.88	0.87	Good
18. Working with peers from different cultures helped me realize that we are not so different.	0.89	0.87	Good

19. Working cross-culturally helped me to reflect on global issues.	0.86	0.85	Good
Working with people from different cultures helped me to learn about study habits that can help me in the future.	0.86	0.86	Good

Finally, Table 5 reports the results of means, standard deviations, and reliability by dimension. The means reflect students' positive perceptions of their experiences in COIL courses regarding interacting with peers in digital environments, the collaboration among multicultural teams, and the differences and similarities among peers during collaboration. The reliability values of the McDonald's Omega and Cronbach's Alpha coefficients are excellent, suggesting that measures to evaluate the variables in each study dimension are adequate.

Table 5

Means, Standard Deviation, McDonald's Omega and Cronbach's Alpha by Dimension of the Scale "Perceptions of Experiences in Collaborative Online International Learning."

Items	M	SD	ω	α
Interaction among students in digital environments.	5.57	1.07	.89	.87
Collaborative work in multicultural teams to achieve objectives.	5.82	1.00	.86	.89
Reflection on differences and similarities with peers during collaboration.	5.83	1.00	.89	.88

Discussion

Developing instruments with robust validity to measure COIL course experiences is essential for a deeper understanding of learning, interaction, and collaboration processes in international virtual environments. The present study aimed to develop a measurement scale for university students' Collaborative Online International Learning experiences and analyze the construct validity and reliability of the scale. In Figure 1, we reported the results of the construct validity performed through Confirmatory Factor Analysis; the findings confirmed the excellent fit of the data to the measurement model proposed in three dimensions: interaction among students in digital environments, collaborative work in multicultural teams to achieve goals, and reflection on the differences and similarities among peers during collaboration. Our findings complement those of instruments used in other COIL courses (Davis et al., 2023; Mestre-Segarra & Ruiz-Garrido, 2022; Naicker et al., 2022) that do not report the evidence of validity and reliability of their scales.

In theory, these results confirm the viability of a model with three dimensions to evaluate the COIL experiences of students. In educational practice, this represents a contribution for teachers and researchers who develop educational practices and studies on the subject; they will now have a valid and reliable measure for the construct.

The reliability of the proposed scale was calculated using McDonald's Omega coefficient and Cronbach's Alpha. The exploration of item reliability allowed for knowing precisely the scores of each for more specific decision-making considering the item's behavior with the rest of the scale. Similarly, we calculated the reliability of the dimensions to know the global behavior of those values. Tables 2, 3, and 4 report the reliabilities of the dimensional items, indicating good values, as suggested in the literature (Green & Yang, 2015). This demonstrates the consistency of each scale item. Similarly, the reliability calculated by dimensions showed values that reflect good internal consistency and the excellent fit of the items to measure the Collaborative Online International Learning experiences.

Limitations

This study is a valuable contribution to knowledge about Collaborative Online International Learning, specifically in the methodological and instrumental aspects. Like every study, the findings presented here must be taken cautiously due to its limitations. In this case, although we sought to reduce them as much as possible, some limitations were beyond our ability to resolve. First, the study sample size was small, so we suggest forming a larger sample for future studies. Second, although we sought a sample with cultural variants, these can be expanded to permit generalizations. Finally, although we used a robust measure such as Confirmatory Factor Analysis to determine construct validity, it is necessary to include other evidence of validity, including concurrent, predictive, and discriminant validity, to strengthen the evidence of the scale's validity.

Conclusion

This study focused on developing a scale to measure experiences in COIL courses, obtaining evidence of validity and reliability. The confirmatory factor analysis results supported a three-dimensional model: interaction among students in digital environments, collaborative work in multicultural teams, and reflection during collaboration. Reliability coefficients by items and dimensions were also obtained, demonstrating adequate internal consistency and validating the robustness of the proposed scale. These findings represent a significant advance in the field and provide a valid and reliable tool to evaluate COIL experiences theoretically and practically.

Declarations

Conflict of interest. The authors have no conflict of interest in the publication of this manuscript.

Data Availability. Data will be available only if there is justification for the request.

References

- Anderson, A. M., & Or, J. (2023). Fostering intercultural effectiveness and cultural humility in adult learners through collaborative online international learning. *Adult Learning*, <https://doi.org/10.1177/10451595231182447>
- Appiah-Kubi, P., & Nichwitz, J. (2020, June). Students' perception of collaborative online international learning. In *2020 ASEE Virtual Annual Conference Content Access*. <https://peer.asee.org/students-perception-of-collaborative-online-international-learning>
- Ballesteros-Sola, M., & Magomedova, N. (2023). Impactful social entrepreneurship education: A US-Spanish service-learning collaborative online international learning (COIL) project. *The International Journal of Management Education*, 21(3), 100866. <https://doi.org/10.1016/j.ijme.2023.100866>
- Blunch, N. J. (2013). *Introduction to structural equation modeling using IBM SPSS statistics and AMOS*. SAGE Publications, Ltd. <https://doi.org/10.4135/9781526402257>
- Byrne, B. M. (2013). *Structural equation modeling with Mplus*. Routledge. <https://doi.org/10.4324/9780203807644>
- Davis, L. L., Bhatarasakoon, P., Chaiard, J., Walters, E. M., Nance, J., & Mittal, M. (2023). Use of Collaborative Online International Learning to teach evidence-based practice. *The Journal for Nurse Practitioners*, 19(5), 104498. <https://doi.org/10.1016/j.nurpra.2022.11.008>
- Green, S. B., & Yang, Y. (2015). Evaluation of dimensionality in the assessment of internal consistency reliability: Coefficient alpha and omega coefficients. *Educational Measurement: Issues and Practice*, 34(4), 14–20. <https://doi.org/10.1111/emip.12100>
- Helm F. (2020). Emi, internationalisation, and the digital. *International Journal of Bilingual Education and Bilingualism* 23(3), 314–325. <https://doi.org/10.1080/13670050.2019.1643823>
- House, S. K., Nielsen, K., & Dowell, S. (2022). International collaboration using Collaborative Online International Learning (COIL)/Globally Networked Learning (GNL) model. *Teaching and Learning in Nursing*, 17(4), 421-424. <https://doi.org/10.1016/j.teln.2022.06.010>
- Inada, Y. (2023). A comparative study of physical versus online classrooms: Co-creation in industry-academia collaborative ducation. *Review of Integrative Business and Economics Research*, 12(2), 97-117. <https://doi.org/10.5539/jel.v11n4p15>
- Leask, B. (2015). *Internationalizing the curriculum*. Routledge. <https://www.routledge.com/Internationalizing-the-Curriculum/Leask/p/book/9780415728157>
- Marconi, D. R., Acevedo, M. L., Serra, M., Fontaine, L. Z., Sanabria, C. M., & Almuna, H. Q. (2023). Aprendizaje colaborativo internacional en línea como estrategia para el desarrollo de competencias transversales en la educación superior, una experiencia desde la carrera de fonoaudiología. *Educación Médica*, 24(5), 100835. <https://doi.org/10.1016/j.edumed.2023.100835>

- Membrillo-Hernández, J., Cuervo-Bejarano, W. J., Mejía-Manzano, L. A., Caratozzolo, P., & Vázquez-Villegas, P. (2023). Global shared learning classroom model: A pedagogical strategy for sustainable competencies development in higher education. *International Journal of Engineering Pedagogy*, 13(1). <https://doi.org/10.3991/ijep.v13i1.36181>
- Mestre-Segarra, M. Á., & Ruiz-Garrido, M. F. (2022). Examining students' reflections on a collaborative online international learning project in an ICLHE context. *System*, 105, 102714. <https://doi.org/10.1016/j.system.2021.102714>
- Naicker, A., Singh, E., & van Genugten, T. (2022). Collaborative online international learning (COIL): Preparedness and experiences of South African students. *Innovations in Education and Teaching International*, 59(5), 499-510. <https://doi.org/10.1080/14703297.2021.1895867>
- O'Dowd, R. (2017). Virtual exchange and internationalizing the classroom. *Training, Language and Culture*, 4(2), 8–27. <https://doi.org/10.29366/2017tlc.1.4.1>
- Otchie, W. (2018). Is technology the solution to effective pedagogy? A constructivist perspective. https://www.auburn.edu/academic/international/_assets/docs/iputl/essays/IsTechnologyTheSolutionToEffectivePedagogy.pdf
- Romero-Rodríguez, J. M., Ramírez-Montoya, M. S., Glasserman-Morales, L. D., & Navas-Parejo, M. R. (2022). Collaborative online international learning between Spain and Mexico: a microlearning experience to enhance creativity in complexity. *Education + Training*, 65(2), 340-354. <https://doi.org/10.1108/ET-07-2022-0259>
- Rozo-García, H., Alcantar-Nieblas, C., & Ramírez-Montoya, M. S. (2024). Scale to measure student perception in collaborative online international learning experiences: Design and validation. *Frontiers in Education*, 9. <https://doi.org/10.3389/feduc.2024.1401295>
- Rubin, J. & Guth, S. (2023). *The guide to COIL virtual exchange: Implementing, growing, and sustaining collaborative online international learning*. Taylor & Francis. <https://www.routledge.com/The-Guide-to-COIL-Virtual-Exchange-Implementing-Growing-and-Sustaining-Collaborative-Online-International-Learning/Rubin-Guth/p/book/9781620369838>
- Sharma, S., Mukherjee, S., Kumar, A., & Dillon, W. R. (2005). A simulation study to investigate the use of cutoff values for assessing model fit in covariance structure models. *Journal of Business Research*, 58(7), 935–943. <https://doi.org/10.1016/j.jbusres.2003.10.007>
- SUNY (2015) *Faculty guide for collaborative online international learning course development*. The State University of New York Global Center. http://www.ufic.ufl.edu/UAP/Forms/COIL_guide.pdf
- SUNY COIL. *Professional development workshops*. <https://coil.suny.edu/professional-development/>
- Tecnologico de Monterrey. (2023). *Global Shared Learning Classroom*. <https://globalsharedlearning.tec.mx/es/gsl-classroom>
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press. <https://doi.org/10.2307/j.ctvjf9vz4>

Woodley, L. K., Rodriguez dos Santos, M., Crandell, J. L., Grant, G. G., & Cosgrove, B. (2023). Collaborative online international learning in undergraduate nursing education: from inspiration to impact. *International Journal of Nursing Education Scholarship*, 20(1), 20220077. <https://doi.org/10.1515/ijnes-2022-0077>

Exploring Preservice Teachers' Design Thinking Mindset in a Technology-Enhanced Active Learning Environment for STEM Courses

Areej ElSayary
Zayed University

Abstract

This study explores how a technology-enhanced active learning environment, supported by interactive technologies, may influence preservice teachers' perceptions of their design thinking (DT) mindsets in interdisciplinary STEM courses. Using a blend of digital tools and the design thinking process, the research aimed to engage students in activities that promote key DT traits, including managing uncertainty, empathy, mindfulness, collaboration, learning orientation, and creative confidence. Ninety-four preservice teachers from an early childhood education program in a UAE university participated, receiving two weeks of intensive training on digital tools (e.g., Genially, Canva, PowToon, AR/VR apps), concluding in earning an Apple Teaching Certificate. These tools were later utilized to facilitate key components of the DT process, including user empathy, iterative prototyping, and collaborative challenge design, thereby directly supporting the development of DT mindsets within a technology-enhanced framework. This study employed an explanatory sequential mixed-methods approach, beginning with quantitative analysis (mean, standard deviation, and one-sample t-test) and followed by qualitative insights from focus groups. Findings suggest a perceived positive shift across all DT mindset categories, with students reporting enhanced confidence in tackling complex challenges using technology-driven and collaborative techniques. These results should be interpreted with caution due to the absence of baseline (pre-test) data. Nevertheless, they highlight the potential of technology-enhanced active learning frameworks to support the development of mindsets revealed to be effective in STEM education.

Keywords: Design thinking mindset, technology-enhanced active learning environment, interdisciplinary STEM courses, transformative learning, technological pedagogical content knowledge

ElSayary, A. (2025). Exploring preservice teachers' design thinking mindset in a technology-enhanced active learning environment for stem courses. *Online Learning*, 30(1), pp. 213-245. <https://doi.org.10.24059/olj.v30i1.4840>

In a rapidly evolving and interconnected world, education systems must adapt to meet the diverse needs of various cultures and societies. Individuals must receive a high-quality education that is meaningful and relevant to their cultural or geographical context (UNESCO, 2016). Educational transformation aims to develop learners both academically, socially, and spiritually (Khoo & Jørgensen, 2021) and prepare them for future careers that may not exist (Khoo & Jørgensen, 2021). International organizations such as UNESCO, the Organization for Economic Co-operation and Development (OECD), Partnership for 21st Century Skills (P21), and Assessment and Teaching of the 21st Century Skills emphasize the urgent need to integrate 21st-century competencies, such as collaboration, creativity, digital literacy, and adaptability, into education (González-Salamanca et al., 2020). Some experts argue that the rapid advancement in digitalization may lead to a faster rate of job loss than job creation (Schleicher, 2018). On the contrary, the emergence of the “knowledge economy” concept reflects a shift towards new job types that demand expertise in communication, systems, or interpersonal skills (Capone & Lepore, 2021).

In the Gulf region, many nations, including the United Arab Emirates (UAE), are transitioning from dependence on oil to building a knowledge-based economy. One of the UAE’s core national priorities under the 2030 Agenda for Sustainable Development is educational reform aimed at equipping future generations with the skills required for this transition (UAE National Committee on SDGs, 2017). A key performance indicator within this agenda is increasing the proportion of highly qualified teachers, reflecting the nation’s commitment to improving teaching quality as a driver of sustainable development (UAE National Committee on SDGs, 2017). In alignment with the UAE Science, Technology, and Innovation Policy (STI), this research aims to increase interdisciplinary STEM talents among Emirati students (UAE Government, 2015). To prepare students to acquire the essential skills for future jobs, including those shaped by automation and digital transformation, curriculum reform that integrates technology-enhanced learning approaches is essential (UAE Ministry of Education, 2017). In the 2019/2020 World Education Forum (WEF) report, the UAE was rated slightly above average in areas related to 21st-century readiness. These skills include active learning, leadership, analytical thinking and creativity, technology use, and self-direction (Schwab & Zahidi, 2020).

Science, Technology, Engineering, and Mathematics (STEM) education is an interdisciplinary model that integrates multiple disciplines to promote problem-solving, innovation, and real-world application through student-centered learning (Hsu & Tsai, 2022). The interdisciplinary STEM model aims to engage students with real-world applications, fostering an inquiry-based mindset and problem-solving skills essential for the 21st century (Chai et al., 2020). STEM integrates scientific subjects, while the “A” in STEAM refers to the non-scientific subjects. Understanding the interconnections between these domains is critical: Science is reflected in hands-on exploration, technology is in the project-based tools, engineering through Design Thinking (DT), art through creative products, and mathematics via modeling and abstraction (ElSayary et al., 2015). Additionally, a broader integration model, STReAM, which includes reading, has been piloted in UAE government schools to further promote literacy alongside STEM learning. As science and technology continue to evolve rapidly, educators must adapt to new teaching demands, requiring both technical fluency and mindset shifts among teachers and students alike (Capone & Lepore, 2021). Technology plays a pivotal role in supporting STEM instruction by enhancing interactivity, creativity, and interdisciplinary

problem-solving. Moreover, research suggests that technology can deepen educators' understanding of the design-thinking process by enabling creative experimentation and iterative solution-building (Novak & Mulvey, 2020). While not solely responsible for the development of DT mindsets, technology-enhanced learning environments can significantly contribute to their cultivation by fostering collaboration, adaptability, and reflective thinking.

Design-thinking (DT) is a human-centered innovation approach inspired by how design thinkers from multiple disciplines understand individuals' needs, rapid prototyping, and generate innovative ideas that will change how individuals develop products, services, processes, and organizations (Simeon et al., 2020). It has been viewed as approaching integrated problems in the curriculum where incorporating technology into pedagogy improves teachers' professionalism (Noh & AbdulKarim, 2021). Students' ability to develop essential STEM competencies depends on their teachers' expertise in integrating technology and interdisciplinary learning. To foster creativity and problem-solving, teachers must first promote a DT mindset, which encourages adaptability, collaboration, and innovation. This shift requires moving beyond traditional teaching methods toward designing a technology-enhanced active learning environment where students actively engage with digital tools to construct knowledge. Developing a DT mindset among teachers is particularly critical, as it directly influences students' creative confidence and ability to tackle problems.

While previous research on DT primarily focused on business (Xiao et al., 2023), engineering (Dagienè et al., 2022), and design and planning fields (Lachheb et al., 2023), its application in education remains an emerging area of study (Henriksen et al., 2020; VanGronigen et al., 2022). Recent studies highlight its potential to transform teaching practices, yet the integration of DT in technology-enhanced active learning environments, particularly in STEM education, remains underexplored. Current research lacks insights into how DT mindsets evolve through interactive digital pedagogies and how they impact interdisciplinary STEM learning outcomes (Hite et al., 2024). This study employs a technology-enhanced active learning framework (TEALF), which integrates digital tools, interactive pedagogies, and collaborative problem-solving approaches. This framework aims to promote a perceived shift in design-thinking mindset among pre-service teachers within STEM education. The framework aligns with the Technological Pedagogical Content Knowledge (TPACK) model and transformative learning principles, ensuring technology is not merely an instructional supplement but an integral component of active learning engagement. Accordingly, this study explores the impact of using a TEALF on preservice teachers' DT mindset. The study aims to answer the following questions that would address the main aim of the study:

1. How do preservice teachers perceive their Design Thinking mindset after engaging in a Technology-Enhanced Active Learning Environment in STEM courses?
2. What are the preservice teachers' perceptions of using the technology-enhanced active learning design framework in STEM courses?

Literature Review

Theoretical Framework

One of the well-known frameworks used to conceptualize and guide technology integration in teacher education is the Technological Pedagogical Content Knowledge (TPACK) framework, which was developed to provide teachers with the necessary knowledge to plan technology-integrated lessons (Koheler et al., 2014). The TPACK framework integrates content, pedagogical, and technological knowledge, providing a foundation for effective technology-enhanced learning (Novak & Mulvey, 2020; Vijayatheepan, 2025). In this study, the Technology-Enhanced Learning Framework (TEALF) operationalizes TPACK by equipping pre-service teachers with hands-on experience using digital tools within interdisciplinary STEM contexts, with the explicit aim of fostering habits of mind associated with design thinking. Gess-Newsom (1999) differentiated between integrative and transformative applications of TPACK. The integrative approach merges the content, pedagogical, and technological knowledge within the traditional framework of teaching and learning. The integrative approach emphasizes the use of technology to enhance conventional teaching and learning methods without fundamentally altering them. In contrast, the transformative approach, which aligns with Mezirow's (1997) transformative learning theory, goes beyond mere integration; it aims to fundamentally change or redefine the teaching and learning experience through innovative technology (Capone & Lepore, 2021). This study adopts the transformative lens, positioning TEALF not merely as a tool for instructional efficiency but as a mechanism to disrupt habitual thinking and promote reflective, student-centered design practices in future STEM classrooms. Moreover, the focus on the DT mindset rather than the process is intentional and central to the study's conceptual framework. As Elsbach and Stigliani (2018) argue, mindset encompasses the cognitive, affective, and behavioral dispositions that enable individuals to approach challenges with empathy, creativity, and openness, skills particularly crucial for preservice teachers who must design for diverse early learners in interdisciplinary contexts. This emphasis informed both the design of the intervention, which embedded technology in reflective, collaborative, and ill-defined problem scenarios, and the selection of the measurement instrument, which assesses DT mindsets such as empathy, uncertainty tolerance, mindfulness, and creative confidence. By grounding the TEALF within both TPACK and transformative learning theory, this study frames DT not as a technical procedure but as a way of thinking that technology can help cultivate in meaningful, contextually responsive ways.

Mezirow's Transformative Learning Theory (TLT) (1997) emphasizes the process by which individuals critically assess their assumptions, engage in reflective discourse, and ultimately transform their frames of reference, particularly when faced with unfamiliar, uncomfortable, or disorienting experiences. Key elements of TLT include encountering a disorienting dilemma, engaging in critical reflection, participating in dialogue, and gradually adopting new perspectives or habits of mind (Strange & Gibson, 2017). These processes are especially relevant in teacher education, where preservice teachers must question traditional pedagogies and embrace learner-centered approaches grounded in inquiry, creativity, and adaptability.

In this study, the TEALF was deliberately designed to foster transformative learning by immersing preservice teachers in new digital learning environments, requiring them to navigate

ambiguity, collaborate in diverse teams, and design interdisciplinary STEM solutions using unfamiliar technological tools. The study's findings demonstrate that participants experienced cognitive and perspective transformation, reinforcing Mezirow's assertion that transformative learning occurs when individuals engage in self-directed, reflective practice in unfamiliar contexts. In transformative learning, individuals question their perspectives, particularly in uncomfortable situations, thereby transforming their frame of reference, including their points of view and habits of mind (Strange & Gibson, 2017). The 2020 lockdown, an unexpected and uncomfortable situation, forced educators and learners worldwide to rethink and transform their educational practices, aligning with the principles of Mezirow's theory (Bao, 2020; Trust & Whalen, 2020). TEALF operationalizes transformative learning theory by structuring learning experiences that challenge habitual thinking and provoke identity shifts, moving learners from passive knowledge receivers to active, reflective designers. This theoretical alignment positions transformative learning not only as a desired outcome but as an embedded mechanism within the instructional design of the intervention.

The global disruption caused by COVID-19 exposed deep systemic challenges in education that extend far beyond temporary learning gaps. It accelerated the need for flexible, learner-centered approaches that integrate technology meaningfully into pedagogical design. This study addresses the need by integrating the DT process into a TEALF, positioning technology not as an add-on, but as an enabler of collaborative problem-solving and creative exploration within STEM education. Mainly, preservice teachers in the study used the DT process in two contexts: as learners designing solutions to interdisciplinary challenges using digital tools, and as future educators applying these same processes to design developmentally appropriate STEM experiences for children enrolled in early childhood education programs. This dual-context application provided rich opportunities for reflective practice and role-shifting, key features of transformative learning. Integrating DT within TEALF also reflects a deliberate alignment with the transformative dimension of the TPACK framework and Mezirow's transformative learning theory (ElSayary et al., 2022). The use of unfamiliar technologies, the collaborative resolution of complex and ill-structured problems, and the emphasis on iterative feedback loops required preservice teachers to re-evaluate prior assumptions about teaching and learning. In doing so, the framework encouraged them to engage in critical reflection, embrace uncertainty, and shift from traditional instructional habits toward more empathetic, learner-responsive design approaches.

Design Thinking (DT) Mindset

The DT mindset, a concept gaining traction in educational research, encapsulates a set of cognitive, emotional, and behavioral traits that support innovative, human-centered problem-solving. At its core, the DT mindset emphasizes qualities such as empathy, creativity, collaboration, adaptability, and reflective learning. Kimbell and Seidel (2019) argue that DT is a mindset that emphasizes empathy, creativity, and collaboration and can be applied across various educational contexts. Another recent study has elaborated on various facets of this mindset, emphasizing its role in fostering creativity, adaptability, and reflective practice in academic settings (ElSayary et al., 2022). Valencia et al. (2021) and Auernhammer et al. (2022) expand this view, highlighting key traits, openness, empathy, intrinsic motivation, mindfulness, adjustment, and optimism, that underlie the DT mindset and support learner adaptability in complex scenarios. This multidimensional perspective is echoed across multiple studies. For

example, Alashwal (2020) and Li and Zhan (2022) emphasize the importance of comfort with *uncertainty* and ill-defined problems, a hallmark of creative resilience and systems thinking. Loderer & Kock (2021) and Vignoli et al. (2023) similarly link uncertainty tolerance to the mindset's exploratory nature, noting that design thinkers actively seek novel possibilities in ambiguous contexts. User *empathy*, another cornerstone of DT, has been extensively studied. Altay and Porter (2021) and Noh and AbdulKarim (2021) found that empathy not only fosters inclusivity and perspective-taking but also leads to less judgmental and more inclusive design processes. Additionally, a study by Adams and Brown (2017) demonstrated how empathy enhances collaborative efforts in design teams. *Mindfulness*, as discussed by Vignoli et al. (2023) and Patel and Kumar (2018), supports DT by enhancing learners' metacognitive awareness and their ability to navigate complex, iterative processes. Collaboration remains central to DT, particularly in interdisciplinary environments. Henriksen et al. (2022) and Groeger and Schweitzer (2020) argue that *collaborative* diversity facilitates idea generation, collective knowledge construction, and visualization, critical elements in problem-based learning. Equally important is the concept of *learning orientation*, or the sustained motivation to engage with new knowledge. Simeon et al. (2020) observe that this orientation underpins the iterative, growth-focused nature of DT, enabling learners to learn from failure and adapt solutions in real-time. Finally, *creative confidence*, the belief in one's capacity to generate novel ideas and solutions, is recognized as a fundamental DT trait. Hamat et al. (2019) popularized the term, and Henriksen et al. (2020) found that creative confidence has a significant influence on problem-solving effectiveness in design teams. As conducted by Kwek & Toh (2020), Liu (2023), and Yilmaz-Soylu et al. (2021), DT fosters a holistic suite of skills, including empathy, creativity, problem-solving, and collaboration skills, that make it a promising pedagogical approach for preparing learners to navigate the complex challenges of 21st-century education.

Technology-Enhanced Active Learning Environment

A technology-enhanced active learning environment is characterized by the purposeful integration of interactive technologies to foster learner engagement, critical thinking, and transferable skills such as collaboration, self-direction, and creativity. Several researchers defined a technology-enhanced active learning environment; for instance, Hite et al. (2024) mentioned that when students actively engage with information, they activate their existing knowledge of the topic to encode new information in a virtual learning environment (VLE). Similarly, Gar & Idris (2021) described technology-enhanced learning as a space where immersive and interactive technology enhances students' cognitive engagement through exploration and interaction. In the present study, a technology-enhanced learning environment is conceptualized as a framework that supports the development of 21st-century competencies, such as computational thinking, innovation, and collaboration, by embedding technology into meaningful, learner-centered tasks.

However, implementing technology-enhanced learning is not without challenges. Rybakova et al. (2021) noted that the absence of human interactions and the excessive, unplanned use of digital connectivity can lead to a sense of isolation and reduced motivation. When students are mindful of the independent use of technology, they avoid isolation and build a sense of satisfaction as they research information, criticize and empathize, collaborate with others, solve complex problems, orient their learning process, and suggest creative solutions. Supporting this concern, Novak and Mulvey (2020) noted that students who opted to drop out of

technology-enhanced active learning courses reported significantly lower satisfaction with this approach compared to students who took on-campus courses. When technology tools are used appropriately, they improve individuals' lives by giving them access to information and the opportunity to solve complex real-world problems (Hirsh & Baronak, 2020).

When implemented effectively, a technology-enhanced active learning environment is a process that encourages students to take the lead in their learning (Abykanova et al., 2016). It fosters a collaborative learning environment in which they can communicate with one another (Rybakova et al., 2021). These features are further enhanced in STEM education, which significantly shifts from traditional teaching methods, focusing on active learning *where* students engage in hands-on, practical problem-solving (Tey et al., 2020). When learners use information, research, solve ill-structured problems, empathize with individuals' needs, and create new products, they build creative confidence, become innovative, and become mindful of their learning process (Abykanova et al., 2016). Furthermore, collaborative projects are integral, fostering teamwork and communication skills that mirror future workplace environments (Vennix et al., 2022). In this way, technology functions not merely as a delivery tool but as a core enabler of inquiry, creativity, and skill transfer. Additionally, technology is a tool and also a central element of learning, enhancing interactivity and preparing students for a tech-centric world (Abykanova et al., 2016; ElSayary et al., 2022), which leads to a perceived shift in learners' DT mindsets (Daniela et al., 2018; Scanlon et al., 2019). These active engagement strategies, teamwork, and technological integration collectively address the diverse needs and skills required for success in today's rapidly evolving global landscape (Chai et al., 2020). Empirical examples illustrate how TEALF supports interdisciplinary learning. For instance, a robotics project inspired by Hsu & Tsai (2022) engages students in applying mathematical theories and engineering principles, utilizing technology as an integral component of learning, and programming robots to perform tasks that require a blend of these disciplines. Drawing on a study by He (2023), students combined artistic creativity with scientific principles, using technology for design and mathematics for structural calculations, thereby enriching the learning experience and fostering analytical and creative skills. In another study by Zuhaida et al. (2022), students delved into science using interactive technology for data collection, applying mathematical models and engineering solutions to real-world ecological issues, demonstrating the potential of TEALF to unify diverse disciplines around meaningful challenges.

Methodology

This study employed an explanatory sequential mixed-methods design beginning with a post-intervention survey administered to 94 preservice teachers enrolled in an early childhood education program. The survey aimed to assess perceived shift in their Design Thinking (DT) mindsets following the full implementation of the Technology-Enhanced Active Learning Framework (TEALF) framework. A pre-test was not conducted, as the focus was on evaluating the outcomes of the TEALF after its full implementation rather than tracking incremental changes over time. Additionally, prior studies indicate that pre-tests in similar pedagogical interventions can introduce response bias, as participants may not fully grasp the constructs being measured for the intervention (Johnson & Christensen, 2014). Following the post-test survey, focus groups were conducted to provide deeper insights into the quantitative findings. The quantitative analysis revealed perceived shifts in all six DT mindset categories (uncertainty,

empathy, mindfulness, collaboration, learning orientation, and creative confidence), but it did not capture the underlying reasons for these changes. The qualitative phase was therefore designed to explore how preservice teachers experienced these transformations, the challenges they encountered, and their perceptions of using the TEALF in STEM education. This design follows Creswell and Clark's (2017) explanatory sequential mixed-methods framework, in which quantitative results are analyzed first and then further explained and expanded through qualitative data. Mixed-methods designs are helpful in mitigating biases that may be present when relying solely on one approach (Johnson & Christensen, 2014). The quantitative data aimed to understand the impact on learners' learning, while the qualitative data were used to gain a deeper understanding of the phenomenon of participants' perceptions.

Participants

The intended sample size was 120 preservice teachers studying in an early childhood program at a federal university in the UAE. The final purposeful sample consisted of 94 participants who met the predefined criteria: they were enrolled in semesters 4-8, registered in Practicum I, II, or III courses, attended Math, Science, Technology, and Integrated Curriculum courses, and expressed a willingness to participate in the study. Those who did not meet the criteria were excluded from the study. The participants were 100% female students between 18 and 25 years old, as the program does not accept male students. Before conducting the study, participants were fully informed of the study's purpose and procedures. They were advised of their right to withdraw at any time without penalty, in line with ethical research standards. Informed consent was obtained, and anonymity of all survey and focus group responses was assured. Following the survey, preservice teachers were invited to participate in focus groups to elaborate on their learning experiences with TEALF. Participants were selected based on their willingness to engage in reflective discussions and their varied experiences with the framework. A total of twelve students participated in two focus group sessions, each with six participants, ensuring diverse perspectives from different levels of engagement with the technology-enhanced learning environment. The discussions followed a semi-structured format, exploring four key themes: challenges faced when adopting the TEALF, the evolution of DT mindsets, the perceived impact on their teaching practices, and recommendations for improving the framework.

Context of the Study

This study was conducted at a federal university in the UAE, which is recognized nationally and regionally for its educational innovation. The preservice teachers enrolled in an early childhood education program that follows a semester-based structure, integrating academic studies, practicum, STEM, and elective courses. Instructors are specialized in STEM education and were certified as Apple Teachers and Certified Online Instructors. The courses employed a blended learning approach, emphasizing the use of technology and the DT process to support preservice teachers in creating STEM-based instructional materials for childhood education students. Practicum assignments involved direct, hands-on teaching practice in school settings and were designed to allow preservice teachers to implement the DT process as both learners and emerging educators. At the start of the semester, preservice teachers completed a two-week training on various applications, including iCloud Apps, Genially, Canva, Doodly, PowToon, as well as tools for augmented reality and virtual reality. They earned Apple Teaching Certificates and developed e-portfolios showcasing their teaching materials. This training prepared them to

apply the DT process and integrate technology in their practicum courses, where they designed and taught STEM challenges to childhood education students. Practicum placements included private and government schools across various curricula, including American, British, the UAE's Ministry of Education, and International Baccalaureate (IB) programs.

Instruments

Pre-Service Teachers Survey

The preservice teachers' survey was used to investigate the impact of using technology in a technology-enhanced active learning environment on exploring preservice teachers' design-thinking mindsets. The survey focused on six dependent variables associated with the DT mindset: uncertainty, empathy, mindfulness, collaboration with others, learning orientation, and creative confidence. The survey consisted of two sections: demographic information, where the selection criteria were set, and DT mindset categories. It included multiple-choice questions to ask preservice teachers about the age range, semester enrolled in, STEM courses registered, and practicum courses registered. The second section of the survey comprised items targeting the six DT mindsets dimensions. The scale used in the survey was a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

The DT mindset items were adapted from a previously validated instrument (ElSayary et al., 2022) to suit the local educational and cultural context of the UAE. Adaptations included simplifying technical terminology, aligning item language with regional educational standards, and rephrasing items for clarity when translated into Arabic.

For content validity purposes, the adapted survey was reviewed by two educational experts with doctoral qualifications in curriculum and instruction and extensive experience in teacher education and instructional design. Their feedback focused on item clarity, cultural appropriateness, and the language suitability for non-native English speakers. Based on their input, several minor wording changes were implemented, and the entire instrument was translated into Arabic to ensure accurate interpretation by the target sample. To evaluate the instrument's reliability before main data collection, the revised survey was piloted with 30 in-service early childhood teachers from a similar demographic background to the study's target population. These participants were not part of the main study.

The reliability test using Cronbach's Alpha was run to assess internal consistency. The reliability values for each of the six DT mindset categories were $\alpha = 0.98$, and the overall instrument reliability was $\alpha = 0.99$, indicating excellent consistency ($\alpha > 0.9$). These results confirmed the instrument's suitability for use in the current study. The reliability test was measured again with all samples, and the results remained highly consistent across categories (from $\alpha=0.93$ to $\alpha=0.98$) and overall ($\alpha=0.99$).

Focus Group Discussion

Focus group discussions were conducted via Zoom conference and averaged approximately forty-five minutes each. The interview protocol was designed using Kolb's (1984) experiential learning model to guide the structure and thematic flow of the conversations. Kolb's model consists of four cyclical stages: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation, each of which informs one of the main

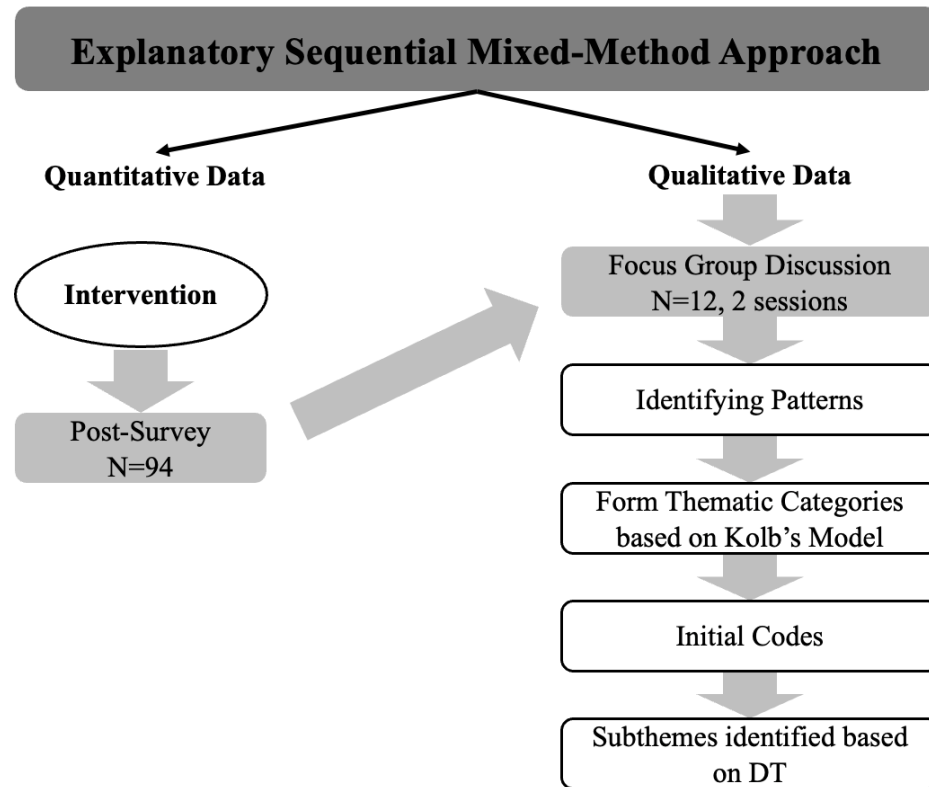
categories used to frame the focus group questions. This theoretical foundation ensured that participants were guided through a process of reflecting on their lived experiences, interpreting their meaning, and envisioning future improvements. To assess the face validity and clarity of the questions, the draft protocol was reviewed by an educational expert and two STEM instructors not involved in the study. Their suggestions led to the merging of overlapping questions and the refinement of language to ensure accessibility and comprehension for the target participants. The final set of open-ended questions after editing included prompts that asked participants to describe the experience using technology in the DT process (*Concrete Experience*), reflect on how it influenced their thinking and professional views on early childhood STEM education (*Reflective Observation*), evaluate the positive aspects and challenges of the experience (*Abstract Conceptualization*), and consider what they might do differently in the future and why (*Active Experimentation*). These questions were designed to elicit deep, personal insights into how the TEALF shaped participants' learning processes and Design Thinking mindsets.

Procedure

The study adopted an explanatory sequential mixed-method design, in which quantitative data collection and analysis were conducted first, followed by qualitative data collection to provide a deeper insight into the qualitative results (Creswell & Clark, 2017). While the term methodological triangulation is sometimes used to describe the use of multiple methods in a single study, the present design primarily sought to elaborate on statistical patterns through participants' reflections, rather than to cross-validate parallel measures of the same construct. Thus, the qualitative phase offered a complementary perspective that enriched the interpretation of the initial findings. First, the quantitative data approach was employed to answer the study's first question: *How do preservice teachers perceive their Design Thinking mindset after engaging in a technology-enhanced active learning environment (TEALF) in STEM courses? This was achieved using a one-sample t-test.* The subsequent qualitative phase was employed to address the second question of the study: *What are the preservice teachers' perceptions of using the technology-enhanced active learning design framework in STEM courses?* This phase involved focus group discussions that explored learners' experiences and perceptions of the intervention. The integration of findings enabled a more comprehensive understanding of the impact and perceived value of TEALF in fostering DT mindsets within interdisciplinary STEM education. Figure 1 illustrates the flow of the data collection of the study design. The following sections provide a detailed explanation of the data collection and analysis for each method.

Figure 1

The Study Design Follows an Explanatory Sequential Mixed-Method Design



Quantitative Data Collection & Analysis

At the beginning of the semester, participants received a consent form that provided a full explanation of the study's purpose, procedures, and their rights as participants. Data collection for the quantitative phase was conducted at the end of the semester, when participants received a link to complete the post-intervention survey. The survey responses were then analyzed using both descriptive and inferential statistics to examine participants' perceptions of their Design Thinking (DT) mindsets after engaging with the TEALF. Descriptive statistics, including means and standard deviations, were calculated for each of the six DT mindset subscales to summarize participants' responses and identify general trends. To determine whether the assumptions for inferential testing were met, Q-Q plots were generated for each subscale to assess the normality of the data distribution. These visual inspections were supported by standard normality tests, which confirmed that the data approximated a normal distribution. Based on these findings, a one-sample t-test was conducted to determine whether the mean scores for each DT mindset dimension differed significantly from the neutral midpoint value of 3.0 on the 5-point Likert scale. This analytical approach provided an appropriate method for assessing whether participants perceived a meaningful shift in their DT mindset following the intervention, but it does not measure change over time. As no pre-test was conducted, this method cannot establish causal claims or quantify actual growth resulting from the TEALF intervention. The decision to use $m = 3$ as the comparison point aligns with established interpretations of Likert-scale

midpoints as indicators of neutral or baseline perceptions (Handal et al., 2013). While the World Bank (2021) highlights the importance of fostering growth mindsets and an intermediate level of competence among educators globally, its application here serves only as a broad contextual benchmark, not a direct validation of the DT scale. Thus, any significant deviations from $m = 3$ in this study should be interpreted as indicative of perceived positive orientation toward DT mindset traits, rather than definitive evidence of development or intervention impact.

Qualitative Data Collection & Analysis

Focus group discussions were conducted following the quantitative data collection to delve deeper into participants' perceptions and to further explore patterns emerging from the initial data. The survey results indicated varying levels of agreement across different dimensions of the DT mindset, with particularly high scores in learning orientation and collaboration, and lower mean scores in creative confidence and empathy. These quantitative trends informed the design of the focus group questions, prompting the researchers to probe more deeply into the factors contributing to participants' confidence, challenges with creativity, and their experiences of collaboration and uncertainty in practice. The questions were framed to elicit reflective accounts that could explain or contextualize the statistical outcomes. Each discussion session on Zoom lasted 30-60 minutes, with an average duration of 45 minutes. Participant responses were transcribed and subjected to thematic analysis to enrich and elaborate upon the quantitative findings. This mixed-method approach ensured that the qualitative phase directly responded to key findings from the survey and provided a more detailed understanding of how preservice teachers perceived and experienced the influence of the TEALF on their DT mindsets. This study employed a thematic analysis approach following the six-phase approach outlined by Braun & Clarke (2006) to systematically examine patterns within the qualitative data. The process began with familiarization, during which the researcher transcribed and repeatedly read the focus group data to become immersed in the content. The researcher organized the qualitative data using four experiential categories: (1) Descriptions, (2) Feelings, (3) Evaluations, and (4) Conclusions and Plans, which were directly informed by Kolb's (1984) experiential learning cycle. These categories reflected the structure of the focus group questions and served as an initial framework to explore how preservice teachers made sense of their learning. Next, initial codes were generated to identify meaningful features related to participants' experiences with the TEALF and its influence on their DT mindsets. In other words, within each category, the researcher identified patterns that aligned with six core traits of the DT mindset: Uncertainty, Empathy, Mindfulness, Collaboration, Learning Orientation, and Creative Confidence. In the third phase, these codes were collated and organized into potential sub-themes, enabling the mapping of emerging patterns across the dataset. During the reviewing phase, these preliminary sub-themes were refined to ensure they accurately represented both the coded extracts and the full data set. The final stage was report production, where illustrative quotes and interpretations were developed to convey the findings. This approach ensured a coherent progression from guided experiential reflection to the identification of mindset-specific perceptions, providing a detailed understanding of how TEALF shaped preservice teachers' perceptions of DT mindsets.

Qualitative data were manually coded using an iterative and reflexive process that involved multiple readings of each transcript to ensure deep engagement with the content. During the initial phase, two independent researchers generated preliminary codes separately, drawing on both the research questions and emergent insights from the data. These initial code

lists were then compared and refined through discussion to create a shared coding framework. The researchers used this framework to recode the transcripts, followed by additional rounds of review and refinement to ensure alignment with emerging patterns and theoretical constructs. To enhance researcher triangulation, the coders not only worked independently during the initial phases but also held regular debriefing sessions to discuss their interpretations, challenge assumptions, and refine theme development collaboratively. This ongoing dialogue supported a deeper interpretive process and helped maintain analytic consistency. To further establish intercoder reliability, Cohen's kappa was calculated, yielding a substantial agreement score of 0.82, in line with thresholds defined by Landis & Koch (1977). Any discrepancies in coding were discussed and resolved through consensus to enhance coding accuracy and thematic alignment.

Results

Survey Analysis

Preliminary Normality Test on a Subset of Participant

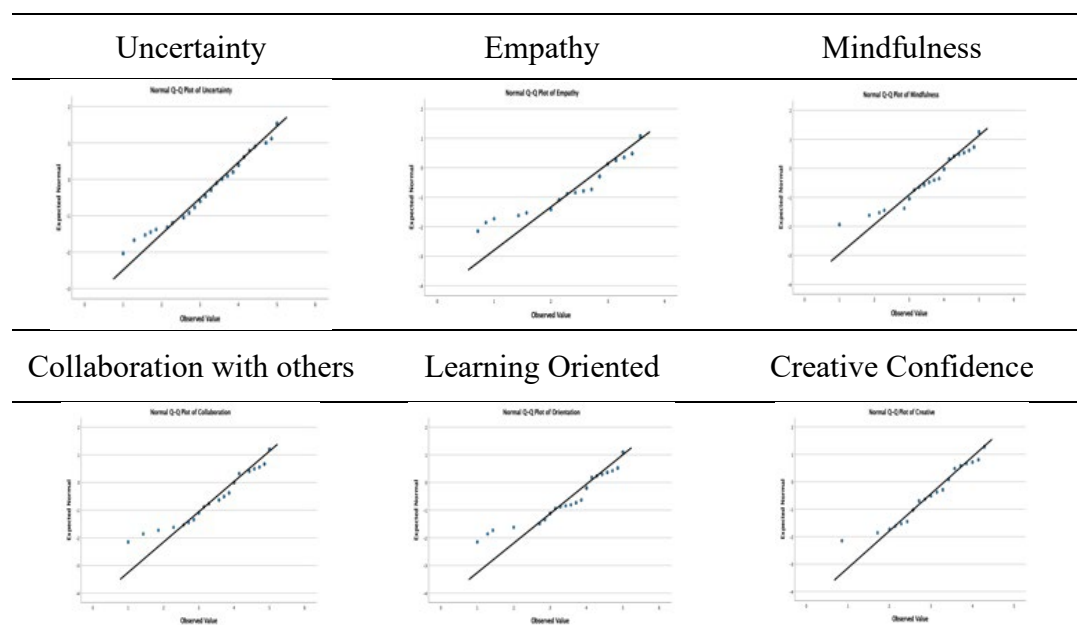
A preliminary normality test was conducted on a randomly selected subset of 20 participants from the full sample ($n=94$) to assess the distributional characteristics of the dataset before conducting a one-sample t-test. This subset was chosen to allow for an early diagnostic check before proceeding with inferential analysis, while preserving the integrity of the full dataset for the primary test. The Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that five of the six DT mindset dimensions (uncertainty, empathy, mindfulness, collaboration, and orientation) followed a normal distribution. However, for “creative confidence,” both tests yielded $p<0.05$, suggesting some deviation from normality. Despite this, it was determined that the normality assumption was sufficiently met to proceed with the t-test based on several factors. First, the sample size for the main analysis ($n = 94$) exceeds the threshold at which the t-test is generally considered robust to modest violations of normality, especially for Likert-scale data (Lumley et al., 2002). Second, a visual inspection of Q-Q plots for the full dataset revealed no extreme skewness or kurtosis for “creative confidence,” supporting the assumption of approximate normality. Furthermore, the nature of the variable (a composite score based on multiple Likert-scale items) increases the likelihood of near-normality due to the central limit theorem. Based on this combination of statistical testing, visual inspection, and established guidelines, the one-sample t-test was considered an appropriate method for subsequent analysis.

The normality tests were performed using SPSS via q-q plot testing to visually inspect distributional patterns before conducting the one-sample t-test, following guidance from Field (2009). As illustrated in Table 1, most DT mindset variables (e.g., uncertainty, empathy, mindfulness, collaboration, and learning orientation) showed data points that closely aligned with the diagonal, indicating approximate normality. However, the Q-Q plot for “creative confidence” revealed more noticeable deviations from the expected line, suggesting potential non-normality. This finding is consistent with earlier statistical tests (Kolmogorov-Smirnov and Shapiro-Wilk) conducted on a subset of the data. Despite this deviation, the one-sample t-test was deemed appropriate for all variables, including “creative confidence,” based on several considerations. First, the sample size ($n = 94$) exceeds the threshold at which t-tests are robust to moderate violations of normality (Lumley et al., 2002). Second, “creative confidence” is a composite score derived from multiple Likert-scale items, and the central limit theorem supports

the assumption that such aggregate scores tend toward normality in larger samples. Therefore, the Q-Q plot results were interpreted in conjunction with sample size and scale structure, allowing the study to proceed with the t-test while maintaining statistical validity.

Table 1

Normality Tests of Sub-Factors and Total (Q-Q Plot Tests)



One-Sample T-test

In this study, the TEALF served as the pedagogical intervention implemented before data collection. A one-sample t-test was conducted to determine whether the post-intervention mean scores for each DT mindset category significantly differed from the neutral midpoint of 3.0 on a 5-point Likert scale (Kent State University Libraries, 2017). While this test does not allow for causal inference or measurement of change over time, due to the absence of pre-intervention data, it does provide insight into whether preservice teachers' self-reported perceptions of their DT mindsets, following exposure to the TEALF, are significantly above a neutral reference point. The results indicated that all mean values across the six DT mindset categories were statistically higher than the neutral midpoint (See Table 2). As a result, the null hypothesis, which posited no significant difference between the observed sample mean set and the hypothesized population mean of 3.0, was rejected at the 95% confidence level. These findings suggest that, after participating in the TEALF, preservice teachers perceived themselves as demonstrating levels of DT mindset traits that exceed a neutral stance. However, no direct claims of growth or development can be made without a baseline comparison. The results showed that the mean scores for all six DT mindset categories were statistically significantly higher than the neutral midpoint of 3.0 ($p < .001$), indicating that preservice teachers rated their post-intervention perceptions of these traits as above neutral. Among the six categories, learning orientation had the highest mean score ($M = 4.05$, $SD = 0.938$), followed by collaboration ($M = 3.96$, $SD = 0.912$) and mindfulness ($M = 3.89$, $SD = 0.978$). These scores indicate relatively strong self-reported perceptions in these areas following engagement with the TEALF. Creative confidence,

while the lowest mean increase ($M = 3.32$, $SD = 0.738$), was still significantly above the midpoint, with a moderate effect size ($d = 0.73$). The findings indicate that, following their perceptions in the TEALF, preservice teachers reported perceiving themselves as demonstrating levels of DT mindsets that exceed a neutral stance. However, due to the absence of pre-test data, these results should be interpreted as a snapshot of post-intervention perceptions, rather than evidence of change or growth over time. To better understand the relative strength of each DT mindset domain, the difference between each category's mean score and the scale midpoint ($M = 3.0$) was calculated. Orientation to learning exhibited the largest difference from the midpoint, exceeding it by 1.05 points. This was followed by collaboration (0.96), mindfulness (0.89), and uncertainty (0.52), suggesting higher perceived development in these areas. In contrast, the categories of empathy and creative confidence showed smaller differences, with values of 0.46 and 0.32, respectively, indicating more modest elevations above the neutral benchmark. These comparative differences reflect the varying degrees to which preservice teachers perceived alignment with each DT mindset domain after participating in the technology-enhanced active learning environment.

Table 2

Descriptive Statistics and One-Sample t-test

	Mean	SD	t-value	df	p-value	<i>d</i>	95% CI
Uncertainty	3.52	1.01	4.99	93	<.001	1.01	0.3-0.731
Empathy	3.46	0.81	5.52	93	<.001	0.81	0.3-0.628
Mindfulness	3.89	0.978	8.82	93	<.001	0.97	0.7-1.091
Collaboration	3.96	0.912	10.26	93	<.001	0.91	0.8-1.154
Learning Orientation	4.05	0.938	10.93	93	<.001	0.93	0.9-1.25
Creative Confidence	3.32	0.738	4.25	93	<.001	0.73	0.2-0.475

All six design thinking (DT) mindset categories yielded mean scores significantly above the proposed neutral midpoint ($M = 3.0$), indicating positive post-intervention perceptions. For the uncertainty, although one item, *I am comfortable dealing with unsolved problems*, did not reach statistical significance ($p=0.155$), the overall category mean was significantly higher ($M=3.52$, $SD=1.01$), $t(93) = 4.99$, $p<.001$, with a large effect size ($d=1.01$). This supports the overall strength of the uncertainty construct despite the isolated non-significant item. The empathy category also showed a significant result ($M=3.46$, $SD=0.81$), $t(93) = 5.52$, $p<.001$, $d=.810$, suggesting a moderate to large effect. Similarly, participants scored significantly above the midpoint in mindfulness ($M=3.89$, $SD=0.978$), $t(93) = 8.82$, $p<.001$, $d=.97$, and in collaboration ($M=3.96$, $SD=0.912$), $t(93) = 10.26$, $p<.001$, $d=.91$, both reflecting large effects. Orientation to

learning recorded the highest mean among all categories ($M=4.05$, $SD=0.938$), $t(93) = 10.93$, $p<.001$, $d=.93$, highlighting a strong inclination toward active engagement with new knowledge. Finally, while creative confidence had the lowest mean ($M=3.32$, $SD=0.738$), it still exceeded the midpoint significantly, $t(93) = 4.24$, $p<.001$, $d=.73$, suggesting a moderate positive tendency. These results indicate that preservice teachers rated themselves above neutral across all DT mindset categories following their participation in the TEALF. These results reflect post-intervention perceptions, as they do not demonstrate a measurable change from the baseline or establish a causal impact.

Focus Group Discussion

The responses from the focus group discussion were analyzed using Braun and Clarke's (2006) six-phase thematic analysis approach to identify patterns across participants' experiences. This iterative process involved data familiarization, generation of initial codes, theme searching, theme reviewing, theme definition, and reporting. Thematic categories were initially informed by Kolb's experiential reflection model, Description, Feelings, Evaluation, and Conclusion/Plans, which provided a structured lens for examining participants' learning journeys. These categories helped organize and interpret the data while remaining open to emergent DT mindset themes, including Uncertainty, Empathy, Mindfulness, Collaboration, Learning Orientation, and Creative Confidence.

For instance, in the description phase, many participants reflected positively on their use of technology within the DT process, though they also expressed feelings of initial cognitive overload. One participant described the experience as "overwhelming but transformative," highlighting the challenge of learning multiple new apps simultaneously. In the *feelings* category, most students reported initial discomfort and uncertainty but noted a growing sense of clarity and confidence in their teaching philosophy as the semester progressed. Regarding the *evaluation* category, students emphasized practical challenges, such as time management and choosing the right team, and shared that a few of their colleagues resisted the change. They also revealed increased confidence and appreciation for the flexibility that technology offers. Notably, participants connected their increased empathy for students' needs and mindfulness in lesson planning with their DT experiences. Finally, in *conclusion and action plans*, preservice teachers articulated their future goals and professional intentions, such as differentiating instruction, selecting tools purposefully, and cultivating student-centered learning environments. Table 3 presents a selection of representative participant quotes, organized by theme and experiential category, illustrating how these reflections align with and demonstrate development across the six core DT mindset constructs.

Table 3

Analysis of Coding Themes That Emerged from Participants' Responses

Theme	Initial codes	Subthemes	Participants' Quotes
Challenges in Adopting TEALF (Descriptions)	• Overwhelm • New tools • Digital learning curve	• Initial confusion • Cognitive overload • Adapting to new technologies	<i>At the beginning of the semester, we were overwhelmed with what we were learning. There were too many new applications to learn and apply. However, when we started working using these apps, we were very proud of what we achieved. (Student-1)</i> <i>Our instructor guided us to use the iCloud applications and earn badges to earn the Apple Teaching Certificate. In addition, we learned many other applications and understood how to be used in teaching, learning, and assessments. (Student-2)</i>
Transformation in DT Mindsets (Feelings)	• Growth, reframing • Self-awareness • Learner empathy	• Growth in uncertainty tolerance • Empathy • Mindfulness	<i>We were not feeling comfortable at the beginning of the semester as we were confused about the amount of information we received and how we will use all of these apps. However, later on, I noticed that I changed how I think of each application and how to use it in teaching and learning. (Student-1)</i> <i>I feel that dealing with uncertainty was not easy to do; however, being empathetic about students' needs and creating activities to meet their needs is something I learned. Also, being aware of the process and purposes and having clear goals was added to me. (Student-3)</i> <i>The DT process was so confusing in the beginning....especially when we set checking points after each step to reflect and receive</i>

			<i>feedback. We did not apply it properly in the first two challenges, but I believe we became experts later. (Student-4)</i>
Collaboration and Knowledge Sharing (Evaluations)	• Peer support • Teamwork • Creative brainstorming	• Peer learning • Teamwork in designing STEM challenges	<i>To design an early-year STEM challenge and projects, we collaborated and used shared applications such as iCloud sheets, Google Docs, etc. (Student-3)</i> <i>I liked how we collaborated with our peers and came up with creative ideas. We feel confident that we can think of creative ideas whenever we start working on an idea. This motivated me to direct our process, learn more things, and be well-prepared for my future as a teacher.(Student-4)</i>
Creative Confidence Development (Evaluations)	• Experimentation • Learning through failure • Design iteration	• Iterative learning • Overcoming fear of failure	<i>Before, I hesitated to experiment with new teaching strategies, but now I feel more confident designing innovative learning experiences. The DT process showed me that failure is part of learning. (Student-1)</i> <i>There are some ways of learning we cannot forget as we learned something from. I benefit from using the DT process in my personal life....without being conscious, I found myself using the DT process to solve my problems to empathize, ask questions, plan and suggest solutions, evaluate my solutions, and improve when needed.(Student-3)</i>
Technology as an Essential Teaching Skill (Evaluations)	• Pedagogical tech use • Instructional flexibility • Confidence with tools	• Technology preparedness, flexibility in teaching	<i>Using technology applications in differentiating students' learning is beneficial. We used videos, audio, and sometimes writing to reflect on our work and give childhood learners feedback. It was easier to ensure that they understood the feedback by</i>

			<i>sending them audios about their work.... Using different forms of presenting lessons in interactive ways makes students learn better. (Student-1)</i> <i>I believe we learned a lot of essential skills for teachers. We were well prepared to use technology, especially in quarantine. We learned that there are no limits to learning, and the quarantine will not limit how we teach students. (Student-2)</i>
Technology as an Essential Teaching Skill <i>(Evaluations)</i>	• Technology preparedness • Flexibility in teaching • Overcoming resistance • Deeper understanding of pedagogy	• Overcoming initial resistance to change • Deeper understanding of pedagogy	<i>The only disadvantage I felt was that I was uncomfortable with this new learning environment where technology and DT are essential. It took time to understand and get used to that. However, it is beneficial and changed how I prepare and plan for STEM challenges and projects. (Student-2)</i> <i>During our study in this program, we learned a lot of theories and how beneficial they are; however, it is the first time we feel it as learners and think of how to create a Technology-Enhanced Active Learning Environment with young learners. I feel I can make a difference in students' lives. (Student-4)</i>
Recommendations for Future TEALF Implementation <i>(Conclusions and Plans)</i>	• Planning • Learner-centered strategies • Scaffolding • Reflective goals	• Students' needs • Need for gradual introduction • More structured feedback loops • Mindfulness	<i>I will consider my students' needs before planning and designing STEM challenges. I will differentiate the STEM challenges and projects that can meet their needs. I will also continue learning new applications and the purposes of using each application to ensure their effective use of them. (Student-1)</i>

			<i>The first thing I will do is set a list of applications, their purposes, levels of using technology, etc., and then start the DT process. It is essential to ensure the effectiveness of technology applications used. (Student-2)</i> <i>I will be mindful of my goals for myself, and for each goal, I will set mini-steps to be achieved. This will give me a better feeling about achieving my goals and keep me on track..... I realized how important mindfulness is, and I believe it is an essential skill to be taught for students in early years. (Student-3)</i> <i>I need to figure out more simple ways to teach early years students DT. It is vital for them not only for their cognitive development but also for their social, physical, and emotional development. So we teach a whole child who can cope in their lives not only to achieve high marks. (Student-4)</i>

Discussion

Q1: How Do Preservice Teachers Perceive Their Design Thinking Mindset After Engaging in a Technology-Enhanced Active Learning Environment in STEM Courses?

The DT mindset survey revealed that preservice teachers reported mean scores significantly above the neutral midpoint across all six mindset categories, suggesting a generally positive perception of their design thinking dispositions following the TEALF experience. While this post-intervention outcome indicates favorable self-assessments, it does not provide direct evidence of mindset development or transformation, given the absence of baseline (pre-test) data. Nevertheless, the findings offer preliminary support for the potential of integrating TEALF with DT processes in preservice teacher education, particularly within interdisciplinary STEM fields. This observation aligns with a previous study highlighting how innovative uses of technology may support the redefinition of teaching and learning experiences (Capone & Lepore, 2021).

The results indicated that empathy and creative confidence, while still scoring significantly above the neutral midpoint, exhibited the smallest mean differences among the six DT mindset categories. This suggests that participants' self-reported levels in these two areas were less pronounced compared to other mindset components such as learning orientation or collaboration. This pattern may reflect broader challenges in cultivating these particular traits within a short intervention period. For instance, Vignoli et al. (2023) emphasize that empathy requires deeper experiential engagement and sustained exposure to diverse perspectives, which may not be fully achieved through brief training formats. Similarly, Yilmaz-Soylu et al. (2021) highlight that creative confidence is often a cumulative outcome, developing over time as individuals repeatedly test ideas, receive feedback, and build resilience against failure. Therefore, the relatively smaller shifts observed in these areas are consistent with existing research, which positions empathy and creative confidence as traits that typically evolve more gradually within the DT framework. These findings suggest that while TEALF may foster initial positive orientations in these areas, more intensive or longitudinal interventions might be needed to produce stronger effects.

For *uncertainty*, the preservice teachers reported feeling generally comfortable with navigating unknown situations, embracing new contexts, and recognizing that solutions can emerge from unexpected directions. These attitudes are reflected in several survey items that received mean scores significantly above the neutral midpoint, particularly those addressing openness to ambiguity and adaptability in problem-solving. However, not all items within this category demonstrated strong alignment with a fully developed mindset of uncertainty. One item, *I feel comfortable dealing with unsolved problems*, did not reach statistical significance, suggesting lingering discomfort with situations where outcomes are undefined. This indicates a disagreement in their perceptions of uncertainty tolerance: While learners may welcome novel situations, they may still struggle when clarity is absent. Loderer & Kock (2021) noted that being comfortable with complex issues is used to explore all possibilities to consider a solution as an ill-structured and questionable concept. Similarly, Vignoli et al. (2023) suggest that the ambiguity inherent in the DT process, especially when both outcomes and timelines are uncertain, can provoke discomfort in learners unfamiliar with iterative, open-ended problem spaces. The findings here partially reflect this tension: Although preservice teachers

demonstrated positive orientations toward ambiguity, full comfort with unresolved challenges may require deeper engagement or longer-term exposure. Thus, while the results suggest an emerging disposition aligned with the DT construct of uncertainty, they stop short of providing definitive evidence of its complete internalization. These interpretations are derived from the quantitative survey data. They should be considered in light of the study's post-test-only design, which cannot confirm developmental progression but can provide insight into post-intervention perceptions.

For *empathy*, preservice teachers reported efforts to understand the individual needs of early years students, often describing how they considered problems from the child's perspective when designing STEM challenges. These interpretations are drawn from the post-intervention survey responses related to the empathy dimension, where scores were significantly above the neutral midpoint. This empathetic stance aligns with the human-centered design approach, which emphasizes the ability to adopt multiple viewpoints and appreciate the motivations behind others' behaviors (Altay & Porter, 2021). Participants indicated that they sought to design challenges that reflected students' interests and aspirations, aiming to make a meaningful impact. They also associated empathy with maintaining a nonjudgmental mindset and feeling comfortable working with individuals from diverse backgrounds and perspectives, which reflects traits described by Noh and AbdulKarim (2021) as central to inclusive design practice. The TEALF intervention may have supported this empathetic orientation by immersing preservice teachers in iterative, learner-centered design tasks, where understanding students' needs was positioned as the starting point of the design process. Although these findings suggest that participants valued and attempted to apply empathy in their instructional design, the study's results indicate a positive self-reported disposition toward empathy following exposure to the TEALF environment. This insight contributes to the growing body of research linking TEALF with human-centered teaching practices in STEM education.

For *mindfulness*, survey responses suggested that participants valued open-mindedness and demonstrated an ability to stay focused on the problem-solving process. They reported an awareness of the need to redefine problems clearly and to explore alternative approaches without being hindered by fear of failure. Responses further indicated that participants recognized the importance of maintaining multiple possible solutions simultaneously and appreciated the iterative nature of the design process. Several noted an understanding of when to transition between divergent and convergent thinking phases, suggesting a growing process-oriented awareness. These findings align with Vignoli et al. (2023), who emphasized the importance of learners being mindful of the different stages of the design thinking process, including knowing when to engage in expansive idea generation versus targeted refinement. Although causality cannot be claimed due to the study's post-test-only design, the TEALF environment may have supported this awareness by embedding reflective checkpoints and structured opportunities for iterative work.

For *collaboration with others*, participants' survey responses suggested a strong preference for working in groups over working alone. They reported feeling comfortable collaborating with individuals from diverse backgrounds and valued learning from different perspectives. These responses were interpreted from the collaboration subscale of the DT mindset survey. Participants also indicated a willingness to engage in joint decision-making,

share information openly, and co-construct new knowledge with peers. Such traits align with the collaborative competencies highlighted by Henriksen et al. (2022), who emphasized the importance of sharing knowledge and utilizing visualization tools to support group dialogue and meaning-making. Although visualization tools were not explicitly discussed in the current dataset, the TEALF intervention utilized collaborative digital platforms, such as shared iCloud sheets and Google Docs, which may have facilitated effective communication and content co-creation. Groeger and Schweitzer (2020) similarly stressed the value of multidisciplinary teamwork in fostering communication and broadening perspectives. The positive orientation toward collaboration observed in the survey responses suggests that the TEALF environment may have supported the perceived shift in mindsets.

Regarding *orientation to learning*, responses from the DT mindset survey indicated that participants valued experiential learning, reflection, and active engagement. They reported that they learn from their experiences, observations, and actions; apply newly acquired knowledge; incorporate feedback into their learning; and seek out unfamiliar information. They also described learning through discussion, sharing, and reflecting on their mistakes, as well as striving to gather as much relevant knowledge as possible. These behaviors align with the characteristics of design thinkers described by Vignoli et al. (2023), who emphasize the importance of challenging existing ideas and exploring new contexts. Similarly, Simeon et al. (2020) highlighted how such orientations support continuous learning and adaptability, qualities essential in design-driven fields. Although the study's quantitative design limits causal inference, it is possible that specific features of the TEALF intervention, such as iterative STEM challenge development and peer feedback mechanisms, contributed to the emergence of this active and self-directed learning mindset. The elevated mean score on the orientation-to-learning scale suggests that participants demonstrated a perceived shift in their mindset toward growth and learning after engaging in the TEALF-based activities, though further investigation using longitudinal or pre-post designs would be needed to confirm developmental change.

Finally, for *creative confidence*, results from the DT mindset survey indicated that preservice teachers reported the ability to propose ideas even with incomplete information, apply innovative thinking to solve complex problems, and generate novel ideas beyond existing solutions. They also noted the capacity to create models to represent new concepts, explore alternative possibilities, and derive value from outcomes to overcome challenges. These reported characteristics reflect key elements of creative confidence as described in the literature. Hamat et al. (2019) emphasize that the ability to think differently and to trust in one's capacity to solve problems innovatively signifies the development of creative confidence. Similarly, Henriksen et al. (2020) argue that creative confidence is a major contributor to effective problem-solving in design-oriented teams. While these results suggest a positive disposition toward creative confidence post-intervention, the study's quantitative methodology, specifically, the use of a one-sample t-test comparing scores to a neutral midpoint, limits the ability to claim definitive development. However, it is possible that components of the TEALF intervention, such as iterative STEM challenges, exposure to diverse digital tools, and scaffolded opportunities to experiment with instructional models, created an environment that encouraged risk-taking and creativity. This interpretation aligns with transformative learning theories (Capone & Lepore, 2021; Trust & Whalen, 2020), which highlight how immersive educational experiences can

reshape learners' perspectives and promote deep shifts in mindset, especially when supported by reflective practice and active engagement.

Q2: What Are the Preservice Teachers' Perceptions of Using the Technology-Enhanced Active Learning Design Framework in STEM Courses?

The second question was addressed through the focus group discussion using four different aspects inspired by Kolb's experiential learning model: description, feelings, evaluation, conclusion, and plans, as a lens to analyze preservice teachers' perceptions. These perceptions were thematically analyzed using Braun and Clarke's six-phase approach, which helped interpret data from the DT dimensions.

In *Descriptive Perceptions*, the initial exposure to TEALF allowed preservice teachers to describe their experiences integrating technology with the DT process in a TEALF environment. Many expressed feeling overwhelmed at the beginning of the semester due to the steep learning curve associated with mastering multiple digital applications, earning the Apple Teaching Certificate, and understanding how to apply DT in their practice. Despite this, participants gradually developed familiarity with the tools and began to distinguish between applications used for teaching, assessment, and student engagement. This process of active engagement supported the activation of learners' prior knowledge, enabling them to encode new information more effectively within a virtual learning environment (VLE) (Hite et al., 2024). Such engagement provides insight into how technology can be used not only to deliver content but also to act as a driver of innovative, student-centered learning approaches (ElSayary et al., 2022). Preservice teachers described their experiences using technology with DT to create a TEALF, where they understood the differences between the applications used and how to use them in teaching, learning, and assessment. This is confirmed in a previous study by Chai et al. (2020), who highlighted the importance of providing teachers with the primary knowledge they need to plan technology-integrated lessons. Additionally, they described the DT process as confusing initially, but using it in planning STEM challenges and projects made them understand it very well. Similarly, a study by Tey et al. (2020) emphasized that STEM education marks a significant shift from traditional teaching methods, focusing on active learning where students engage in hands-on, practical problem-solving. This approach encourages a more profound understanding and suits the dynamic nature of 21st-century learners (Abykanova et al., 2016). They added that the tricky part was deciding when to create assessment checkpoints within the DT process to allow early-year students to reflect and receive feedback on their work. Capone & Lepore (2021) highlighted that the transformative approach integrates the content, pedagogy, and technology domains to support instructors in the teaching and learning process, which is challenging to achieve.

Regarding emotional reactions (*feelings*), preservice teachers felt overwhelmed at the beginning of the semester, as their learning environment was perceived as uncomfortable during the early stages of implementation. However, they recognized the value of learning and applying new approaches in teaching and learning through the DT process. This discomfort eventually facilitated growth, as learners developed a sense of competence and efficacy in using educational technologies. These emotional responses align with the principles of transformative learning theory, which posits that individuals can transform their perspectives and develop new skills and habits when confronted with challenging situations (Strange & Gibson, 2017). Abykanova et al.

(2016) and Capone & Lepore (2021) also stress that navigating such discomfort is a key catalyst for developing new habits of mind and pedagogical strategies. The key here is not only to know how to use new applications but also to understand when to use them and set them within teaching, learning, and assessment. Similar results were highlighted in a previous study where the efficient use of technology can empower teachers and students to build transferrable skills in a technology-enhanced active learning environment, such as computational thinking, creativity and innovation, critical thinking, self-direction, collaboration, and communication (ElSayary et al., 2022). In the present study, preservice teachers also appreciate collaborating with their teammates to create new ideas. They mentioned that each has different interests, strengths, and weaknesses, and they benefit from their differences. The same results were noted in a previous study, which stated that learners' collaboration helps establish a friendly learning environment among them, allowing for open communication (Rybakova et al., 2021). This study contributes to the body of knowledge surrounding the TPACK framework by exploring the implementation of technology, content, and pedagogy in a technology-enhanced active learning environment. It offers a unique perspective on how this framework can be applied in preservice teacher education (Hirsh & Baronak, 2020), where preservice teachers expressed that they became advanced technology users.

In *evaluating* the technology-enhanced active learning environment, participants offered critical reflections on the benefits and limitations of TEALF. A frequently cited challenge was identifying the optimal timing for formative assessment check-points within the DT process, particularly when working with early years learners. Participants noted that, although the DT process was initially unclear, experiential engagement helped them understand when and how to utilize it. They highlighted how technology enabled differentiation by allowing multiple modes of feedback, including audio, video, and written formats. They considered themselves in the students' place and tried to think about how to meet their different individual needs. They shared some ideas, such as recording the feedback using audio, videos, and sometimes writing. They added that they could differentiate the learning environment using interactive technology, where students act as active rather than passive learners. ElSayary et al. (2022) stated that providing a technology-enhanced active learning environment that supports students' development, meets individual needs, and designs a thinking mindset is essential. In the present study, preservice teachers demonstrated familiarity with the DT process to the extent that they reported applying it intuitively when solving problems, suggesting a perceived shift in their DT mindsets. Previous studies mentioned that teachers and students should be involved in the analysis, design, development, and evaluation process when using technology, as it leads learners to a perceived shift in their DT mindsets needed to prepare them for future jobs (Scanlon et al., 2019).

In reflecting on their *plans*, learners stated some essential actions they would consider. For instance, they mentioned using TEALF and DT to differentiate the learning environment to meet all students' needs. They also noted that they need to list the technology applications, purposes, and the level of thinking required to design a technology-enhanced active learning environment that effectively utilizes technology. They expressed a desire to create technology-enhanced active learning environments that support not only academic but also social, emotional, and cognitive development. In addition, they mentioned the importance of developing mindfulness skills in students from an early age due to the positive impact it has on their social, emotional, physical, and cognitive development. These reflections align with previous studies

highlighted the importance of developing mindfulness, stating that learners build up creative confidence and become innovative when they are mindful of their learning process as learners who can use information, act as researchers, solve complex problems, empathize with individuals' needs and create new products that meet their needs (Abykanova et al., 2016). Furthermore, preservice teachers believed that they could integrate the content, pedagogical, and technological knowledge, aligning with the goals of the TPACK framework (Capone & Lepore, 2021; Gess-Newsom, 1999). The focus group data reveal how preservice teachers' engagement with TEALF impacted their instructional perspectives in the DT mindset across all of Kolb's reflective stages. Their perceptions were closely tied to experiential learning, peer collaboration, and exposure to innovative technology. This confluence supports a shift toward more adaptive, empathetic, and creative teaching practices in STEM contexts. This study's contribution lies in its holistic approach to integrating technology and DT in teacher education, its insights into transformative learning processes, and its practical implications for enhancing the pedagogical skills of future educators, as mentioned in previous studies (Hsu & Tsai, 2022; Zuhaida et al., 2022). These findings can inform future research, policy-making, and practice in educational technology and teacher education.

Conclusion and Recommendations

This study explored how preservice teachers perceived their DT mindsets after participating in a TEALF within interdisciplinary STEM courses. Post-intervention survey results showed that participants reported DT mindset scores significantly higher than the neutral midpoint across all six mindset dimensions: uncertainty, empathy, mindfulness, collaboration, orientation to learning, and creative confidence, indicating a generally positive disposition following their experience with TEALF. These findings suggest that the framework may support the cultivation of DT traits when implemented with digital tools and scaffolded experiential learning, although the study design does not allow for causal conclusions. Participants engaged with a variety of interactive digital applications and completed an intensive training period that included earning the Apple Teaching Certificate. While these components may have contributed to the observed positive perceptions, direct attribution of mindset outcomes to specific intervention features should be made cautiously. Notably, one aspect of uncertainty (comfort with unsolved problems) did not change significantly; it was still encompassed within the broader positive shift. This item was neglected as the overall result of uncertainty showed a considerable difference. Mezirow (1997) notes that transformation in habits of mind can require reflective thinking, which may explain this challenge with some aspects of uncertainty.

Preservice teachers initially reported feelings of discomfort and confusion during their two-week training period, particularly due to the intensity of mastering new technologies and understanding the DT process. These reactions emerged clearly in the focus group discussions, where participants described the early learning environment as overwhelming yet necessary for growth. However, after applying the DT process, they recognized the benefits of what they had learned. This aligns with Strange and Gibson (2017), who found that perspective shifts often occur in response to uncomfortable situations. Such shifts are key features of transformative learning, wherein individuals reframe their prior assumptions through critical reflection and experiential engagement. In this study, the experience of navigating uncertainty, applying iterative thinking, and collaborating with peers likely served as catalysts for such transformation.

The participants' recognition of these benefits, expressed in their reflections on future teaching practices and their increased confidence, suggests that the initial cognitive dissonance played a productive role in shaping their DT mindsets.

Based on the study's findings, it is recommended that preservice teachers' education programs continue to emphasize the development of technological pedagogical content knowledge, with a particular focus on the DT process. Focus group results highlighted that preservice teachers valued the opportunity to use technology creatively and collaboratively to design meaningful STEM learning experiences. They reported that engaging with the DT process enhanced their ability to navigate ambiguity, generate innovative ideas, and reflect critically on their pedagogical practices, core competencies aligned with the TPACK framework.

Additionally, several participants highlighted how mindfulness, both in managing their own learning goals and in empathizing with students, was essential to their growth as future educators. This suggests that embedding structured mindfulness activities and elements of positive education should be considered for inclusion in teacher education programs, which could further support emotional well-being, self-regulation, and reflective practice. Such strategies may be particularly beneficial in cultivating resilience and purpose in teaching from early years through secondary education, aligning with broader goals for social-emotional learning and sustainable professional development across K–16 settings.

Future research should build upon the current study by addressing both its methodological constraints and the conceptual insights it has generated. While the survey revealed that preservice teachers exhibited DT mindset scores above a neutral midpoint following their participation in the TEALF, the post-test-only design limited the ability to assess change or causality. To more robustly examine the development of DT mindsets over time, future studies should adopt longitudinal or pre-post designs, allowing for direct comparisons and stronger causal inferences. Additionally, although the findings suggest a possible link between Design Thinking and personal growth areas, such as mindfulness and empathy, the role of positive education in supporting DT mindset development and enhancing student well-being remains underexplored. Investigating this relationship could uncover synergies between emotional well-being and creative, collaborative problem-solving.

This study's sample, comprised exclusively of female preservice teachers in an early childhood education program at a federal university in the UAE, also limits the generalizability of the findings. Future research should aim to include more diverse populations across gender, academic level (e.g., K–12 teacher preparation), and cultural contexts to validate and extend the applicability of TEALF. In addition, the suggestion to analyze preservice teachers' weekly reflections stems from the recognition that self-reported survey responses may not fully capture the evolving, detailed nature of mindset development. Incorporating longitudinal qualitative data, such as reflective journals or learning portfolios, could offer deeper insights into how individual perspectives and competencies shift throughout training. Finally, this study also encountered limitations related to the use of a one-sample t-test and the interpretation of mean scores against a neutral benchmark. While this provided an initial indication of positive disposition post-intervention, it does not substitute for direct evidence of learning gains. Future research should employ more rigorous statistical models and ensure that theoretical constructs are consistently

defined and cited, thereby avoiding reliance on placeholder references. Addressing these methodological limitations will not only strengthen the evidence base but also enhance the practical utility of TEALF in shaping resilient, reflective, and innovative educators in STEM education and beyond.

Declarations**Conflicts of Interest**

Author certifies that she has no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Funding

No financial support was received.

Data Availability

All relevant data, material and coding is included in the manuscript.

Ethics Statement

The study was approved by the Researcher University's Ethics Committee with approval no. ZU21_148_F

References

- Abykanova, B., Nugumanova, S., Yelezhanova, S., Kabylkhamit, Z., & Sabirova, Z. (2016). The use of interactive learning technology in institutions of higher learning. *The International Journal of Environmental and Science Education*, 11(18). <http://files.eric.ed.gov/fulltext/EJ1124626.pdf>
- Altay, B., & Porter, N. (2021). Educating the mindful design practitioner. *Thinking Skills and Creativity*, 41, 100842. <https://doi.org/10.1016/j.tsc.2021.100842>
- Auernhammer, J. M., Leifer, L., Meinel, C., & Roth, B. (2022). *A humanistic and creative philosophy of design*. In C. Meinel & L. Leifer (Eds.), *Design thinking research: Achieving real innovation*. Springer Nature.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Capone, R., & Leopre, M. (2021). From distance learning to integrated digital learning: A fuzzy cognitive analysis focused on engagement, motivation, and participation during COVID-19 pandemic. *Technology, Knowledge and Learning*. <https://doi.org/10.1007/s10758-021-09571-w>
- Chai, C. S., Rahmawati, Y., & Jong, M. S. (2020). Indonesian science, mathematics, and engineering preservice teachers' experiences in STEM-TPACK design-based learning. *Sustainability*, 12(21), 9050. <https://doi.org/10.3390/su12219050>
- Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.
- Dagienė, V., Jeviskova, T., Stupurienė, G., & Juškevicienė, A. (2022). Teaching computational thinking in primary schools: Worldwide trends and teachers' attitudes. *Computer Science and Information Systems*, 19(1), 1–24. <https://doi.org/10.2298/csis201215033d>
- Daniela, L. Visvizi, A., Gutiérrez-Braojos, C., & Lytras, M. (2018). Sustainable higher education and technology-enhanced learning (TEL). *Sustainability*, 10(1), 1-22. <https://doi.org/10.3390/su10113883>
- ElSayary, A. Forawi, S. & Mansour, N. (2015). Teaching thinking in STEM subjects: STEM education and problem-based learning, pp. 357- 368, in: *The Routledge International Handbook of Research on Teaching Thinking*. Routledge International Handbooks. London and New York. Routledge Taylor & Francis Group.
- ElSayary, A., Zein, R., & San Antonio, L. (2022). Using Interactive Technology to Develop Preservice Teachers' STEAM Competencies in Early Childhood Education Program. *Eurasia Journal of Mathematics, Science and Technology Education*, 18(2), em2079. <https://doi.org/10.29333/ejmste/11649>

- Elsbach, K. D., & Stigliani, I. (2018). Design thinking and organizational culture: A review and framework for future research. *Journal of Management*, 44(6), 2274–2306.
<https://doi.org/10.1177/0149206317744252>
- Field, A. (2009). *Discovering statistics using SPSS*. London: SAGE Publications Ltd.
- Gar, P., & Idris, M. Z. (2021). Employing virtual reality (VR) technology with experiential learning perspective to enhance students' learning experience. *International Journal of Academic Research in Business & Social Sciences*, 11(4).
<https://doi.org/10.6007/ijarbss/v11-i4/9712>
- González-Salamanca, J. C., Arias Agudelo, O. L., & Salinas, J. (2020). Key competences, education for sustainable development and strategies for the development of 21st century skills: A systematic literature review. *Sustainability*, 12(24), 10366.
<https://doi.org/10.3390/su122410366>
- Groeger, L., & Schweitzer, J. (2020). Developing a design thinking mindset: Encouraging designerly ways in postgraduate business education. In *Design science and innovation* (pp. 41–72). https://doi.org/10.1007/978-981-15-5780-4_3
- Henriksen, D., Gretter, S., & Richardson, C. (2020). Design thinking and the practicing teacher: Addressing problems of practice in teacher education. *Teaching Education*, 31(2), 209–229. <https://doi.org/10.1080/10476210.2018.1531841>
- Henriksen, D., Heywood, W., & Gruber, N. (2022). Meditate to create: Mindfulness and creativity in an arts and design learning context. *Creativity Studies*, 15(1), 147–168.
<https://doi.org/10.3846/cs.2022.13206>
- Hirsh, R. A., & Baronak, K. (2020). Empowering early childhood pre-service teachers with tech fluency. *Creative Education*, 11, 2730–2748. <https://doi.org/10.4236/ce.2020.1112200>
- Hite, R.L., Jones, M.G. and Childers, G.M. (2024). Classifying and modeling secondary students' active learning in a virtual learning environment through generated questions, *Computers & Education*, 208, 104940.
<https://doi.org/10.1016/j.compedu.2023.104940>
- Hsu, R. C., & Tsai, T.-H. (2022). Assessing the impact of a project-based learning robotics course with integrating of STEM education using content analysis method. *European Journal of STEM Education*, 7(1), 09. <https://doi.org/10.20897/ejsteme/12633>
- Johnson, B., & Christensen, L. (2014). *Educational research: quantitative, qualitative, and mixed-method*. SAGE.
- Kent State University Libraries. (2017). SPSS tutorials: One sample t-test Retrieved from <http://libguides.library.kent.edu/SPSS/IndependentTTest>

- Khoo, S., & Jørgensen, N. J. (2021). Intersections and collaborative potentials between global citizenship education and education for sustainable development. *Globalisation, Societies and Education*, 19(4), 470–481. <https://doi.org/10.1080/14767724.2021.1889361>
- Kimbell, L., & Seidel, V. P. (2019). DT in education: A critical review. *Technology, Pedagogy and Education*, 28(3), 253-265. <https://doi.org/10.1080/1475939X.2019.1598210>
- Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In *Handbook of research on educational communications and technology* (Fourth ed., pp. 101–111). Springer. https://doi.org/10.1007/978-1-4614-3185-5_9
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, N.J: Prentice-Hall.
- Lachheb, A., Abramenska-Lachheb, V., Moore, S., & Gray, C. M. (2023). The role of design ethics in maintaining students' privacy: A call to action to learning designers in higher education. *British Journal of Educational Technology*, 54(6), 1653–1670. <https://doi.org/10.1111/bjet.13382>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33(1), 159. <https://doi.org/10.2307/2529310>
- Li, T. and Zhan, Z. (2022) A systematic review on DT integrated learning in K-12 education. *Applied Sciences*, 12(16), p. 8077. <https://doi.org/10.3390/app12168077>
- Liu, H. (2023). Measuring design thinking competence in Taiwanese nursing students: A cross-cultural instrument adaptation. *BMC Medical Education*, 23(1). <https://doi.org/10.1186/s12909-023-04911-z>
- Lumley, T., Diehr, P., Emerson, S., & Chen, L. (2002). The importance of the normality assumption in large public health data sets. *Annual Review of Public Health*, 23, 151–169. <https://doi.org/10.1146/annurev.publhealth.23.100901.140546>
- Mezirow, J. (1997). Transformative learning: Theory to practice. *New Dir Adult Cont Educ.*, (74), 5-12. <https://doi.org/10.1002/ace.7401>
- Noh, S. C., & Abdularim, M. A. (2021). Design thinking mindset to enhance education 4.0 competitiveness in Malaysia. *International Journal of Evaluation and Research in Education (IJERE)*, 10(2), 494. <https://doi.org/10.11591/ijere.v10i2.20988>
- Novak, E. & Mulvey, B. (2020). Enhancing design thinking in instructional technology students. *Journal of Computer-Assisted Learning*, 1-11. <http://dx.doi.org/10.1111/jcal.12470>
- Partnership for 21st Century Skills. (2009). *P21 Framework Definitions; Partnership for 21st Century Skills: Washington, DC, USA*.

- Rybakova, A., Shcheglova, A., Bogatov, D., & Alieva, L. (2021). Using interactive technologies and distance learning in sustainable education. *E3S Web of Conferences*, 250(07003), 1-7. <https://doi.org/10.1051/e3sconf/202125007003>
- Scanlon, E., Anastopoulou, S., Conole, G., & Twiner, A. (2019). Interdisciplinary working methods: Reflections based on technology-enhanced learning (TEL). *Frontiers in Education*, 4, 134. <https://doi.org/10.3389/feduc.2019.00134>
- Simeon, M.I., Samsudin, M.A. and Yakob, N. (2020) Effect of design thinking approach on students' achievement in some selected physics concepts in the context of STEM learning, *International Journal of Technology and Design Education*, 32(1), pp. 185–212. <https://doi.org/10.1007/s10798-020-09601-1>
- Strange, H., & Gibson, H. (2017). An investigation of experiential and transformative learning in study abroad programs. *Frontiers: The Interdisciplinary Journal Of Study Abroad*, 29(1), 85-100. <https://doi.org/10.36366/frontiers.v29i1.387>
- Tey, T. C. Y., Moses, P., & Cheah, P. K. (2020). Teacher, parental and friend influences on STEM interest and career choice intention. *Issues in Educational Research*, 30(4), 1558–1575. <https://www.ier.org.au/ier30/tey.pdf>
- Trust, T. & Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. *Journal of Technology and Teacher Education*, 28(2), 189-199. Waynesville, NC USA: Society for Information Technology & Teacher Education. from <https://www.learntechlib.org/primary/p/215995/>.
- UAE Government (2015). *Science, Technology and Innovation Policy in the United Arab Emirates..*
- UAE National Committee on SDGs (2017). *UAE and the 2030 Agenda for Sustainable Development: Excellence In Implementation.*
- UNESCO. (2016). Education 2030 Incheon Declaration and Framework for Action: Towards Inclusive and Equitable Quality Education and Lifelong Learning for All. <http://www.uis.unesco.org/Education/Documents/incheon-framework-for-action-en.pdf>
- Valencia, A., Lievesley, M., & Vaugh, T. (2021). Four mindsets of designer-entrepreneurs. *Design Journal*, 24(5), 705–726. <https://doi.org/10.1080/14606925.2021.1958601>
- VanGronigen, B. A., Meyers, C. V., Adjei, R. A., Marianno, L., & Charris, L. (2023). The design and characteristics of school improvement plan templates. *AERA Open*, 9, 233285842311683. <https://doi.org/10.1177/23328584231168378>
- Vennix, J., den Brok, P., & Taconis, R. (2022). An exploration of guide's roles in STEM outreach activities: A contribution to students' motivation for career aspirations? In S. G. Taukeni (Ed.), *Motivation and success*. IntechOpen. <https://doi.org/10.5772/intechopen.108427>

- Vijayatheepan, R. (2025). The application of TPACK model in teachers' teaching practices: A study on integration and effectiveness. *International Journal of Research and Innovation in Social Science*, VIII(XII), 3955–3969. <https://doi.org/10.47772/ijriss.2024.8120328>
- Xiao, W., Qu, L., Li, K., Guo, C., & Li, J. (2023). An assessment of the rational range of eco-compensation standards: A case study in the Nujiang Prefecture, Southwestern China. *Land* 2022, 11, 1417. *Land*, 12(5), 1052. <https://doi.org/10.3390/land12051052>
- Yilmaz-Soylu, M., Karakus, T., & Inal, Y. (2021). DT in education: A systematic review. *Educational Technology Research and Development*, 69(1), 1–34. <https://doi.org/10.1007/s11423-020-09908-9>
- Zuhaida, A., Zuhri, M. K., & Ayyubi, S. H. (2022). Analysis of students' critical thinking skills through science, technology, engineering and mathematics (STEM) approach. *AIP Conference Proceedings*. <https://doi.org/10.1063/5.0112996>

Mixed Reality System for Automotive Vocational School: Academic Performance and Experience Assessment

Satrio Pradono Suryodiningrat*

School of Computing and Creative Arts, University of Bina Nusantara, Jakarta, Indonesia

Harjanto Prabowo

Department of Computer Science, Doctor of Computer Science, BINUS Graduate Program, Bina Nusantara University, Jakarta, Indonesia

Arief Ramadhan

School of Computing, Telkom University, Bandung, Indonesia

Harry Budi Santoso

Faculty of Computer Science, Universitas Indonesia, Depok, Indonesia

Abstract

Mixed reality (MR) devices, such as Microsoft HoloLens, offer immersive and interactive learning opportunities that can enhance vocational education. While MR technologies are increasingly used in K–12 settings, their application in vocational schools remains limited, despite the potential to improve workplace readiness of graduates in alignment with Industry 5.0 standards. This study investigates the effectiveness of MR in automotive vocational schools using a quasi-experimental pre-test/post-test design to measure student performance and a SPRADO assessment tool to assess user experience. The study involved 42 students and 9 teachers from 4 vocational high schools (from grades 9 and 10) divided into MR and non-MR groups. Academic performance was assessed through standardized pre- and post-tests, and the MR group also completed a survey using the SPRADO assessment tool, which evaluates six dimensions of MR learning systems: usability, system functionality, pedagogical alignment, realism, accessibility, and user satisfaction. The findings show a significant improvement in academic performance among students in the MR group compared to the non-MR group and revealed positive perceptions from both students and teachers in the MR group regarding the capabilities of MR in supporting learning. These results provide empirical support for integrating MR into vocational curricula as a strategic response to evolving technological and industrial demands.

Keywords: SPRADO assessment tool, mixed reality, quasi-experimental design, vocational education

Suryodiningrat, S. P., Prabowo, H., Ramadhan, A., & Santoso, H.B. (2026). Mixed reality system for automotive vocational school: Academic performance and experience assessment, *Online Learning*, 30(1), pp. 246-264. <https://doi.org/10.24059/olj.v30i1.4805>

In recent years, there have been significant improvements in mixed reality (MR) technology, resulting in the creation of a hybrid environment that seamlessly combines the physical and digital worlds. These systems utilize state-of-the-art technology, including advanced sensors, real-time 3D visualization, spatial mapping, and AI-driven interactions to offer immersive experiences that surpass the capabilities of standard virtual reality and augmented reality (Morimoto et al., 2022). Devices such as Microsoft HoloLens 2 and Magic Leap One demonstrate the advancements in MR hardware, allowing users to view and engage with digital content that is overlaid with the physical world. These systems utilize advanced cameras and sensors to comprehend the physical surroundings, enabling holograms to be precisely integrated into the real world (Maas & Hughes, 2020).

Education is being transformed by MR, as it allows students to engage with 3D models of intricate architecture, historical landmarks, and scientific processes, thereby making abstract ideas more tangible and captivating. Within the healthcare field, the utilization of MR technology is revolutionizing both medical training and practice (Sievers et al., 2020). In engineering education, MR enhances learners' ability to visualize systems, diagnose problems, and test solutions in simulated settings (Rokhsaritalemi et al., 2020). These examples reflect MR's growing role in bridging theoretical instruction with real world application. The potential of MR in the future offers the possibility of a more profound integration into our everyday lives, fundamentally transforming our interactions with technology, other individuals, and the physical environment (Pellas et al., 2020).

Despite its promise, MR remains underutilized in vocational education. Compared to K-12 schools, which increasingly adopt MR to enhance learning in subjects like Physics, History, and Mathematics, vocational schools have been slower to integrate this technology (Suryodiningrat et al., 2023). This disparity can be attributed to several factors, including limited funding, reliance on conventional teaching methods, and a lack of teacher preparation or familiarity with emerging technologies (Béduwé & Giret, 2011; Heaviside et al., 2018; Jaya et al., 2020). As a result, vocational students often miss out on the immersive and practical experiences that MR can offer. This is particularly concerning in automotive vocational schools where students must develop both conceptual knowledge and hands-on skills. Many graduates of these schools encounter considerable difficulties while transitioning into the job world, as a large number of them fail to fulfill the industry's requisite competency standards and are insufficiently equipped to become fully prepared professionals (Durmus & Dağlı, 2017; Suharno et al., 2020). As a result, graduates may encounter difficulties in effectively operating, maintaining, and resolving issues with modern equipment, which might result in a significant learning challenge when they start working. Employers often face the need to allocate time and resources to provide additional training for new personnel, which can impede production and efficiency. Furthermore, the lack of alignment between academic preparation and industrial requirements can lead to decreased self-assurance and job contentment among graduates, which can harm their overall professional growth and advancement (Heaviside et al., 2018; Imam Agung et al., 2018).

Integrating MR into vocational education offers a promising solution. MR can revolutionize vocational training by providing immersive and interactive teaching environments that seamlessly integrate academic knowledge with practical applications (Smith et al., 2021). Through technologies such as holograms, real-time 3D visualization, and interactive simulations,

students can safely practice tasks like disassembly, troubleshooting, and machine operations (Boel et al., 2023). MR also facilitates collaborative learning by allowing teachers to offer immediate advice and feedback from a distance, overcoming geographical limitations, and making education more accessible to a wider range of people (Wang & Li, 2024). In addition, MR can accurately reproduce real-life situations, thereby equipping students with the necessary skills and experience to tackle the obstacles they may encounter in professional settings (Ogunseiju et al., 2022). By incorporating MR into the curriculum, vocational schools can produce more confident, workforce-ready graduates who are better equipped for modern industrial demands.

Despite these advantages, empirical research on MR in vocational education, particularly in the automotive sector, remains limited. To address this gap, this study used a quasi-experimental design to investigate how MR could improve student performance in four automotive vocational schools in Indonesia. The study also looked at user experience. By combining test results and user impressions, the study gives a full view of how MR can support vocational education and help prepare students for modern industry needs.

Literature Review

Given the promise of MR to provide immersive environments that connect theoretical learning with practical application, several studies have explored its impact across diverse training contexts. For example, Adams et al. (2022) investigated the use of MR with the Microsoft HoloLens 2 in vocational education, namely in nursing curricula. The findings emphasize MR's capacity to improve spatial reasoning and situational judgment, allowing learners to engage thoroughly with course material. At the same time, this study identifies technical barriers, including interaction with college networks and user authentication difficulties, that must be resolved for wider implementation. Notably, the authors emphasize the significance of culturally responsive approaches, integrating Tikanga Māori to match MR applications with New Zealand's educational principles, especially in nursing programs where adherence to cultural conventions is crucial. This study underscores how MR can enhance vocational training when thoughtfully contextualized.

Another study, Smith et al. (2021), investigated the use of MR in vocational training for electrical technicians. This study was a comparative analysis between novices and experienced individuals performing the same task. In the study, novices used a mobile MR application to complete a fault diagnosis task on a three-phase power supply, while experienced individuals (i.e., those with prior relevant knowledge or field experience) completed the same task without the MR application. The study demonstrated that novice users utilizing the MR guidance outperformed the experienced group, suggesting that MR can supplement traditional training models by simulating practical tasks and work contexts.

While prior studies demonstrate the promise of MR in enhancing vocational training across various fields—particularly in nursing and electrical engineering—there remains a noticeable lack of empirical research focused on its application in automotive vocational education. Given the significant skills gap faced by graduates and the low adoption rate of MR in vocational schools (Suryodiningrat et al., 2023), further investigation is needed to explore how

MR can impact both academic performance and user experience in this context. Therefore, this study aims to evaluate the effectiveness of MR systems in improving learning outcomes and student engagement in automotive vocational schools in Indonesia. Using a quasi-experimental design and the SPRADO assessment tool, the study seeks to answer:

1. Does the use of MR improve students' academic performance in automotive vocational training?
2. How do students and teachers perceive the usability and educational value of MR through the SPRADO assessment tool?

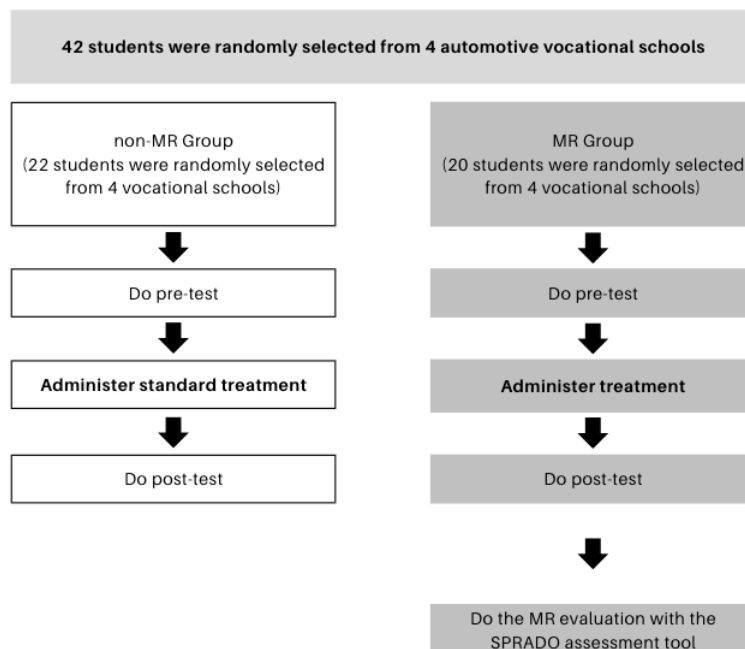
Methodology

Participants and Context of the Study

Four vocational schools for grades 10-12 in Indonesia provided the context for the study. Two groups were established: the MR group and the non-MR group. Initially, each group consisted of five grade 10 students from each school. One vocational school later contributed two additional students to the non-MR group. This brought the total number of participants to 42 students: 22 in the non-MR group, and 20 in the MR group. The objective of this study was to determine whether instruction using MR could improve students' performance. (The overall quasi-experimental design with a pre-test/post-test design is illustrated in Figure 1). In addition to the student participants, nine teachers from the MR group also engaged in the study to contribute insights on the MR's effectiveness.

Figure 1

Methodology



Data Collection Procedures

Once all the students had been assigned to their respective groups, the study began with both groups completing an identical pre-test, which consisted of 15 questions (10 multiple-choice and 5 short-answer questions). These questions were developed by a team of teachers from the four vocational schools.

Following the execution of the pre-test, the MR group engaged in an interactive learning experience using MR technology. With the Microsoft HoloLens, students explored 3D models of motorcycle engine parts, specifically from the Yamaha YZR Superbike. This allowed them to view, rotate, and examine individual components in detail to better understand their structure and function. The content focused on an introductory lesson covering the names, positions, and roles of various engine components. Before beginning the lesson, students received guidance on how to operate the MR device, enabling them to navigate the experience independently. The MR-based learning was conducted over two sessions, lasting a total of approximately 100 minutes, and emphasized exploratory learning, allowing students to interact freely with the materials and proceed at their own pace.

Meanwhile, the non-MR group learned the same content using a conventional teaching method. These students received instruction through a PowerPoint presentation delivered by the teacher, following a more traditional, lecture-based format without any immersive or interactive technologies.

After completing their respective learning sessions, both groups took a post-test using identical questions designed to assess students' understanding of the material they had learned. In addition, the students and teachers from the MR group completed a user experience evaluation using the SPRADO assessment tool, which is a specialized survey instrument designed to evaluate MR systems, focusing on teaching performance for educators and learning experiences for students (Suryodiningrat et al., 2024). This tool assesses MR across six key areas: usability, system functionality, pedagogical alignment, realism, accessibility, and user satisfaction. It applies a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree) to closed-ended questions and also includes open-ended questions to gather deeper insights.

Data Analysis

A paired-sample *t*-test was conducted with each group's pre- and post-test scores to determine whether the difference in scores was statistically significant. The resulting mean deltas between pre- and post-tests were then compared across groups using an independent-sample *t*-test to assess intergroup differences in learning gains.

The SPRADO assessment tool was used to evaluate user experience and perception, and its internal consistency was assessed using Cronbach's alpha. A significance level of $p < 0.01$ was selected for all statistical tests to ensure a high level of confidence in the results while maintaining reasonable sensitivity to detect real effects in a small sample size ($n < 50$). The 1% threshold thus provides a balanced trade-off between statistical rigor and practical feasibility in small-sample educational research.

Results and Discussion

Pre- and Post-Test Findings

Results from the pre-test and post-test scores for both the MR and non-MR groups are presented below. Full score distributions can be seen in Table 1.

In the non-MR group, the average score of the group increased from 50.00 in the pre-test to 59.77 in the post-test. Some students made notable progress. For instance, Participant 1 improved from 60 to 70, Participant 2 went from 50 to 70, and Participant 10 showed a significant gain, increasing from 35 to 100. These improvements suggest that traditional classroom learning worked well for certain individuals. However, the results were not consistent for all students. A few participants experienced a drop in their scores. Participant 9's score fell sharply from 95 to 30, and Participant 13 decreased from 55 to 20. These declines indicate that traditional methods might not have supported these students effectively or that other factors affected their learning outcomes. Some participants showed no change. For example, Participant 8 scored 50 on both tests, and Participant 19 scored 55 on both. This suggests that their performance remained stable, with little to no impact from the learning activities. Overall, the non-MR group showed a mix of improvements, declines, and stable results, reflecting the varied effectiveness of traditional instruction across different students. This observation aligns with findings from previous research, which also reported mixed outcomes in non-immersive learning environments (Moon et al., 2024; Tang et al., 2020).

Compared to the non-MR group, the MR group demonstrated notable improvements in performance. The average score of the group rose from 38.25 in the pre-test to 72.75 in the post-test. This significant increase suggests that the intervention was generally successful in improving the participants' performance. A significant number of participants demonstrated remarkable enhancements in their scores. For instance, Participants 1 through 4 improved their scores, from 50, 80, 50, and 50 in the pre-test to a 100 in the post-test, and participants 18 and 19 increased their scores from 15 in the pre-test to 100 in the post-test. Moderate improvements were also observed, such as Participant 5's score increased from 45 to 90, Participant 7's from 25 to 35, and Participant 8's from 40 to 60. Although not as drastic as the changes that achieved the highest score, these enhancements nonetheless demonstrate significant progress in performance, suggesting that the intervention has a favorable impact across a range of baseline performance levels. A few students made no improvements or their scores remained the same, for example Participant 16's score was 15 in both tests, suggesting that the intervention had no noticeable impact on this individual. Participant 10 had a decline from 45 to 20. Nevertheless, the MR group overall demonstrated a notable and statistically significant improvement in test scores after the intervention, with a considerable number of individuals making meaningful progress.

To evaluate the impact of the intervention, the disparity between the pre-test and post-test scores were calculated for each group. Results are summarized in Table 1 and the outcomes of the paired difference t-test are presented in Table 2.

Table 1*Delta of the Non-MR Group and the MR Group*

Non-MR Group				MR Group			
No.	Pre-Test	Post-test	Delta	No.	Pre-Test	Post-test	Delta
1	60	70	-10	1	50	100	-50
2	50	70	-20	2	80	100	-20
3	35	60	-25	3	50	100	-50
4	40	65	-25	4	50	100	-50
5	30	70	-40	5	45	90	-45
6	45	55	-10	6	20	55	-35
7	30	60	-30	7	25	35	-10
8	50	50	0	8	40	60	-20
9	95	30	65	9	15	40	-25
10	35	100	-65	10	45	20	25
11	30	20	10	11	40	65	-25
12	50	40	10	12	45	70	-25
13	55	20	35	13	50	75	-25
14	60	45	15	14	70	90	-20
15	65	75	-10	15	40	75	-35
16	45	20	25	16	15	15	0
17	40	60	-20	17	40	80	-40
18	55	70	-15	18	15	100	-85
19	55	55	0	19	15	100	-85
20	45	95	-50	20	15	85	-70
21	65	90	-25				
22	65	95	-30				

Table 2*Non-MR Group and MR Group Paired Difference t-test Result*

Non-MR Group t-test Result				MR Group t-test Result			
Null Hypothesis		p-value	$\alpha = 1\%$	Null Hypothesis		p-value	$\alpha = 1\%$
$H_0: m_1 - m_2 =$	0	0.1295527	Accept	$H_0: m_1 - m_2 =$	0	0.0000144	Reject
$H_0: m_1 - m_2 \geq$	0	0.0647763	Accept	$H_0: m_1 - m_2 \geq$	0	0.0000072	Reject

$H_0: m_1 - m_2 \leq 0$	0	0.9352237	Accept	$H_0: m_1 - m_2 \leq 0$	0	0.9999928	

The mean discrepancy (Delta) between the pre-test and post-test scores for the non-MR group was -9.7727, suggesting a general enhancement in student performance. The standard deviation of the differences was 29.0516. Although there has been an improvement, the statistical analysis indicates that the results are not statistically significant at the 1% level of significance. The t-test statistic was calculated to be -1.5778 with 21 degrees of freedom, yielding a p-value of 0.1295527. The p-value above the threshold of 0.01 indicates that the null hypothesis ($H_0: m_1 - m_2 = 0$) can be accepted at a significance level of 1%. Additionally, when alternative assumptions are taken into account, a further analysis of the null hypothesis also confirms this finding. The p-value for the one-tailed test with the null hypothesis ($H_0: m_1 - m_2 \geq 0$) was 0.0647763, while for the opposite one-tailed test ($H_0: m_1 - m_2 \leq 0$), it was 0.9352237. Both p-values surpass the 1% significance threshold, implying that both null hypotheses are accepted. To summarize, although there is some indication of improved performance among students in the non-MR group, the evidence is not sufficiently robust.

The findings of the paired t-test for the MR group present convincing evidence on the efficacy of the MR educational intervention. The mean discrepancy (Delta) between the pre-test and post-test scores for this group was -34.5, suggesting a significant enhancement in student performance. The standard deviation of the differences was 26.7001, indicating a certain degree of variation, suggesting a significant general trend of improvement. The t-test statistic was calculated to be -5.7786 with 19 degrees of freedom, leading to a very small p-value of 0.0000144. The p-value is significantly lower than the 1% significance threshold, indicating that the null hypothesis ($H_0: m_1 - m_2 = 0$) can be rejected at the 1% significance level. This suggests compelling evidence that the MR use had a substantial and beneficial effect on the students' academic achievements. An additional examination of the one-tailed hypotheses provides further evidence for this result. The p-value for the null hypothesis ($H_0: m_1 - m_2 \geq 0$) was 0.0000072, while for the alternative one-tailed hypothesis ($H_0: m_1 - m_2 \leq 0$), it was 0.9999928. The test's exceptionally low p-value, which rejects the null hypothesis $H_0: m_1 - m_2 \geq 0$, confirms that the intervention resulted in a considerable rise in scores, as anticipated. To summarize, the use of MR during instruction had a considerable positive impact on student performance, as indicated by the strong statistical significance of the t-test results.

The findings of the paired t-tests for the non-MR and MR groups show a clear difference in the effectiveness of the two educational programs. The group without MR, which had an average improvement of -9.7727 and a standard deviation of 29.0516, did not provide statistically significant findings ($p = 0.1295527$). The existence of substantial outliers and the heterogeneity in individual results indicate that the non-MR approach had inconsistent effects on the students. On the other hand, the MR group showed a significant and consistent improvement in performance, with an average difference of -34.5 and a standard deviation of 26.7001. The t-test conducted on the MR group produced a very significant outcome ($p = 0.0000144$), indicating strong evidence that the MR use successfully improved student learning results. The one-tailed tests show substantial p-values, which strongly support this finding. These p-values indicate that the MR strategy not only increased scores but did so with a high level of confidence. The findings emphasize the greater effectiveness of MR technology in educational environments

when compared to traditional approaches, indicating that MR could be a significant tool for enhancing student engagement and boosting learning outcomes.

Following this, a statistical test was applied to determine whether there was a significant distinction between the means of the two groups. This method is often used when comparing the averages of two groups to determine if they demonstrate statistically significant differences. Table 3 below presents a summary of the score differences between the two groups. A chart is used to visually compare the pre-test and post-test scores of the two groups. Additionally, the results of the t-test for the difference in means are provided.

Table 3

Summary of Delta from Each Group

No.	Non-MR Group Delta	MR Group Delta
1	10	50
2	20	20
3	25	50
4	25	50
5	40	45
6	10	35
7	30	10
8	0	20
9	-65	25
10	65	-25
11	-10	25
12	-10	25
13	-35	25
14	-15	20
15	10	35
16	-25	0
17	20	40
18	15	85
19	0	85
20	50	70
21	25	
22	30	

Table 4*t-Test for Differences in the Population Means*

Non-MR Group t-test Result			
Null Hypothesis		p-value	$\alpha = 1\%$
$H_0: m_1 - m_2 =$	0	0.0067	Reject
$H_0: m_1 - m_2 \geq$	0	0.0033	Reject
$H_0: m_1 - m_2 \leq$	0	0.9967	Accept

Before the t-test was performed, the differences between pre-test and post-test scores (called *delta*) were calculated for both the non-MR and MR groups (see Table 3). The *delta* represents how much each student's score changed after the learning session. In the non-MR group, the changes varied widely—from a large drop of -65 points to an increase of 65 points. Some students showed improvement, others had no change, and a few even performed worse after the session. In contrast, the MR group had mostly positive deltas, with several students improving by 20 points or more, and some reaching up to 85 points of improvement. This suggests that, overall, students in the MR group gained more from the learning experience compared to the non-MR group.

To better understand if these changes were statistically meaningful for the non-MR group, a paired t-test was used (see Table 4). This test compared the average scores before and after the learning. The first hypothesis ($H_0: m_1 - m_2 = 0$) assumed no difference between the pre-test and post-test averages. Since the p-value (0.0067) was less than 0.01, we rejected this hypothesis. This means there was some difference in scores, though not necessarily a strong one.

The second hypothesis ($H_0: m_1 - m_2 \geq 0$) assumed that students either did worse or stayed the same after learning. The p-value here was 0.0033, again below 0.01, so this hypothesis was also rejected. This indicates that the post-test scores were generally a bit higher. The third hypothesis ($H_0: m_1 - m_2 \leq 0$) proposed that the students' performance either stayed the same or improved. The p-value was 0.9967, much higher than the 0.01 threshold, so we accepted this one. This means it's likely that students improved slightly, but the improvement was not strong or consistent across the group.

Overall, while some individuals in the non-MR group did improve, the group as a whole did not show significant learning progress. The t-test results support this, suggesting only a minor change that cannot be confidently considered a meaningful learning gain.

SPRADO Assessment Findings

The evaluation of teaching and learning in the MR group, as assessed by both the students and teachers using the SPRADO assessment tool, is presented below.

The findings from the teacher evaluations suggest that the MR environment was well-received and perceived as a valuable instructional enhancement. Teachers consistently rated the environment positively across a wide range of dimensions (see Table 5), particularly in terms of improving the effectiveness of content delivery, providing better visualization, and enabling safe engagement with complex tasks—each receiving the highest mean scores (3.56). These results suggest that the MR environment is especially effective in supporting practical, hands-on learning that may be difficult to replicate through traditional instruction. Teachers also reported that the MR environment contributed to a sense of special presence and offered new perspectives in the learning process. While several aspects such as increased student engagement, confidence, and communication showed solid support, the lowest-rated item (“making classroom management easier”) suggests that logistical or classroom control elements may be an area where MR integration presents challenges.

The SPRADO assessment tool also offered valuable insights into students’ perceptions and experiences with this educational technology. Students consistently reported high levels of pleasure and engagement with learning across multiple dimensions (see Table 6). The consistently high ratings for elements such as enhanced engagement with learning topics, heightened learning motivation, and improved efficacy of the learning process suggest that MR contributed positively to the students’ educational experience. Overall, the data indicate that students found MR to be an engaging, flexible, and supportive tool that enhanced both cognitive and affective aspects of their learning.

Teachers’ and students’ evaluations corroborate prior research showing that MR can improve student motivation, interaction with materials, and focus during lessons (Pellas et al., 2020; Tang et al., 2020; Tenberg, 2015). Teacher feedback highlighted MR’s ability to support the development of both physical (psychomotor) and thinking (cognitive) skills. These benefits have been found in other studies as well (Dascalu et al., 2014; Suryodiningrat et al., 2021; Touel et al., 2020). Additionally, students liked that MR allowed flexible and mobile learning, which shows that MR can meet different student needs. These findings echo the idea that MR can expand access to learning and support personal growth (Birt et al., 2018; John & Kurian, 2019; Vasilevski & Birt, 2020).

Table 5

Teachers’ Evaluation Results with SPRADO

No.	Statements	Sum	Mean	V
1	It increases the learning involvement or learning engagement.	31	3.44	0.247
2	It gives me more interactions with the learning topics.	29	3.22	0.173
3	It increases the learning outcomes.	28	3.11	0.099
4	It increases the effectiveness in transferring the learning materials.	32	3.56	0.247
5	The learning process is fun.	32	3.56	0.247
6	It provides better visualization.	31	3.44	0.469
7	It is more possible to collaborate with students at the same or different schools.	30	3.33	0.444

8	It provides more informative learning material.	31	3.44	0.247
9	It provides a safe atmosphere in carrying out learning that has the potential to be dangerous if done directly.	32	3.56	0.247
10	It supports complex scenarios. i.e., disassembling or assembling a car engine.	31	3.44	0.247
11	It increases the confidence level of students.	31	3.44	0.247
12	It can facilitate a systematic learning system.	31	3.44	0.247
13	It makes classroom management easier.	30	3.33	0.222
14	It makes communication between students and teachers better, easier, and more effective.	31	3.44	0.247
15	It provides a better flow in teaching.	32	3.56	0.247
16	It provides a spatial presence or is generally defined as a sense of “being there”.	32	3.56	0.247
17	It improves communication between students and teachers in the teaching and learning context.	31	3.44	0.247
18	It provides some new perspectives in the learning process.	32	3.56	0.247
19	I can do learning anywhere and I don’t have to be at school if I have the appropriate tools.	31	3.44	0.247

Table 6*Students' Evaluation Results with SPRADO*

No.	Statements	Sum	Mean	V
1	It gives me more interactions with the learning topics.	68	3.4	0.340
2	It increases my learning motivation.	68	3.4	0.340
3	It makes my learning process more effective.	64	3.2	0.360
4	It gives me more experience in the learning process.	70	3.5	0.250
5	It improves my learning performance to be better.	64	3.2	0.460
6	The learning process becomes more immersive.	69	3.5	0.448
7	It improves my skills in learning.	71	3.6	0.248
8	It improves my creativity in learning.	74	3.7	0.210
9	It makes me more active in participating.	68	3.4	0.340
10	It improves my expertise or skills in the learning process.	71	3.6	0.248
11	I think the learning process is fun.	72	3.6	0.240
12	It provides better visualization.	67	3.4	0.328
13	It is more possible to collaborate with other students.	67	3.4	0.428
14	It can provide learning tailored to my preferences or personalized learning.	65	3.3	0.288
15	It can improve my cognitive skills.	67	3.4	0.228
16	It can provide more informative learning materials.	65	3.3	0.288
17	It makes me have a positive attitude.	65	3.3	0.488
18	It makes me have a positive impression.	70	3.5	0.250
19	It provides a safe atmosphere in carrying out learning that has the potential to be dangerous if done directly.	67	3.4	0.328
20	It supports complex scenarios, i.e., disassembling or assembling a car engine.	60	3.0	0.700
21	It provides a positive impact on psychomotor development.	64	3.2	0.460
22	It provides a spatial presence or is generally defined as a sense of "being there".	65	3.3	0.688
23	It improves communication between students and teachers in the teaching and learning context.	68	3.4	0.240
24	It improves my judgment ability.	66	3.3	0.310
25	It improves my logic skills.	70	3.5	0.250
26	It increases my level of independence in learning.	69	3.5	0.348
27	It provides better learning satisfaction.	66	3.3	0.310
28	It provides some new perspectives in the learning process.	67	3.4	0.228
29	It stimulates my creativity.	71	3.6	0.348
30	I can do learning anywhere and I don't have to be at school as long as I have the appropriate tools.	69	3.5	0.248

To ensure the reliability of teachers' and students' evaluations, internal consistency was assessed using Cronbach's alpha. Tables 7 and 8 present the reliability coefficients for the teacher and student responses to the SPRADO assessment tool.

Table 7

Cronbach's α Result from Teachers

No. of Questions	19
No. of Item Variance	4.864
Total Score of Variance	62
Cronbach α	0.973

Table 8

Cronbach's α Result from Students

No. of Questions	30
No. of Item Variance	10.233
Total Score of Variance	123.63
Cronbach α	0.949

The Cronbach α reliability statistics indicate that the teacher assessments (Table 5) yielded a coefficient of 0.973, and the student assessments (Table 6) yielded a coefficient of 0.949. Both values reflect a very high level of internal consistency. Cronbach's α values approaching 1 indicate a stronger reliability, suggesting that the items in the SPRADO assessment were consistently interpreted and rated by respondents. In this case, the high coefficients demonstrate a strong degree of agreement among the items in each form, indicating that the instrument reliably measured a unified set of constructs. Put simply, the respondents rated items in a consistent manner, suggesting that they were accurately assessing the same fundamental concepts. When employing a 4-point Likert scale in an assessment form, this high level of consistency supports the validity of the obtained data.

Conclusion

In this quasi-experiment with a pre-test/post-test design, the results revealed notable findings that highlight the effectiveness of MR use in vocational education. The MR group demonstrated greater improvement between pre and post test scores compared to the non-MR group, indicating that MR technology can enhance learning outcomes, particularly in machinery-focused vocational programs. A paired difference t-test confirmed this effect, showing a

statistically significant difference between the scores obtained in the pre-test and post-test, highlighting the effectiveness of the MR intervention. Furthermore, the t-test for the differences in population means resulted in the rejection of the null hypothesis, confirming a significant improvement for the MR group. Together, these findings further validate the efficacy of the MR-based training.

Teachers' and students' evaluations of the teaching and learning environment in the MR-group indicated that the MR-supported instruction was well-received as an engaging, effective, and supportive instructional approach, enhancing both cognitive and practical aspects of learning. The feedback emphasized MR's potential to increase student motivation and engagement, facilitate hands-on learning, create a flexible learning experience, and improve communication between students and teachers. The reliability of the SPRADO assessment tool used by teachers and students in this evaluation was supported by high Cronbach's alpha coefficients, which yielded findings of 0.973 for teachers and 0.949 for students. These values indicate strong internal consistency across the items in the evaluation form, suggesting that SPRADO is a dependable instrument for evaluating MR systems in educational settings.

It is important to acknowledge the study's limitations. The research involved a small and specific sample of 42 students and 9 teachers. Furthermore, the intervention was carried out over a single session. These limitations may impact the generalizability of the results and highlight the need for further studies involving larger and more diverse populations. This study also focused specifically on students in automotive technology programs.

Despite these limitations, the findings have important implications for the design and delivery of technical education. MR provides an engaging learning environment that connects academic knowledge with practical applications. By simulating practical setting for skill development, MR aligns well with modern educational priorities, which emphasize experiential and student-centered learning. It serves not only as a technological enhancement but also as a bridge between theory and practice in vocational education.

In the context of Indonesian machinery vocational schools, particularly in rural areas, the integration of MR technology offers notable advantages. Firstly, it promotes the standardization of learning materials and instructional methods, helping to ensure consistent quality in educational delivery, in alignment with the rules set by the Ministry of Education, Culture, Research, and Technology. Additionally, MR allows students to virtually engage with cutting-edge equipment, offering exposure to the tools and processes that may not be accessible in traditional classroom environments. Furthermore, the standardization of MR content can guarantee that students in both rural and urban locations have equal access to high-quality education.

Future research should explore the integration of artificial intelligence (AI) and machine learning (ML) to augment the functionalities of MR systems. Investigations should prioritize collaborative learning, training, and assessments utilizing MR technology in machinery vocational schools. To accurately measure educational results, it is necessary to conduct specialized research that involves collecting data at regular intervals over one semester or a complete academic year.

This approach would provide a more comprehensive understanding of the long-term effects of MR interventions.

Declarations

Availability of data and materials: Not applicable.

Competing interests: The authors declare that they have no conflicts of interest.

Funding: Not applicable.

Author contribution section: The authors declare that they have co-written the article and share authorship among them.

Acknowledgments: Not applicable.

References

- Adams, J., Flavell, F., & Raureti, R. (2022). Mixed reality results in vocational education: A case study with HoloLens 2. *Research in Learning Technology*, 30.
<https://doi.org/10.25304/rlt.v30.2803>
- Béduwé, C., & Giret, J. F. (2011). Mismatch of vocational graduates: What penalty on French labour market? *Journal of Vocational Behavior*, 78(1), 68–79.
<https://doi.org/10.1016/j.jvb.2010.09.003>
- Birt, J., Stromberga, Z., Cowling, M., & Moro, C. (2018). Mobile mixed reality for experiential learning and simulation in medical and health sciences education. *Information (Switzerland)*, 9(2), 1–14. <https://doi.org/10.3390/info9020031>
- Boel, C., Dekeyser, K., Lemal, M., Rotsaert, T., Valcke, M., Schellens, T., & Struyf, D. (2023). Towards a framework for a nation-wide implementation of augmented, virtual and mixed reality in K-12 technical and vocational education. *TechTrends*.
<https://doi.org/10.1007/s11528-023-00925-y>
- Dascalu, M. I., Moldoveanu, A., & Shudayfat, E. A. (2014). Mixed reality to support new learning paradigms. *2014 18th International Conference on System Theory, Control and Computing, ICSTCC 2014*, 692–697. <https://doi.org/10.1109/ICSTCC.2014.6982498>
- Durmus, A., & Dağlı, A. (2017). Integration of vocational schools to Industry 4.0 by updating curriculum and programs. *International Journal of Multidisciplinary Studies and Innovative Technologies*, 1(1), 1–3.
- Heaviside, H. J., Manley, A. J., & Hudson, J. (2018). Bridging the gap between education and employment: A case study of problem-based learning implementation in postgraduate sport and exercise psychology. *Higher Education Pedagogies*, 3(1), 463–477.
<https://doi.org/10.1080/23752696.2018.1462095>
- HoloLens 2—Overview, Features, and Specs | Microsoft HoloLens*. (n.d.).
<https://www.microsoft.com/en-us/hololens/hardware>
- Holstein, K., McLaren, B. M., & Aleven, V. (2018). Student learning benefits of a mixed-reality teacher awareness tool in AI-enhanced classrooms. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 10947 LNAI*. Springer International Publishing.
https://doi.org/10.1007/978-3-319-93843-1_12
- Imam Agung, A., Mukhadis, A., Sutadji, E., & Purnomo. (2018). Embedding entrepreneurs in improving the skills of entrepreneurs of technology based vocational school in Indonesia. *IOP Conference Series: Materials Science and Engineering*, 336(1).
<https://doi.org/10.1088/1757-899X/336/1/012043>

- Jaya, H., Haryoko, S., Lu'mu, & Ida, P. (2020). Use of remote lab for online and real time practicum at vocational school in Indonesia. *International Journal of Online and Biomedical Engineering*, 16(5), 4–14. <https://doi.org/10.3991/IJOE.V16I05.13201>
- John, B., & Kurian, J. (2019). Making the world a better place with mixed reality in education. *Australasian Conference on Information Systems*, 344–354.
- Maas, M. J., & Hughes, J. M. (2020). Virtual, augmented and mixed reality in K–12 education: A review of the literature. *Technology, Pedagogy and Education*, 29(2), 231–249. <https://doi.org/10.1080/1475939X.2020.1737210>
- Moon, S. H., Jeong, H., & Choi, M. J. (2024). Integrating mixed reality preparation into acute coronary syndrome simulation for nursing students: A single-group pretest-posttest study. *BMC Nursing*, 23(1). <https://doi.org/10.1186/s12912-024-02110-9>
- Morimoto, T., Kobayashi, T., Hirata, H., Otani, K., Sugimoto, M., Tsukamoto, M., Yoshihara, T., Ueno, M., & Mawatari, M. (2022). XR (extended reality: Virtual reality, augmented reality, mixed reality) technology in spine medicine: Status quo and quo vadis. *Journal of Clinical Medicine*, 11(2). <https://doi.org/10.3390/jcm11020470>
- Ogunseiju, O. R., Gonsalves, N., Akanmu, A. A., Bairaktarova, D., Bowman, D. A., & Jazizadeh, F. (2022). Mixed reality environment for learning sensing technology applications in Construction: A usability study. *Advanced Engineering Informatics*, 53, 101637. <https://doi.org/10.1016/j.aei.2022.101637>
- Pellas, N., Kazanidis, I., & Palaigeorgiou, G. (2020). A systematic literature review of mixed reality environments in K-12 education. *Education and Information Technologies*, 25(4), 2481–2520. <https://doi.org/10.1007/s10639-019-10076-4>
- Rokhsaritalemi, S., Sadeghi Niaraki, A., & Choi, S. M. (2020). A review on mixed reality: Current trends, challenges and prospects. *Applied Sciences*, 10(2), 636. <https://doi.org/10.3390/app10020636>
- Sievers, T. S., Schmitt, B., Rückert, P., Petersen, M., & Tracht, K. (2020). Concept of a mixed reality learning environment for collaborative robotics. *Procedia Manufacturing*, 45, 19 to 24. <https://doi.org/10.1016/j.promfg.2020.04.034>
- Smith, E., McRae, K., Semple, G., Welsh, H., Evans, D., & Blackwell, P. (2021). Enhancing vocational training in the post-COVID era through mobile mixed reality. *Sustainability*, 13(11), 6144. <https://doi.org/10.3390/su13116144>
- Suharno, Pambudi, N. A., & Harjanto, B. (2020). Vocational education in Indonesia: History, development, opportunities, and challenges. *Children and Youth Services Review*, 115(May), 105092. <https://doi.org/10.1016/j.childyouth.2020.105092>

- Suryodiningrat, S. P., Prabowo, H., Meyliana, & Hidayanto, A. N. (2021). Mixed reality system for teaching and learning: A systematic literature review. *2021 IEEE 5th International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE)*, 387–392. <https://doi.org/10.1109/icitisee53823.2021.9655922>
- Suryodiningrat, S. P., Prabowo, H., Ramadhan, A., & Santoso, H. B. (2024). *SPRADO: The Assessment Tool for Mixed Reality Systems in Machinery Vocational Schools*. Any more publishing information?
- Suryodiningrat, S. P., Ramadhan, A., Prabowo, H., Santoso, H. B., & Hirashima, T. (2023). Mixed reality systems in education: A systematic literature review. *Journal of Computers in Education*. <https://doi.org/10.1007/s40692-023-00281-z>
- Tang, Y. M., Au, K. M., Lau, H. C. W., Ho, G. T. S., & Wu, C. H. (2020). Evaluating the effectiveness of learning design with mixed reality (MR) in higher education. *Virtual Reality*, 24(4), 797–807. <https://doi.org/10.1007/s10055-020-00427-9>
- Tenberg, R. (2015). Learning in a mixed reality system in the context of “Industrie 4.0.” *Journal of Technical Education (JOTED)*, 3(2).
- Touel, S., Marfisi Schottman, I., & George, S. (2020). Analysis of mixed reality tools for learning math in primary and secondary school. *Lecture Notes in Computer Science*, 12517, 112 to 121. https://doi.org/10.1007/978-3-030-63464-3_11
- Vasilevski, N., & Birt, J. (2020). Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environments. *Research in Learning Technology*, 28(1063519), 1–23. <https://doi.org/10.25304/rlt.v28.2329>
- Wang, Q., & Li, Y. (2024). How virtual reality, augmented reality and mixed reality facilitate teacher education: A systematic review. *Journal of Computer Assisted Learning*, 40(3), 1276–1294. <https://doi.org/10.1111/jcal.12949>
- Yannier, N., Hudson, S. E., & Koedinger, K. R. (2020). Active learning is about more than hands on: A mixed reality AI system to support STEM education. *International Journal of Artificial Intelligence in Education*, 30(1), 74 to 96. <https://doi.org/10.1007/s40593-020-00194-3>

Tracking Self-Regulated Learning Strategies in Blended Learning: A Digital Trace Approach

Maxim Boitcov, Anna Gorbunova, Anastasiia Kapuza, Regina Sutarmina

Higher School of Economics (HSE) University, Moscow, Russia

Abstract

This study examined digital traces in the form of clicks on Learning Management System (LMS) modules to infer and monitor students' Self-Regulated Learning (SRL) strategies in a blended learning environment. Digital traces were aligned with students' responses on the A-SRL questionnaire (Magno, 2010), and these findings were further triangulated through student interviews. The results suggest that clicks on LMS modules containing theoretical material and gradebook indicate students' use of a single corresponding SRL strategy and may serve as a good indicator of SRL behavior, while other digital traces relate to multiple strategies at once and lack a singular interpretation. Additionally, it was found that students in blended courses may use SRL strategies outside of the LMS. The study offers practical implications for instructional designers and practitioners seeking to support SRL in blended learning environments.

Keywords: Self-regulated learning; digital traces; blended learning

Boitcov, M., Gorbunova, A., Kapuza, A., & Sutarmina, R. (2026). Tracking self-regulated learning strategies in blended learning: A digital trace approach. *Online Learning*, 30(1), pp. 265-293. <https://doi.org/10.24059/olj.v30i1.4860>

Introduction

The COVID pandemic has dramatically changed the learning landscape of higher education, accelerating a shift from traditional offline learning to fully online or partially online models. Partially online learning models include hybrid and blended learning, where face to face instruction is combined with online elements to varying degrees (Singh et al., 2021). In both online and blended learning models, learners need to be more self-directed and autonomous in managing their learning. These demands are closely aligned with the concept of Self-Regulated Learning (SRL), and the importance of SRL is well-established in both online and blended environments (Xu et al., 2023).

SRL is a cyclical process, during which students plan their learning activities, monitor, control, and assess their learning progress in order to reach their intended academic goals (Zimmerman, 2002). Research has consistently demonstrated that learners who use SRL strategies achieve higher academic performance than those who do not (Pintrich & De Groot, 1990).

While considerable research has focused on enhancing and measuring SRL in fully online learning (Kizilcec et al., 2017; Lee et al., 2019), blended courses are less studied in terms of the application and measurement of SRL (Anthonysamy et al., 2020). This gap is significant because students in blended courses must navigate both online and offline learning simultaneously (Broadbent et al., 2021), and results observed in fully online courses may not directly translate to blended settings.

There is extant research on different aspects of SRL as well as the effects it can have on academic performance (Xu et al., 2023). However, most studies rely on self-reported data (Han & Ellis, 2023). Digital traces, or data generated from students' interactions with online learning systems, have gained increasing attention with the shift toward online education as they offer researchers and practitioners a way to monitor SRL and student activity without overburdening students with surveys and interviews (Maldonado-Mahauad et al., 2018). The current study builds on this emerging approach by exploring the potential of using digital traces as an instrument to infer and monitor students' SRL strategies in a blended course.

Literature Review

Self-regulated Learning and Strategies

SRL has been conceptualized in various ways, with researchers offering multiple models to describe its process. Currently, several theories aim to describe and operationalize SRL (Panadero, 2017). According to the most widely used model, there are three phases of SRL: forethought, performance, and self-reflection (Zimmerman, 2000). Students iteratively engage in these phases during the learning process. In the forethought phase, learners set goals, plan strategies, and activate their motivation. During the performance phase, learners monitor their progress and adjust their strategies accordingly. In the self-reflection phase, learners evaluate their performance and reflect on their learning experience. Beyond Zimmerman's foundational model, Pintrich (2000) proposed an expanded framework that incorporates "monitoring" and

“control” phases, highlighting the cyclical nature of SRL. Unlike Zimmerman, who treats motivation as an influence on SRL, Pintrich’s model positions motivation as an integral component of self-regulatory behavior itself, arguing that students cannot effectively self-regulate without a strong motivational drive. While models such as Boekaerts’ (1999) model focusing on adaptation, or Winne and Hadwin’s (1998) model that emphasizes cognitive processing and orchestration, offer valuable insights into specific facets of self-regulation, Zimmerman’s model is widely regarded as offering the most comprehensive and holistic framework. Its strength lies in its detailed articulation of the cyclical processes of SRL, encompassing planning, performance, and reflection phases, which provides a robust framework for understanding and investigating the breadth of self-regulatory activities. Furthermore, the widespread adoption and application of Zimmerman’s model in numerous educational contexts underscores its generalizability and practical utility for researchers and educators alike (Panadero, 2017).

The ability to self-regulate the learning process is not a fixed trait or quality of a person, but a dynamic set of skills and strategies that students may or may not employ to achieve academic goals (Zimmerman, 1989). This set consists of cognitive, metacognitive, and resource management strategies that students use as a part of their SRL behavior (Puzziferro, 2008). Cognitive strategies, such as rehearsal, help students better acquire and retain information (Zimmerman, 2000). Metacognitive strategies, for instance, goal setting, seeking assistance, and self-evaluation, help students to monitor and adjust the learning process (Schunk, 2005). Resource management strategies allow students to optimize their use of educational and environmental resources (Puzziferro, 2008). Self-regulated learning strategies may be taught to students in order to assist the process of constructing knowledge in a structured way (Zimmerman, 1989). The application of SRL strategies is usually related to high academic achievement in traditional learning settings (Pintrich & De Groot, 1990).

Because SRL is a recursive process that unfolds over time (Butler & Winne, 1995), more accurate and authentic research may be conducted by exploring how SRL strategies are used as sequences of events in real time (Rovers et al., 2019). Previous studies have typically measured students’ use of SRL strategies with either structured interviews (Zimmerman & Pons, 1986) or self-report questionnaires, such as the Academic Self-Regulated Learning Scale (A-SRL-S), developed by Magno (2010), or MSLQ, published by Pintrich et al. (1991). Both methods rely on students recalling and reporting their past SRL behaviors rather than capturing actual SRL in real time. As a result, they are susceptible to recall bias (Winne, 2017). The think-aloud method, a form of interview where students verbalize their thoughts while completing a task, has been used to demonstrate SRL strategies in real time. However, this method can unintentionally prompt self-reflection, thereby altering the very behaviors it aims to capture and compromising the validity of the findings (Fan et al., 2023).

These validity concerns limit the effectiveness of using questionnaires and interviews as the sole method for measuring SRL. The emergence of digital traces offers a promising supplement for making research more authentic. Digital traces are generated in real time, are free from recall bias, and don’t induce changes in students’ SRL levels (Zhou & Winne, 2012).

Using digital traces to evaluate SRL strategies could mitigate problems associated with more traditional measurement instruments (e.g., social desirability, recall bias, and resource intensiveness), particularly if digital traces are used in conjunction with those instruments to avoid validity issues (Fan et al., 2023).

Digital Traces for SLR Monitoring and Their Validation

In the context of online education, digital traces refer to the data trails left behind by learners as they interact with online learning environments and tools (Rafaeli et al., 2019). Researchers use different types of digital traces: user-generated content (e.g., forum posts); assessment data such as grades and test scores; log files which include records of students' actions and clicks on certain online course modules, which are interpreted as students' actions or sequences of actions (Du et al., 2023). The widespread use of Learning Management Systems (LMS) has led SRL researchers to increasingly rely on clickstream data to analyze students' behaviors through their click activities in these systems (Baker et al., 2020; Crompton et al., 2020).

A recent comprehensive review of literature by Du et al. (2023), which explores the use of digital traces and their correlation with different SRL subprocesses and strategies, highlights the lack of consensus on how to measure SRL using digital traces. Some studies define digital traces in terms of SRL phases (e.g., forethought phase) and do not deconstruct it further into SRL strategies (Cerezo et al., 2020; Yang et al., 2018). Others choose a set of strategies based on an SRL model or questionnaire they use. These sets of strategies vary across studies, often due to differences in online platforms (e.g., the absence of specific modules may inhibit observing related strategies) or SRL models that researchers use (Antonio Perez-Alvarez et al., 2020; Kizilcec et al., 2017).

Several studies that use digital traces base their set of SRL strategies on Zimmerman and Pons' SRLIS questionnaire (1986). The memory strategy is operationalized as interacting with video lectures (Maldonado-Mahauad et al., 2018; Wong et al., 2019) or reading provided texts and adding notes (Antonio Perez-Alvarez et al., 2020; Bernacki et al., 2012; Bouchet et al., 2013; Pérez-Sanagustín et al., 2021). The goal-setting strategy is typically measured through interactions with course elements, such as course syllabus, planning panel (Antonio Perez-Alvarez et al., 2020; Huang & Lajoie, 2021; Milikić et al., 2020; Siadaty et al., 2016) or students' visits to the course information page or weekly overview page (Fan et al., 2023; Jansen et al., 2020; Saint et al., 2022). The self-evaluation strategy is attributed to resolving learning gaps by interacting with grade reports (Rodrigues et al., 2019), revising prior learning content (Fan, Saint, et al., 2021; Kizilcec et al., 2017; Lan et al., 2019), reviewing an assessment (Maldonado-Mahauad et al., 2018; Wong et al., 2019), and interacting with assessments (Fan, Matcha, et al., 2021; Halem et al., 2020; Matcha et al., 2020). The organizing strategy is not in the focus of previous studies due to the fact that it implies physical interactions with learning materials, which pose challenges for tracking by digital traces (Broadbent & Poon, 2015).

Despite the prevalence of measuring SRL through digital trace data, ongoing challenges persist in establishing a clear mapping between actual trace data and SRL processes (Fan, Matcha, et al., 2021; Saint et al., 2020a). Researchers typically infer that the behaviors they observe via digital traces are related to SRL. For example, rewatching an educational video may

be interpreted as memory strategy activation in order to rehearse the new material. However, such behaviors may also be caused by other, non-related to SRL reasons, such as a bad internet connection or distractions. Moreover, the same digital traces could reflect different latent variables, such as SRL, student engagement, motivation, etc. Thus, a problem of trace data validation arises (Winne, 2010).

Researchers tackle this problem by supplementing digital traces with other sources of data. Triangulating data can provide researchers with a fuller picture of actual SRL behavior (Winne, 2010). Questionnaires are often used to cross-reference students' reported SRL strategy use with trace data (Halem et al., 2020; Saint et al., 2020a). Other studies employ interviews as a means of validating and further contextualizing theoretical inferences drawn from trace data.

Triangulation of methods (aligning digital traces, questionnaires, and interviews) helps address the limitations inherent in each individual approach (Fan et al., 2023) and is particularly valuable in online environments, where direct access to students is limited. Du et al. (2023) proposed a guide to online trace data analysis for measuring SRL depending on the LMS systems and suggested to combine different types of data sources. Ye and Pennisi (2022) triangulated questionnaire, digital trace, and interview data in a fully offline asynchronous environment. Applying such triangulation may be even more valuable in a blended educational environment, since it makes it possible to supplement qualitative data with student interviews that further validate the research (Han & Ellis, 2023).

Blended Learning and SRL

Blended learning is an educational environment that allows practitioners to effectively combine the benefits of two approaches: face-to-face classroom and social engagement and interactions, but also the digital tools that provide enhanced learning possibilities (Singh et al., 2021). This integration of various digital resources, as well as the presence of real-world communication among students and instructors, creates a flexible format that can meet learner needs and foster an engaging learning experience.

The range of SRL strategies involved, as well as their effectiveness, can vary depending on the context. Previous research indicated that online learning students reported a higher frequency of utilizing SRL strategies compared to blended learning students (Broadbent, 2017). The type of strategies also differs: learners in blended environments tend to rely more on the SRL strategies that require communication skills (Zhang et al., 2023), while strategies such as goal-setting, task strategies, time management, and environmental structuring are more often used by learners in online environments. Additionally, while students in online learning environments apply SRL across all activities, students in blended courses may experience confusion. Since part of the learning process that happens face-to-face is regulated by the instructor (Broadbent et al., 2021), and another part, such as an online task or assignment, is regulated by students themselves, it might create difficulties to switch from one mode to another and to know when they need to follow teacher's instructions versus when to self-monitor and take responsibility for their learning (Onah et al., 2021).

This ambiguity in blended learning formats also complicates the measurement of SRL skills. While data available from digital traces in online courses reveal the full scope of students' actions and allows us to draw conclusions on their behavioral patterns and thus, the level of self-regulation (Maldonado-Mahauad et al., 2018), in blended environments, students refer to both online activities and face-to-face interactions and instructions, which remain invisible for learning systems and platforms. Hence, to address these challenges, the current study uses a mixed-methods approach, combining a questionnaire, digital traces, and interviews.

Current Study

While previous research has demonstrated that digital traces can be used to track student behavior (Du et al., 2023), there is still a need to interpret which specific actions within an LMS reflect students' SRL strategies. It also remains unclear to what extent these actions correspond to specific strategies and whether such interpretations can be generalized across different learning environments.

The current study assumes that some strategies are more traceable in a digital environment than others. For example, memory strategies may be reflected by the number of times of watching video-lectures (Maldonado-Mahauad et al., 2018), while other strategies, like help-seeking, might not be as visible in blended courses, as there is always room for personal offline communication among students as well as with the instructor. Building on previous research (see Du et al., 2023), this study attempts to examine which strategies belong to both categories using methods triangulation.

To strengthen the evidence linking SRL strategies to students' digital traces, interviews were conducted to gather additional insights from the students. They serve to deepen the understanding of students' self-regulation practices, and to highlight individual differences.

The study attempts to answer the following research questions:

RQ 1: Which SRL strategies could be observed through digital traces in blended courses?

RQ 2: How does digital trace interpretation reflect actual SRL behavior?

Materials and Methods

Sample

The sample comprised 16 first-year master's students enrolled in an educational sciences program at a top-ranked Russian university. The participant demographic included 11 female and 5 male students, with ages ranging from 21 to 33 years ($M = 25$, $SD = 3,79$). All participants self-reported prior experience with blended learning environments. Participants were recruited via email invitation sent to all students ($N = 24$) enrolled in a blended learning course upon its completion and final grade posting. Participation was voluntary and offered no incentives. Of the invited students, 16 agreed to participate in the study.

Course Context

The study took place after a 7-week blended introductory course on statistics and data analysis. The course consisted of seven synchronous lectures and seven seminars, covering three key topics: data and variables, descriptive statistics, and comparison of means. The course was offered in a hybrid format, with lectures streamed online and also available for in-person attendance, allowing students to choose their preferred mode of participation every week. Lecture recordings, additional materials (e.g., textbooks, PowerPoint presentations used by the lecturer), self-assessment tests, course syllabus, and gradebook were available via a Moodle-based LMS.

Measures

To identify which SRL strategies could be observed via digital traces in a blended learning environment, the study aligned digital trace data on students' SRL behavior with a well-known A-SRL scale (Magno, 2010) and is additionally supplemented by interviews with students. The A-SRL scale was selected for its relevance to academic setting and its brevity relative to other questionnaires. The primary purpose of administering the A-SRL scale was to provide a framework for understanding the relationships between students' self-reported SRL strategy usage and their interactions with learning materials within the LMS, as captured by digital trace data.

The instrument consists of seven factors, each corresponding to an SRL strategy:

- Memory strategy—techniques which help learners memorize and retrieve new information (Cronbach's Alpha = 0.65).
- Goal setting—the setting of educational goals in order to exert the effort required to achieve them (Cronbach's Alpha = 0.59).
- Self-evaluation—activities for monitoring the learning process in relation to defined goals (Cronbach's Alpha = 0.44).
- Seeking assistance—asking others for help, or consulting external help and resources (Cronbach's Alpha = 0.60).
- Environmental structuring—efforts to arrange the physical setting to make learning easier (Cronbach's Alpha = 0.66).
- Learning responsibility—prioritizing study above other activities (Cronbach's Alpha = 0.34).
- Organizing—overt or covert rearrangement of instructional materials to improve learning (Cronbach's Alpha = 0.33).

Each factor was measured by several 4-point Likert scale questions. The questionnaire was translated to the Russian language and administered online; 16 students responded (see Appendix A for the questionnaire). Although several factors yielded low Cronbach's alpha values, it may be attributed to the limited sample size. Cronbach's alpha is sensitive to sample size; with small n , even modest variations in responses can significantly impact the coefficient. Specifically, lower-than-expected item covariance in a small sample can result in an artificially depressed alpha. Importantly, Cronbach's alpha measures the internal consistency of the questionnaire itself, indicating how well items within a factor correlate, not the reliability of individual respondents. Given the small sample size, we are focusing on exploring the

relationships between these self-reported SRL strategies, LMS activity (module clicks), and interview data. The distribution of SRL strategy usage within this specific student population is not the primary focus of this analysis. Since the questionnaire is based on a validated instrument with established construct validity, the results are considered to be interpretable and suitable for exploratory analysis, acknowledging the sample size limitations.

The students' digital traces were acquired from the university's LMS. Each student's clicks on a certain LMS module available for students (e.g., syllabus) throughout the length of the course were summarized to create a single value of a variable corresponding to each module (e.g., clicks on syllabus):

- Clicks on lecture recordings—all hybrid lectures were recorded and available for students to watch later.
- Clicks on lecture slides—a module, containing all PowerPoint presentations used by the lecturer.
- Clicks on additional materials—three statistics textbooks, recommended by the lecturer.
- Clicks on the course syllabus—a spreadsheet, containing information on deadlines and knowledge requirements.
- Clicks on the course introduction—a link to a presentation on the final grade formula and other course details.
- Clicks on gradebook—a dashboard with grades for tests and the final project.
- Clicks on self-assessment tests—quizzes, which were readily available for students to test their knowledge without fear of getting an unsatisfactory grade.

All click-based variables were standardized to ensure comparability across modules and simplify subsequent analysis. Given the small sample size, no outlier removal was applied, as the goal was to support descriptive profiling and correlation analysis, rather than model distributional properties. For descriptive statistics before standardization, see Table 1.

Table 1

Descriptive Statistics for Students' Digital Traces

	Mean	SD	Min	Max
Clicks on lecture recordings	6.7	4.9	0	16
Clicks on lecture slides	16.1	8.7	4	21
Clicks on textbooks	8.5	6.4	1	21
Clicks on course syllabus (pdf)	4.2	3.6	0	13
Clicks on course introduction (pptx)	3.3	3.1	0	11
Clicks on gradebook	8.7	1.1	7	10

Clicks on self-assessment test 1	1.5	1.1	0	4
Clicks on self-assessment test 2	1.4	1.1	0	4

Following the completion and analysis of the questionnaire, participants were invited to participate in an hour-long semi-structured interview. Participation in the interviews was voluntary and no incentives were offered. Eight of the initial sixteen questionnaire participants agreed to be interviewed. While the participant pool was reduced, no apparent self-selection bias was detected, with high variance in both achievement level and SRL strategies usage of recruited students.

The interviews were conducted by two of the study's authors, who had no prior relationship with the participants or the course instructor. Prior to conducting the interviews, the interviewers completed a brief training session to familiarize themselves with the interview guide. The interviews were designed to explore the validity of the relationships identified between specific digital trace data and SRL strategies, and to provide further confirmation that the digital traces were reflective of SRL behaviors. The interview guide (see Appendix B) followed the structure of the course, prompting students to discuss their learning organization, homework routines, approaches to the final project, and other relevant course-related activities. Each question in the guide was designed to elicit information pertaining to students' SRL behaviors throughout the course and their use of LMS. Following the completion of all interviews, the recordings underwent manual transcription.

Analysis Strategy

To answer RQ1 (Which SRL strategies could be observed through digital traces in blended courses?) a Pearson's correlation analysis of the reported use of SRL strategies and clicks on LMS course modules was performed.

To answer RQ2 (How does digital trace interpretation reflect actual SRL behavior?), a thematic analysis of the interviews was conducted via ATLAS.Ti software. The analysis followed a widely used 6-step structure (Braun & Clarke, 2006) and was conducted by two independent coders to ensure reliability. First, an in-depth reading to familiarize with the interviews was conducted. After that, each interview was read and coded. Codes aimed to reflect students' ways of using certain LMS modules (e.g., "self-tests as a means of rehearsal", "lecture slides for notes"), learning practices (e.g., "tutor messages for setting deadlines"), and attitudes (e.g., "grade as a motivator"). Codes were then categorized into initial themes by two coders independently. After that, codes and themes were jointly reviewed and refined across coders to ensure trustworthiness. Codes that were present in both coders' results and occurred in many interviews were used to form three themes. Finally, themes were reported.

Results

RQ1: Which SRL strategies could be observed through digital traces in blended courses?

Among the examined strategies, the Memory strategy was the only one to demonstrate a correlational relationship with multiple digital traces (Table 2). Specifically, higher Memory strategy was associated with more views of lecture slides ($r = 0.512, p < 0.1$), course syllabus ($r = 0.546, p < 0.1$), gradebook ($r = 0.459, p < 0.1$), and the second self-assessment test ($r = 0.796, p < 0.1$). Notably, the first self-assessment test was not significantly related to the Memory strategy, or any other strategy for that matter. More surprisingly, the more often students viewed lecture recordings, the weaker was their Memory strategy ($r = -0.548, p < 0.1$). This might be explained by the blended nature of the course under study, but overall, it warrants further exploration in the qualitative part of the analysis.

Table 2

Pearson Correlation Coefficient for SRL Strategies According to the Questionnaire and Students' Digital Traces

	Memory Strategy	Goal Setting	Self-Evaluation	Seeking Assistance	Environmental Structuring	Learning Responsibility	Organizing
Clicks on lecture recordings	-.548*	-.116	-.174	-.213	.084	-.581*	-.437*
Clicks on lecture slides	.512*	.037	-.064	-.008	.471*	.194	.337
Clicks on textbooks	.230	.021	.055	-.088	.601*	.249	.200
Clicks on course syllabus (pdf)	.546*	-.253	.282	.240	.208	.219	.206
Clicks on course introduction (pptx)	.045	-.178	.161	-.148	.280	.280	.203*
Clicks on gradebook	.459*	-.230	.120	.124	.284	.330	.526
Clicks on self-assessment test 1	.248	-.130	.028	-.077	-.280	.341	.233
Clicks on self-	.796*	.136	.167	.240	.080	.496*	.455*

assessment
test 2

* $p < 0.1$

Environmental Structuring was positively related to clicking on lecture slides ($r = 0.471, p < 0.1$) and textbooks ($r = 0.601, p < 0.1$). Learning Responsibility was negatively related to watching lectures ($r = -0.581, p < 0.1$) and positively related to the second self-assessment test ($r = 0.496, p < 0.1$), as was the case with Organizing ($r = 0.455, p < 0.1$). Organizing was further related to viewing the course introduction ($r = 0.203, p < 0.1$) (even though course introduction and syllabus usage were expected to be related to Goal Setting and Self-Evaluation). Goal Setting, Self-Evaluation, and Seeking Assistance were not reflected in interactions with LMS materials at all.

RQ2: How does digital trace interpretation reflect actual SRL behavior?

During the interviews, students were asked how they used different LMS modules. Their answers and corresponding codes help to enrich the understanding of the relationships between clicks and SRL strategies. As a result of the analysis, three main themes emerged: “Common SRL behavior,” “Dissimilar SRL strategies,” and “Non-traceable SRL strategies” (see Table 3).

Table 3

Codes and Themes Generated During Thematic Analysis

Code	Overall number of quotes	Number of students	Theme
Lecture slides as means of rehearsal	12	7	Common SRL behavior
Using slides for notes	7	5	
Textbooks for theory	5	4	
Textbooks difficult	7	5	
Lecture recordings as a substitute for a missed lecture	5	4	
Self-assessment as means of familiarization	5	5	Dissimilar SRL strategies
Self-assessment as means of rehearsal	2	1	

Self-assessment for reflection	11	7	
Syllabus for planning	3	2	
Syllabus for self-evaluation	3	2	
Viewed grades rarely	7	7	
Deadlines in the chat	3	2	Non-traceable SRL strategies
Tutor's reminders	6	3	
Did not view LMS often	4	3	
Consulting with classmates	7	4	

Theme 1: Common SRL Behavior

Students' use of the memory strategy was found to be similar. They recognized the need to prepare for the upcoming seminars and used the LMS to revisit theoretical materials and rehearse. There was a common path taken by students: revisit the presentation, check the textbook, if necessary, rehearse the material via a self-assessment test:

To truly understand this topic, I had to read textbooks and other materials afterwards. I would write down confidence intervals for myself, write down all the terms, and so on. I used textbooks, online courses, presentations, depending on where I liked how the material was presented. (Student 1)

This behavior is in line with using memory strategy (Bernacki et al., 2012; Bouchet et al., 2013) and suggests that clicks on lecture slides, textbooks, and lecture recordings modules should correlate with it.

However, those modules varied in perceived effectiveness and usefulness. Lecture slides, despite not being an additional material (they were used by the lecturer as a visualization tool and then uploaded to LMS), were used by students to refresh their knowledge, write down formulas they hadn't have time to write down during the lecture:

When you study something within a seminar or lecture, a week passes, you don't always go back, and you want to refresh your memory... The presentations often helped to get, well, a brief summary. (Student 2)

Textbooks provided a deeper theoretical material, and were used to deepen the understanding of certain topics and to write notes: "It was the case that we studied, for example, confidence intervals. And in order to really understand this topic, I then used textbooks." (Student 1). But at times, students perceived textbooks as being too complicated and preferred not to use them: "I saved presentations for myself... I used the textbook to a lesser extent, because, for me, it was written in such a complex language." (Student 3). Some students felt that theoretical material provided in lectures was enough for them and did not refer to the textbook:

“I did not get to the textbook. Well. Firstly, I did not have time, and secondly, I did not need it. I understood everything anyway. In principle, the classes were enough for me.” (Student 4).

Lecture recordings weren't used as a source of new material or a way to memorize theory:

I didn't access lecture recordings because I made notes of everything that I needed... I didn't listen to any of the recordings because my notes were enough for me, and I asked all the questions that I had during the classes. (Student 1)

Students used lecture recordings only as a substitute for a missed synchronous lecture—to learn material but not to memorize it: “[When I missed a topic] I just watched the recording again, where the teacher, as always, led the class, explaining everything. I took notes in the same way as I usually did [when attending synchronously].” (Student 5).

Thus, clicks on LMS modules related to theoretical materials were found to be representative of students utilizing a singular strategy (memory strategy) common for the whole group, despite the fact that some modules were used more than others.

Theme 2: Dissimilar SRL Strategies

Other SRL strategies manifested in vastly dissimilar ways for different students. Students resorted to checking the gradebook as a part of self-evaluation strategy: “I always wanted to see if I'm doing well or if I'm not doing well, or if I'm deviating too much, I was afraid, according to the scores. So I was, yeah, I was looking [to the gradebook]” (Student 4). They also used the self-assessment test: “[I used the self-assessment test] to understand what I know and what I don't know. And secondly, to prepare for subsequent exams. But, first and foremost, to understand what I know and what I don't know.” (Student 1). The course syllabus was similarly used to check whether students were prepared for the final test or not, thus helping them to evaluate their own performance:

It helped me to understand how to prepare for the tests. Because we had two mini-tests outlined, they were based on the topics of this syllabus. I would look at it to see if I knew all the material. I would review the syllabus before the tests. (Student 1)

Thus, a singular SRL strategy manifested itself as clicks on three separate LMS modules. In a similar way, students used the course syllabus and the introduction page as a part of the goal-setting strategy. As opposed to memory strategy, there was no common way of utilizing these strategies. Students saw different ways of evaluating performance and planning activities as the best fit for themselves.

Additionally, those modules were sometimes used by different students as a part of dissimilar SRL strategies. For example, some students told us about using self-assessment tests in different, less expected ways, in addition to self-evaluation. Tests were used as a proxy of a final exam (even though students were not told that the final test would resemble self-assessment in any way), which allowed students to imagine a rough picture of it to be better prepared and to increase their psychological comfort:

[I used the self-assessment test] in order to understand what the final exam would look like, because it wasn't quite clear what would be there, So, at least this way, I could see what to expect roughly, and somehow mentally prepared. (Student 5)

Re-taking tests multiple times allowed students to memorize the questions, they felt that that might be useful on the exam: "I went through each test until it was automatic, so I could memorize the answers. And by the way, I also used them before the exam. I even memorized some questions that seemed the most difficult to me." (Student 3). This indicates that taking a self-assessment test may be interpreted both as a sign of self-evaluation strategy and memory strategy.

Similarly, the course syllabus, which contained information on all topics of the course and deadlines, was used to plan performance and learning activities:

[I used the course syllabus] to understand what we would be studying next and when we would need to take a test on that material. The entire list of topics that we needed to cover was clear. For example, if you already know some of the topics from this list, you could roughly estimate when you would need to pay special attention to the lectures. (Student 5)

Hence, students' behavior in accessing the syllabus could be attributed to both self-evaluation and goal-setting strategies.

Thus, goal-setting and self-evaluating strategies were found to manifest themselves as clicks on dissimilar LMS modules for different groups of students, and clicks on the self-assessment tests and the course syllabus were found to be related to different students using those modules as a part of various SRL strategies.

Theme 3: Non-traceable SRL Strategies

Due to the blended nature of the course, a portion of students' SRL behavior occurred face-to-face instead of online. Goal setting was not solely reliant on the course syllabus because students could rely on other sources of information for planning. Some used calendars and task tracking software before the beginning of the course, while others relied on communication with their peers. For example, information on course deadlines was shared between students in a group chat (created by the students themselves) in Telegram:

We have a person in our Telegram chat who writes down all the deadlines, so I know that most people check there, that is, some specifically look at a table [syllabus] where you need to submit things, but I didn't need that because I checked the Telegram chat." (Student 1)

Behavior related to the seeking assistance strategy also occurred offline: "[If you struggle with a certain topic,] you clearly define for yourself what is unclear, you find that point... And then you go somewhere with it. Either to a knowledgeable classmate, someone who understands, or to the teacher." (Student 6).

Another significant finding of the interviews is the fact that students often prefer to download or even print out course materials. Downloading textbooks or lecture slides allowed students to access them offline and to organize files in a preferred storage system on a personal computer: “I understood that I was clearly not finished with this presentation yet, and it would be easier for me to save it in some folder there [on my PC], and open it quickly [later].” (Student 5). A number of students printed out course materials. Printed lecture slides were convenient to merge with handwritten notes and to highlight: “When I wrote my notes, I printed some slides from the presentation for myself, and put them there, maybe, to have something especially important, some formulas. Therefore, yes, I also looked at the presentation.” (Student 5). In a similar way, the syllabus was printed out for easier daily access: “There were absolutely all deadlines, all homework assignments, and by what date. And I printed out this plan for myself and just always looked at it.” (Student 5). Thus, some SRL behavior was untraceable via clicks on LMS modules, due to students acting outside of the LMS.

Overall, the qualitative analysis showed that some SRL behavior was clearly related to clicks on certain LMS modules and easy to interpret, while other types of behavior were dissimilar and associated with clicks on multiple modules, making it harder to interpret. Additionally, some SRL behavior was found to be untraceable via clicks due to occurring outside of the LMS.

Discussion

The results of the current study show that there are certain types of digital traces that allow us to measure students’ use of SRL strategies in blended courses. Previous literature associates interacting with video content (and specifically re-watching lectures) with rehearsing and repeating, which could be attributed to memory strategy (Davis et al., 2016; Delen et al., 2014; Maldonado-Mahauad et al., 2018). However, there are no studies that show a direct relationship between clicks on video content and memorizing. Similarly, the findings of this study show that video watching is not associated with memory strategy. On the other hand, the correlation analysis and interviews support the finding that students resort to memory strategy when viewing lecture slides, which is in line with previous research (Perez-Alvarez et al., 2020; Bouchet et al., 2013; Pérez-Sanagustín et al., 2021).

Existing research shows the relationship between interacting with text materials and memory strategy (Bernacki et al., 2012). However, the results of this study show an insignificant correlation between clicks on the textbooks module and memory strategy, although it was mentioned in the interviews. Students preferred lecture slides to textbooks as a main source of theoretical material, but used textbooks to get a deeper understanding of theory when it was necessary. Hence, students’ interactions with this module were not frequent enough to show a statistically significant correlation, but interviews suggest that this correlation, indeed, exists.

A negative and statistically significant correlation between clicks on video lecture recordings and memory strategy, learning responsibility, and organizing was not supported by interviews. Students viewed the lecture recording module as a mere substitute for a synchronous lecture they had failed to attend. Only a few of them told us about actually using lecture recordings, probably due to the high attendance rate. It is important to add that a lecture

recording was not equivalent to a synchronous online or offline lecture, due to comparatively low sound and video quality. Students with higher SRL behavior would opt to view a lecture synchronously online or face-to-face (Bjork et al., 2013), which could not be reflected by digital traces.

Thus, a negative correlation between clicks on lecture recordings and numerous SRL strategies may be explained by the fact that the lecture recordings module was only accessed by students with lower overall SRL behavior, who did not attend lectures synchronously and hoped that a lecture recording might help them. As a result, lecture recordings proved to be a poor indicator of SRL behavior in this blended course setting, where students typically favored synchronous interactions with the lecturer. In contrast, research on SRL in MOOCs has demonstrated a strong relationship between lecture recording views and memory strategy usage (Maldonado-Mahauad et al., 2018). This finding highlights important differences in students' approaches to video watching in online and blended learning environments.

Clicks on the gradebook module are suggested to be related to self-evaluation strategy, as shown by previous research (Saint et al., 2020b; Wong et al., 2019), however, it is not supported by the correlation analysis in this study. The statistically significant positive correlation between clicks in this module and memory strategy is not supported by the interviews either—students did not mention using the gradebook in regard to any SRL strategy. This could be due to the low number of graded assignments in the course, providing little incentive for students to check the gradebook. It is likely that clicks on the gradebook course module were influenced by other latent variables, which requires future investigation.

Thus, instructional designers in blended courses can use clicks on LMS modules containing theoretical content (but not lecture recordings) as indicators of students' engagement in SRL practices. This information may serve as an indicator of students' SRL (Bernacki et al., 2012; Fan, Matcha, et al., 2021) and can be valuable for providing SRL scaffolding (Azevedo & Hadwin, 2005) or predicting which students may have lower academic achievement due to a lack of self-regulation (Kizilcec et al., 2017). Tracking, analyzing, and interpreting clicks on lecture slides and textbooks modules impose minimal additional burden on instructors. It requires aggregating all clicks on corresponding modules throughout a certain period of time and standardizing them.

Other digital traces also indicate students' SRL behavior but lack a clear interpretation because of their relationship with multiple SRL strategies at once. For example, clicks on the course syllabus and self-assessment tests were related to three SRL strategies simultaneously, as shown by the interviews. This finding doesn't seem particularly unusual, as students' use of different SRL strategies indicates an overall engagement with SRL behavior (Kizilcec et al., 2017). However, this ambiguity in interpretation has negative theoretical and pedagogical implications. Firstly, unclear interpretation prevents further theoretical development of SRL as a construct because it doesn't allow researchers to differentiate between the components of SRL. Secondly, SRL scaffolding is difficult because the instructor cannot provide personalized support to a student if the student is not using the full range of self-regulated learning strategies. Additionally, an instructor lacking the information on which of the student's SRL strategies is less developed is unable to focus their resources on scaffolding this strategy, making the process of scaffolding less effective.

It is important for practitioners to be aware of the fact that students may use SRL strategies outside of the LMS. A significant portion of SRL behaviors are not revealed by digital traces in blended courses because of their nature. Many processes that researchers expect to happen online may have a blended nature or take place completely face-to-face. For example, students may print out all available materials and interact with them in real life, or create group chats separate from the main LMS platform and discuss studying-related issues there. A low number of one student's clicks on an LMS module compared to other students may not suggest a student with lower use of a corresponding SRL strategy.

Limitations of the Study

It is important to note the limitations of this study, which are also reflected in previous research (Eggers et al., 2021) and affect the generalizability of the results. First, the small sample size limited the scope of statistical analyses, and some relationships may not have been discovered due to this limitation. However, the small sample size enabled a more in-depth exploration of students' learning behaviors, allowing for detailed qualitative insights that might not have emerged in a larger study. At the same time, the limited number of observations inevitably affected the statistical power of the qualitative part of the analysis and may have contributed to the non-significance of certain effects. Nevertheless, the relationships that did emerge appear relatively strong, as they were evident even in this constrained context. Importantly, the quantitative results in this study are intended to complement the findings of the qualitative analysis, rather than stand alone. Future studies should aim to replicate and extend these findings using larger and more diverse samples to enhance their generalizability.

Second, the types of digital traces used in this study are not universal; they were tied both to specific features and options provided by the LMS modules as well as to the course content. Nonetheless, the study attempted to mitigate this limitation by focusing the interviews and the questionnaire specifically on the student experience on this specific course.

Another limitation connected to digital traces lies in the nature of blended courses, which implies that some significant part of the learning process stays out of the scope of the platform and cannot therefore reflect the whole variety of SRL strategies that learners might use in face-to-face parts of the course. The potential for future research lies in conducting a quantitative study of the correlation between SRL strategies and digital traces in blended courses which would have a bigger sample and would not be limited to a single course.

Self-selection bias was also initially a concern—only 16 out of 24 (66%) course students agreed to participate in the questionnaire, and even fewer students gave interviews (8). However, as interviews showed, there was sufficient variance in student profiles. Some students reported excellent preparation, having a high GPA and being responsible, while others told us about cheating on the final exam and having trouble with the final project. Moreover, the potential impact of self-selection bias on our findings is limited due to the specific focus of our research. Our study primarily investigates the relationships between students' clicking behaviors, their reported SRL strategies, and their qualitative interview reflections. While the overall levels of academic achievement or general SRL usage within the sample might be influenced by self-selection (e.g., if only highly motivated students volunteered), these factors are not central to our research questions. Instead, we are primarily interested in how variations in clicking behaviors

relate to variations in reported SRL strategies and interview narratives. Therefore, while acknowledging the potential for self-selection bias to influence the absolute levels of performance or SRL, we argue that it is less likely to substantially alter the relationships between the variables under investigation. Nevertheless, future research employing more representative sampling techniques is warranted to further validate these findings and assess the potential influence of self-selection bias more comprehensively.

Another factor to consider when interpreting our results is that all participants in this study had prior experience with blended learning courses. This pre-existing familiarity with the blended format may have influenced their learning strategies, expectations, and overall engagement with the course under investigation. For instance, students with prior positive experiences may have been more adept at navigating the online components, utilizing digital resources effectively, and integrating online and face-to-face learning activities. Conversely, those with prior negative experiences might have approached the course with pre-conceived notions or anxieties that affected their self-regulated learning behaviors and their interactions with LMS. Therefore, the observed relationships between clicking behaviors, SRL strategies, and interview narratives might be specific to learners with a degree of pre-existing comfort and competence in blended learning environments. It is possible that novice blended learners, lacking this prior experience, would exhibit different patterns of engagement and demonstrate different relationships between these variables. Future research should explore the potential impact of prior blended learning experience by including participants with varying levels of familiarity with the blended format, allowing for a more comprehensive understanding of how experience shapes learning in blended environments.

Conclusion

The present study aims to explore the potential of using digital traces as a tool to infer and monitor students' SRL strategies in a blended course, addressing the current research gap and contributing to the development of effective SRL strategies in blended learning environments. To do that, the triangulation of methods was used. The questionnaire, interview, and digital traces analysis were used to investigate the relationship between students' SRL strategies and clicks on different course modules in LMS, and to find the real processes behind these clicks.

Clicks on LMS modules related to theoretical materials (textbooks and lecture slides) had a positive correlation with memory strategy use by students. This result may be valuable for instructional designers of blended courses. Clicks on other LMS modules were found to either relate to several SRL strategies at once, which made their interpretation difficult, or to not have a meaningful correlation with SRL strategies at all.

Thus, while our study demonstrates the potential of using digital traces to monitor SRL strategies in blended learning environments, it does so with several limitations. Despite the proliferation of opportunities to leverage digital data, they still fall short of providing researchers and practitioners with the ability to rely exclusively on these data sources. Triangulation of data sources emerges as a way forward for researchers, and it would be beneficial to continue employing this methodology in related future studies.

Statements and Declarations

Competing Interests

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

Ethics

This study involved an analysis of hybrid course students' LMS trace data and interview recordings. Given the nature of the data and the minimal risk to participants (as the data were anonymized, no personally identifiable information was collected or used, and the interview recordings focused solely on learning behaviors rather than sensitive personal topics), this research was classified as low-risk and did not require full review by Higher School of Economics (HSE) University's Institutional Review Board (IRB). LMS trace data was analyzed in aggregate. Interview recordings were transcribed and analyzed thematically, with all identifying information removed to ensure anonymity. All participants signed informed consent forms prior to participating in the study. This determination was made in accordance with HSE University's guidelines on research ethics.

Funding

The article was prepared within the framework of the HSE University Basic Research Program.

Author Contributions

Maxim Boitcov: study conception and design; data collection; analysis and interpretation of results; draft manuscript preparation.

Anna Gorbunova: study conception and design; interpretation of results; draft manuscript preparation.

Anastasiia Kapuza: study conception and design; data analysis; draft manuscript preparation.

Regina Sutarmina: study conception and design; data collection.

All authors reviewed the results and approved the final version of the manuscript.

References

- Anthonyamy, L., Koo, A.-C., & Hew, S.-H. (2020). Self-regulated learning strategies and non-academic outcomes in higher education blended learning environments: A one decade review. *Education and Information Technologies*, 25(5), 3677–3704.
<https://doi.org/10.1007/s10639-020-10134-2>
- Antonio Perez-Alvarez, R., Maldonado-Mahauad, J., Sharma, K., Sapunar-Opazo, D., & Perez-Sanagustin, M. (2020). Characterizing learners' engagement in MOOCs: an observational case study using the NoteMyProgress tool for supporting self-regulation. *IEEE Transactions on Learning Technologies*, 13(4), 676–688.
<https://doi.org/10.1109/TLT.2020.3003220>
- Azevedo, R., & Hadwin, A. F. (2005). Scaffolding self-regulated learning and metacognition—Implications for the design of computer-based scaffolds. *Instructional Science*, 33(5–6), 367–379. <https://doi.org/10.1007/s11251-005-1272-9>
- Baker, R., Xu, D., Park, J., Yu, R., Li, Q., Cung, B., Fischer, C., Rodriguez, F., Warschauer, M., & Smyth, P. (2020). The benefits and caveats of using clickstream data to understand student self-regulatory behaviors: Opening the black box of learning processes. *International Journal of Educational Technology in Higher Education*, 17(1), 13.
<https://doi.org/10.1186/s41239-020-00187-1>
- Bernacki, M. L., Byrnes, J. P., & Cromley, J. G. (2012). The effects of achievement goals and self-regulated learning behaviors on reading comprehension in technology-enhanced learning environments. *Contemporary Educational Psychology*, 37(2), 148–161.
<https://doi.org/10.1016/j.cedpsych.2011.12.001>
- Bjork, R. A., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: Beliefs, techniques, and illusions. *Annual Review of Psychology*, 64(1), 417–444.
<https://doi.org/10.1146/annurev-psych-113011-143823>
- Boekaerts, M. (1999). Motivated learning: Studying student situation transactional units. *European Journal of Psychology of Education*, 14(1), 41–55.
<https://doi.org/10.1007/bf03173110>
- Bouchet, F., Harley, J. M., Trevors, G. J., & Azevedo, R. (2013). Clustering and profiling students according to their interactions with an intelligent tutoring system fostering self-regulated learning. *Journal of Educational Data Mining*, 5(1), 104–146.
<https://doi.org/10.5281/zenodo.3554614>
- Broadbent, J. (2017). Comparing online and blended learner's self-regulated learning strategies and academic performance. *The Internet and Higher Education*, 33, 24–32.
<https://doi.org/10.1016/j.iheduc.2017.01.004>

- Broadbent, J., & Poon, W. L. (2015). Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review. *The Internet and Higher Education*, 27, 1–13. <https://doi.org/10.1016/j.iheduc.2015.04.007>
- Broadbent, J., Sharman, S., Panadero, E., & Fuller-Tyszkiewicz, M. (2021). How does self-regulated learning influence formative assessment and summative grade? Comparing online and blended learners. *The Internet and Higher Education*, 50, 100805. <https://doi.org/10.1016/j.iheduc.2021.100805>
- Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of Educational Research*, 65, 245–281. <https://doi.org/10.2307/1170684>
- Cerezo, R., Bogarín, A., Esteban, M., & Romero, C. (2020). Process mining for self-regulated learning assessment in e-learning. *Journal of Computing in Higher Education*, 32(1), 74–88. <https://doi.org/10.1007/s12528-019-09225-y>
- Crompton, H., Bernacki, M., & Greene, J. A. (2020). Psychological foundations of emerging technologies for teaching and learning in higher education. *Current Opinion in Psychology*, 36, 101–105. <https://doi.org/10.1016/j.copsyc.2020.04.011>
- Davis, D., Chen, G., Van Der Zee, T., Hauff, C., & Houben, G. (2016). Retrieval practice and study planning in MOOCs: Exploring classroom-based self-regulated learning strategies at scale. *Lecture notes in computer science* (pp. 57–71). https://doi.org/10.1007/978-3-319-45153-4_5
- Delen, E., Liew, J., & Willson, V. (2014). Effects of interactivity and instructional scaffolding on learning: Self-regulation in online video-based environments. *Computers & Education*, 78, 312–320. <https://doi.org/10.1016/j.compedu.2014.06.018>
- Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning*, 3(3), 231–264. <https://doi.org/10.1007/s11409-008-9029-x>
- Du, J., Hew, K. F., & Liu, L. (2023). What can online traces tell us about students' self-regulated learning? A systematic review of online trace data analysis. *Computers & Education*, 201, 104828. <https://doi.org/10.1016/j.compedu.2023.104828>
- Eggers, J. H., Oostdam, R., & Voogt, J. (2021). Self-regulation strategies in blended learning environments in higher education: A systematic review. *Australasian Journal of Educational Technology*, 175–192. <https://doi.org/10.14742/ajet.6453>
- Fan, Y., Matcha, W., Uzir, N. A., Wang, Q., & Gašević, D. (2021). Learning analytics to reveal links between learning design and self-regulated learning. *International Journal of Artificial Intelligence in Education*, 31(4), 980–1021. <https://doi.org/10.1007/s40593-021-00249-z>

- Fan, Y., Rakovic, M., van der Graaf, J., Lim, L., Singh, S., Moore, J., Molenaar, I., Bannert, M., & Gašević, D. (2023). Towards a fuller picture: Triangulation and integration of the measurement of self-regulated learning based on trace and think aloud data. *Journal of Computer Assisted Learning*, 39(4), 1303–1324. <https://doi.org/10.1111/jcal.12801>
- Fan, Y., Saint, J., Singh, S., Jovanovic, J., & Gašević, D. (2021). A learning analytic approach to unveiling self-regulatory processes in learning tactics. LAK21: *11th International Learning Analytics and Knowledge Conference*, 184–195. <https://doi.org/10.1145/3448139.3448211>
- Halem, N. van, Klaveren, C. van, Drachsler, H., Schmitz, M., & Cornelisz, I. (2020). Tracking patterns in self-regulated learning using students' self-reports and online trace data. *Frontline Learning Research*, 8(3), Article 3. <https://doi.org/10.14786/flr.v8i3.497>
- Han, F., & Ellis, R. A. (2023). Self-reported and digital-trace measures of computer science students' self-regulated learning in blended course designs. *Education and Information Technologies*, 28(10), 13253–13268. <https://doi.org/10.1007/s10639-023-11698-5>
- Huang, L., & Lajoie, S. P. (2021). Process analysis of teachers' self-regulated learning patterns in technological pedagogical content knowledge development. *Computers & Education*, 166, 104169. <https://doi.org/10.1016/j.compedu.2021.104169>
- Jansen, R. S., van Leeuwen, A., Janssen, J., Conijn, R., & Kester, L. (2020). Supporting learners' self-regulated learning in Massive Open Online Courses. *Computers & Education*, 146, 103771. <https://doi.org/10.1016/j.compedu.2019.103771>
- Kizilcec, R. F., Pérez-Sanagustín, M., & Maldonado, J. J. (2017). Self-regulated learning strategies predict learner behavior and goal attainment in Massive Open Online Courses. *Computers & Education*, 104, 18–33. <https://doi.org/10.1016/j.compedu.2016.10.001>
- Lan, M., Hou, X., Qi, X., & Mattheos, N. (2019). Self-regulated learning strategies in world's first MOOC in implant dentistry. *European Journal of Dental Education*, 23(3), 278–285. <https://doi.org/10.1111/eje.12428>
- Lee, D., Watson, S. L., & Watson, W. R. (2019). Systematic literature review on self-regulated learning in massive open online courses. *Australasian Journal of Educational Technology*, 35(1). <https://doi.org/10.14742/ajet.3749>
- Magno, C. (2010). Assessing academic self-regulated learning among Filipino college students: The factor structure and item fit. *The International Journal of Educational and Psychological Assessment*, 5. <https://papers.ssrn.com/abstract=2287208>
- Maldonado-Mahauad, J., Pérez-Sanagustín, M., Kizilcec, R. F., Morales, N., & Munoz-Gama, J. (2018). Mining theory-based patterns from Big data: Identifying self-regulated learning strategies in Massive Open Online Courses. *Computers in Human Behavior*, 80, 179–196. <https://doi.org/10.1016/j.chb.2017.11.011>

- Matcha, W., Gašević, D., Uzir, N. A., Jovanović, J., Pardo, A., Lim, L., Maldonado-Mahauad, J., Gentili, S., Pérez-Sanagustín, M., & Tsai, Y.-S. (2020). Analytics of learning strategies: Role of course design and delivery modality. *Journal of Learning Analytics*, 7(2), Article 2. <https://doi.org/10.18608/jla.2020.72.3>
- Milikić, N., Gašević, D., & Jovanović, J. (2020). Measuring effects of technology-enabled mirroring scaffolds on self-regulated learning. *IEEE Transactions on Learning Technologies*, 13(1), 150–163. <https://doi.org/10.1109/TLT.2018.2885743>
- Onah, D. F. O., Pang, E. L. L., & Sinclair, J. E. (2021). Investigating self-regulation in the context of a blended learning computing course. *The International Journal of Information and Learning Technology*, 39(1), 50–69. <https://doi.org/10.1108/IJILT-04-2021-0059>
- Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology*, 8. <https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00422>
- Pérez-Sanagustín, M., Sapunar-Opazo, D., Pérez-Álvarez, R., Hilliger, I., Bey, A., Maldonado-Mahauad, J., & Baier, J. (2021). A MOOC-based flipped experience: Scaffolding SRL strategies improves learners' time management and engagement. *Computer Applications in Engineering Education*, 29(4), 750–768. <https://doi.org/10.1002/cae.22337>
- Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)* (Tech. Report No. 91-B-004). Board of Regents, University of Michigan. <https://eric.ed.gov/?id=ED338122>
- Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation* (pp. 451–502). Academic Press. <https://doi.org/10.1016/B978-012109890-2/50043-3>
- Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, 82(1), 33–40. <https://doi.org/10.1037/0022-0663.82.1.33>
- Puzziferro, M. (2008). Online technologies self-efficacy and self-regulated learning as predictors of final grade and satisfaction in college-level online courses. *American Journal of Distance Education*, 22(2), 72–89. <https://doi.org/10.1080/08923640802039024>
- Rafaeli, A., Ashtar, S., & Altman, D. (2019). Digital traces: New data, resources, and tools for psychological-science research. *Current Directions in Psychological Science*, 28(6), 560–566. <https://doi.org/10.1177/0963721419861410>
- Rodrigues, R. L., Ramos, J. L. C., Silva, J. C. S., Dourado, R. A., & Gomes, A. S. (2019). Forecasting students' performance through self-regulated learning behavioral analysis. *International Journal of Distance Education Technologies (IJDET)*, 17(3), 52–74. <https://doi.org/10.4018/IJDET.2019070104>

- Rovers, S. F. E., Clarebout, G., Savelberg, H. H. C. M., de Bruin, A. B. H., & van Merriënboer, J. J. G. (2019). Granularity matters: Comparing different ways of measuring self-regulated learning. *Metacognition and Learning*, 14(1), 1–19. <https://doi.org/10.1007/s11409-019-09188-6>
- Saint, J., Fan, Y., Gašević, D., & Pardo, A. (2022). Temporally-focused analytics of self-regulated learning: A systematic review of literature. *Computers and Education: Artificial Intelligence*, 3, 100060. <https://doi.org/10.1016/j.caeai.2022.100060>
- Saint, J., Gašević, D., Matcha, W., Uzir, N. A., & Pardo, A. (2020a). Combining analytic methods to unlock sequential and temporal patterns of self-regulated learning. *Proceedings of the Tenth International Conference on Learning Analytics & Knowledge*, 402–411. <https://doi.org/10.1145/3375462.3375487>
- Saint, J., Whitelock-Wainwright, A., Gasevic, D., & Pardo, A. (2020b). Trace-SRL: A framework for analysis of microlevel processes of Self-Regulated Learning from trace data. *IEEE Transactions on Learning Technologies*, 13(4), 861–877. <https://doi.org/10.1109/tlt.2020.3027496>
- Schunk, D. (2005). Self-regulated learning: The educational legacy of Paul R. Pintrich. *Educational Psychologist—EDUC PSYCHOL*, 40, 85–94. https://doi.org/10.1207/s15326985ep4002_3
- Siadat, M., Gašević, D., & Hatala, M. (2016). Measuring the impact of technological scaffolding interventions on micro-level processes of self-regulated workplace learning. *Computers in Human Behavior*, 59, 469–482. <https://doi.org/10.1016/j.chb.2016.02.025>
- Singh, J., Steele, K., & Singh, L. (2021). Combining the best of online and face-to-face learning: Hybrid and blended learning approach for COVID-19, post vaccine, and post-pandemic world. *Journal of Educational Technology Systems*, 50(2), 140–171. <https://doi.org/10.1177/00472395211047865>
- Winne, P. H., & Hadwin, A. F. (1998). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 277–304). Lawrence Erlbaum Associates Publishers.
- Winne, P. H. (2010). Improving measurements of self-regulated learning. *Educational Psychologist*, 45(4), 267–276. <https://doi.org/10.1080/00461520.2010.517150>
- Winne, P. H. (2017). The trajectory of scholarship about self-regulated learning. *Teachers College Record: The Voice of Scholarship in Education*, 119(13), 1–16. <https://doi.org/10.1177/016146811711901312>
- Wong, J., Khalil, M., Baars, M., de Koning, B. B., & Paas, F. (2019). Exploring sequences of learner activities in relation to self-regulated learning in a massive open online course. *Computers & Education*, 140, 103595. <https://doi.org/10.1016/j.compedu.2019.103595>

- Xu, Z., Zhao, Y., Liew, J., Zhou, X., & Kogut, A. (2023). Synthesizing research evidence on self-regulated learning and academic achievement in online and blended learning environments: A scoping review. *Educational Research Review*, 39, 100510. <https://doi.org/10.1016/j.edurev.2023.100510>
- Yang, T.-C., Chen, M. C., & Chen, S. Y. (2018). The influences of self-regulated learning support and prior knowledge on improving learning performance. *Computers & Education*, 126, 37–52. <https://doi.org/10.1016/j.compedu.2018.06.025>
- Ye, D., & Pennisi, S. (2022). Using trace data to enhance Students' self-regulation: A learning analytics perspective. *The Internet and Higher Education*, 54, 100855. <https://doi.org/10.1016/j.iheduc.2022.100855>
- Zhang, Z., Xu, Q., Koehler, A., & Newby, T. (2023). Comparing blended and online learners' self-efficacy, self-regulation, and actual learning in the context of educational technology. *Online Learning*, 27(4), Article 4. <https://doi.org/10.24059/olj.v27i4.4039>
- Zhou, M., & Winne, P. H. (2012). Modeling academic achievement by self-reported versus traced goal orientation. *Learning and Instruction*, 22(6), 413–419. <https://doi.org/10.1016/j.learninstruc.2012.03.004>
- Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, 81(3), 329–339. <https://doi.org/10.1037/0022-0663.81.3.329>
- Zimmerman, B. J. (2000). Attaining self-regulation. In *Handbook of self-regulation* (pp. 13–39). Elsevier. <https://doi.org/10.1016/B978-012109890-2/50031-7>
- Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice*, 41(2), 64–70. https://doi.org/10.1207/s15430421tip4102_2
- Zimmerman, B. J., & Pons, M. M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal*, 23(4), 614–628. <https://doi.org/10.3102/00028312023004614>

Appendix A

Items of A-SRL-S questionnaire (Magno, 2010) used to measure SRL strategies usage by the students.

Memory strategy

- I use note cards to write information I need to remember.
- I make lists of related information by categories.
- I rewrite class notes by rearranging the information in my own words.
- I use graphic organizers to put abstract information into a concrete form.
- I represent concepts with symbols such as drawings so I can easily remember them.
- I make a summary of my readings.
- I make outlines as guides while I am studying.
- I summarize every topic we would have in class.
- I visualize words in my mind to recall terms.
- I recite the answers to questions on the topic that I made up.
- I record the lessons that I attend to.
- I make sample questions from a topic and answer them.
- I recite my notes while studying for an exam.
- I write messages for myself to remind me of my homework.

Goal setting

- I make a detailed schedule of my daily activities.
- I make a timetable of all the activities I have to complete.
- I plan the things I have to do in a week.
- I use a planner to keep track of what I am supposed to accomplish.
- I keep track of everything I have to do in a notebook or on a calendar.

Self-Evaluation

- I make a detailed schedule of my daily activities.
- I make a timetable of all the activities I have to complete.
- I plan the things I have to do in a week.
- I use a planner to keep track of what I am supposed to accomplish.
- I keep track of everything I have to do in a notebook or on a calendar.

Seeking assistance

- I use a variety of sources in making my research papers.
- I use library resources to find the information that I need.
- I take my own notes in class.
- I enjoy group works because we help one another.
- I call a classmate about the homework that I missed.

- I look for a friend whom I can have an exchange of questions.
- I study with a partner to compare notes.
- I explain to my peers what I have learned.

Environmental Structuring

- I avoid watching the television if I have a pending a homework.
- I isolate myself from unnecessary noisy places.
- I don't want to hear a single sound when I'm studying.
- I can't study nor do my homework if the room is dark.
- I switch off my TV for me to concentrate on my studies.

Learning Responsibility

- I recheck my homework if I have done it correctly before passing.
- I do things as soon as the teacher gives the task.
- I am concerned with the deadlines set by the teachers.
- I prioritize my schoolwork over other activities.
- I finish all my homework first before doing unnecessary things.

Organizing

- I highlight important concepts and information I find in my readings.
- I picture in my mind how the test will look like based on previous tests.
- I put my past notebooks, handouts, and the like in a certain container.
- I study at my own pace.
- I fix my things first before I start studying.
- I make sure my study area is clean before studying.

Appendix B

Guide used to conduct semi-structured interviews.

Section 1: Learning Goals and Habits

- Can you walk me through how you approached the beginning of the course?
(Prompts: Did you set any goals for yourself? What were you hoping to get out of the course?)
- What did you typically do before a new study week started or before class sessions?
(Prompts: Any preparation rituals? How did you organize your study time?)
- How did the course fit into your broader weekly schedule or other responsibilities?
- Tell me about how you tracked or remembered important course information—assignments, deadlines, grading rules.
(If they mention SmartLMS, follow up: What exactly did you look at? How often?)
- What helped you stay on track (or made it difficult to do so)?
(Follow-up: What kinds of challenges did you face in managing your time?)
- When you missed a class or task, what strategies did you use to catch up?
- What learning materials did you return to most often during the course? Why those ones in particular?

Section 2: Learning Environment

- Where did you usually study or work on assignments?
(Follow-up: What made that environment work for you—or not?)
- What kind of setting helps you concentrate and study effectively?
- What usually distracted you while studying? What helped you refocus?
- When did you usually study—mornings, evenings, weekends? How did you decide on that timing?

Section 3: Working with Materials and SmartLMS

- How did you usually work with the course materials provided during classes?
(Prompt: Did you take notes? In what format?)
- Can you describe how you interacted with SmartLMS during the course?
(Prompts: What kinds of materials did you use there? Did you download files? Did you organize them somehow?)
- Beyond what we've already discussed, were there other ways you used SmartLMS throughout the course?

Section 4: Self-Assessment Quizzes

- Tell me about your experience with the optional self-assessment quizzes.
(Prompts: How did you approach them? What did you do before/during/after taking them?)
- How did you decide whether or not to take the quizzes? What were they useful for?

- If you used other materials to prepare, what were they and how did they help?

Section 5: Midterm Exam

- How did you prepare for the midterm exam?
(Prompts: What strategies did you use? What materials did you return to?)
- How did you go about completing the exam? What was your thought process during the task?
- What did you do immediately after finishing the exam?

Section 7: Final Project

- What was your process for working on the final project?
(Prompts: When did you start? Did you plan ahead?)
- What role did you play in your team or group?
- What materials did you rely on most when preparing your project? Why those?
- Did you seek feedback from peers or instructors while working on your project?
(Follow-up: How did you use that feedback?)
- After the project defense, how did you reflect on the feedback you received?

Section 8: Grades and Tracking Progress

- How did you monitor your progress during the course?
- Did you use the “Grades” section in SmartLMS? What for?
- What helped you notice or feel your own learning progress throughout the course?

Section 10: Learning Outcomes and Reflection

- Looking back, how would you describe your overall experience in the course?
- When did you feel you were making progress? What helped you feel that?
- What did you do when you struggled with a topic or assignment?
- Did you collaborate with classmates? How did that collaboration look in practice?
- Were there times when you explained something to your classmates?
(Prompt: Can you share an example?)
- Did you use other resources beyond SmartLMS (e.g., internet, books, videos)? What kinds?

Motivations Matter: Predicting Entrepreneurship Education MOOC Course Completion with a Decision Tree Approach

Chin Jia Wei

Abdullah Muhammad Farhan Shahmi

Wah Yue Qing

Asia School of Business

Nungsari Melati

MIT Sloan School of Management and Asia School of Business

Abstract

Online entrepreneurship education (EE) courses experienced a sharp 66% spike in demand around March 2020, attributed to the COVID-19 pandemic and the subsequent surge in digital entrepreneurship uptake. Completion rates serve as a key indicator of online MOOC efficacy, with students' psychological attributes and contextual factors often examined as explanatory variables in assessing online course completion. This mixed-methods study explores influential factors in student retention in an EE Massive Open Online Course (MOOC) by using survey responses from 222 Malaysian youths who voluntarily registered for an EE MOOC, which was active from February to October 2021. A Decision Tree approach was chosen to predict the course completion likelihood based on sociodemographic and psychological factors, while qualitative content analysis was conducted to explore participant course enrollment motivations from their textual responses. The results indicated that entrepreneurial intention (EI) does not necessarily translate into EE MOOC completion. Instead, internal locus of control and socioeconomic factors held more priority in predicting completion status. These results were reflected in the students' thematic narratives from their textual responses. Both completed (CP) and dropout participants (DP) expressed similar entrepreneurial interests and, indeed, in the transferability of entrepreneurial skills and knowledge beyond entrepreneurial settings. However, there was a distinction in clarity; most CPs had well-defined and detailed enrolment goals, whereas the narratives from DPs were mainly ambiguous. Overall, the study contributes to the methodological discussion of using decision tree modelling, expands the application of Social Cognitive Career Theory (SCCT) and informs practical implications in online EE context.

Keywords: Decision tree, online entrepreneurial education, distance learning, entrepreneurial intention, online completion rate

Chin, J.W., Shahmi, A.M.F., Qing, W.Y., & Melati, N. (2025) Motivations matter: Predicting entrepreneurship education MOOC course completion with a decision tree approach. *Online Learning* 30(1), pp. 294-322. <https://doi.org.10.24059/olj.v30i1.4517>

In the first quarter of 2024, Coursera, the world's leading MOOC (Massive Open Online Course) platform, gained 7 million new registered learners, thus its total number of learners amounted to 148 million (Coursera, 2024). The soaring prominence of online learning has compelled scholarly interest in student retention (Moore & Fetzner, 2019), especially given the high dropout rates traditionally associated with online learning in MOOCs (Toledo et al., 2020). Retention rates have become increasingly regarded as an indicator of institutional efficacy (Moore & Fetzner, 2019); institutions with low retention rates often face reduced profits and challenges in maintaining operations (Liu et al., 2019). Attention to MOOC completion rates may thus enable administrators to allocate resources and budget more effectively for coming fiscal years (Lee & Choi, 2011).

Simultaneously, the constantly evolving economic landscape and learner demographics link completion rates with educational access. Marked inequalities exist within the different social strata of online learners; studies indicate that students most likely to succeed in MOOCs tend to be those who are already educationally and socioeconomically privileged (Emanuel, 2013). The potential of MOOCs to provide universal access to education is further hampered by its "one-size-fits-all" format of lessons, which lacks accommodation for the needs of its diverse learners (Kizilcec et al., 2017). These issues extend to the realm of online entrepreneurship education (EE), which has gained importance since the COVID pandemic, when demand for online EE courses rose by 66% following the boom in digital entrepreneurship during the lockdown (Mescon & van Rest, 2021). Still then, Liguori and Winkler (2020) describe how the widespread adoption of online EE remains challenged due to two major gaps: the underdevelopment of tools and capacity to teach EE online, and scarce academic literature on online EE. In this respect, attrition in online MOOC courses is a worthy focus of attention for researchers and practitioners in EE, as they seek to leverage emerging technologies to benefit the new generation of entrepreneurs (Toledo et al., 2020). In recognition that teaching an entrepreneurial mindset may demand non-traditional approaches to online MOOC education, Liguori and Winkler (2020) have issued a call for more scholarship and resources to adapt EE to its evolving landscape. In tandem with Ng's (2019) call for research that focuses on the needs of diverse online learners through differentiation, this study thus responds by looking into the contextual dimensions surrounding completion rates of online EE MOOC. In a review of online course completion studies between 1999 and 2009, student psychological attributes emerged as the most frequently researched category of explanatory factors (Lee & Choi, 2011). Accordingly, studies have found a strong link between internal locus of control (ILOC) and persistence in online SDL courses (Hart, 2012; Stritto et al., 2023). As such, the current study specifically asks the following questions:

To what degree do psychological variables account for the completion rate of an EE MOOC?

Similarly, to what degree do sociodemographic variables account for the completion rate of an EE MOOC?

In lieu of the conventional logistic regression method, this study proposes a Decision Tree approach for answering the aforementioned research questions in predicting the likelihood of completion among participants in an EE MOOC. The results will then be further

contextualised by considering the participants' motivations for entering the online course. Although prevalent in other disciplines, such as medical research, the decision tree method is utilised less frequently in psychological research (Batterham et al., 2009; Namazkhan et al., 2020). A decision tree not only identifies the most important variables linked to the completion of EE MOOC, but also illustrates the interactions between two or more predictors in the model by providing a visual representation of the relationship between variables. The method provides the advantage of being flexible enough to handle both categorical and continuous data, as well as variables that have missing values, as compared to regression. Therefore, a decision tree is anticipated to offer a more comprehensive understanding of the variables associated with the successful completion of an EE MOOC.

Literature Review

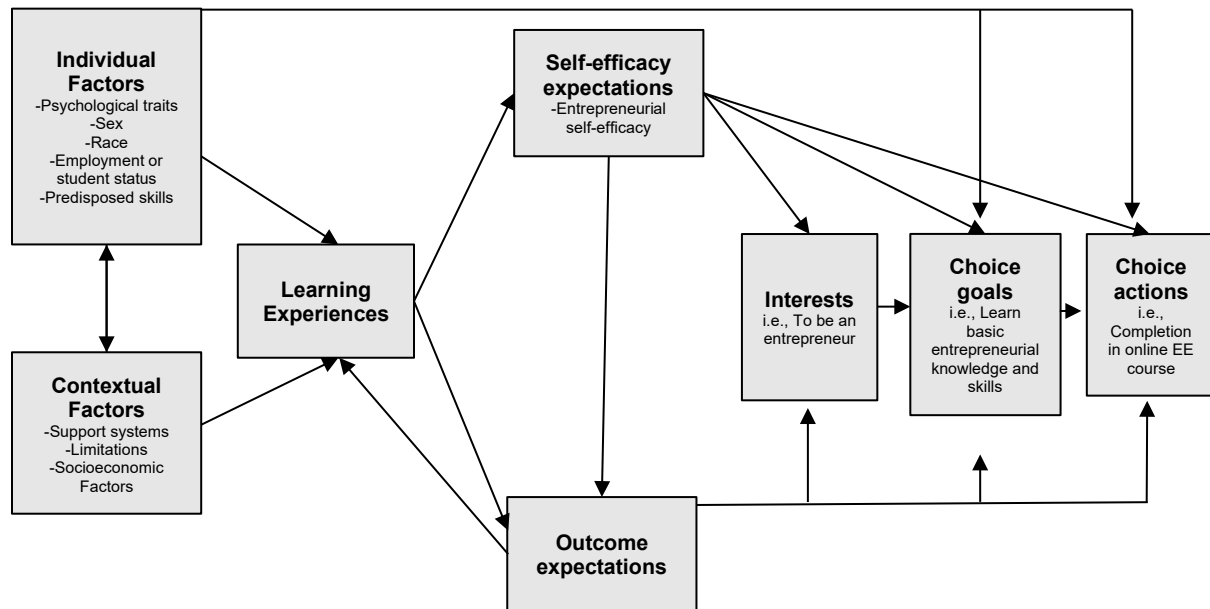
Theoretical Framework

Inquiry into this study is guided by the Social Cognitive Career Theory (SCCT) developed by Lent et al. (2002), which places a strong emphasis on the influence of personal, contextual, and socio-cognitive variables on a person's formation of career interests, job objectives, and performance. SCCT underscores the development of career interests, which are largely determined by several key socio-cognitive beliefs: (1) self-efficacy – a person's belief in their ability to formulate and perform a course of action required to achieve their goals, (2) outcome expectations—beliefs about the overall impact of an individual's actions, with the two initial variables influencing (3) goals—cognitive representations connecting means to desired outcomes. Indeed, SCCT proposes a complex interplay between goals, self-efficacy, and outcome expectations in behavioural self-regulation (Lent et al., 2002). These three core socio-cognitive beliefs operate alongside a multitude of other individual factors (e.g., psychological traits, gender, race, ethnicity, predisposed skills), contextual factors (e.g., support systems, limitations, socioeconomic status), and behavioural factors (e.g., choice action). Collectively these elements may support or inhibit the goals individuals established, ultimately influencing the actions they take to achieve those goals (Lent & Brown, 2019).

The SCCT framework, particularly the Interest Development Model (Lent et al., 2002), posits how personal and contextual influences produce differential learning experiences. These experiences subsequently alter self-efficacy and outcome expectations, which directly affect interest formation, ultimately impacting goal-setting and consequent actions taken towards those goals to sustain that interest. The influence of SCCT in the current study's theoretical framework is illustrated in Figure 1 below. This study postulates that SCCT is particularly relevant in underscoring the relationship between personal and contextual affordances with the retention of participants in an EE MOOC, operationalized in this study as a form of choice action directed towards the course completion for goal-related purposes.

Figure 1

*SCCT Illustration of How Contextual Factors Ultimately Affect Completion in an EE MOOC.
Adapted from the Interest Development Model by Lent et al. (2002, Pp. 269)*



In past studies, SCCT held significant utility in explaining the adoption of online courses (Ray et al., 2019) and in illustrating how background individual and contextual constraints may ultimately lower career goals (Flores et al., 2017; Fouad & Santana, 2017). Thus, SCCT's Interest Development Model serves as this study's foundational perspective in understanding the significance of background inputs (i.e., socioeconomic and psychological traits), which affect entrepreneurial self-efficacy beliefs and outcome expectations, and in turn, entrepreneurial interest (EI). Consequently, these components direct the participation in goal-directed activity (i.e., completion and retention in an EE MOOC in the pursuit of goal-related purposes).

Online Learning Completion Rates

Over the past two decades, numerous studies have found that online course completion rates may be lower than those of traditional F2F courses, subsequently featuring simultaneous, or even alternative, research focus on withdrawal rates (Rahmani et al., 2024; Visser et al., 2002). In a study on an online psychology course designed to replace its pre-existing F2F counterpart, it was found that the online course had more than twice the withdrawal rate of the F2F course (Garratt-Reed et al., 2016). A study on 221 MOOCs revealed completion rates to hover at an average of 12.6% (Jordan, 2015). Inversely, a study on 92 credit-bearing Psychology classes within the same college revealed no significant differences in retention rates between online and traditional instructional formats (Nguyen, 2011). Given such inconclusiveness, retention is unlikely to be explained by course format alone, suggesting that underlying socio-cognitive processes may offer greater explanatory strength. Hence, SCCT is used in this study to provide a theoretical lens to understand learner persistence and disengagement.

In studying online course retention, student psychological attributes emerged as the most frequently researched category of explanatory factors in a review of online course completion studies between 1999 and 2009 (Lee & Choi, 2011). Internal locus of control (ILOC) was found to be highly associated with persistence in online SDL courses (Hart, 2012; Stritto et al., 2023). Defined as the degree to which people believe they have control over their lives (Levenson, 1981), ILOC may encourage higher classroom engagement, probing, and constructive problem-solving (Hart, 2012). From an SCCT perspective, ILOC reinforces learner's self-efficacy beliefs, which sustain persistence in online learning environments. Self-confidence amongst students was found to be a useful predictor of student persistence (Stephen et al., 2020), facilitating elevated self-expectations for academic achievement and a strong belief in their capacity to fulfill those expectations (Holder, 2007).

Additionally, entrepreneurial self-efficacy (ESE), defined by one's belief in their capability to successfully execute entrepreneurial tasks and roles (Chen et al., 1998), has been shown to foster goal commitment, task effort, and persistence amongst entrepreneurs (Cardon & Kirk, 2015; Trevelyan, 2011). This finding is supported by studies that found positive links between ESE and EI (Chen et al., 1998; Liu et al., 2019), known as the best predictor of planned behavior to start a business (Krueger et al., 2000). EE strengthened this pathway by enhancing EI through shaping self-efficacy (Hoang et al., 2020; Liu et al., 2019), reflecting the SCCT pathway towards interest formation in entrepreneurship via self-efficacy and outcome expectations. However, these studies largely examine learners who have received EE, focusing on outcomes such as heightened EI. Far less is known about what pushes learners to finish EE in the first place. SCCT posits that developed interests and goals should guide choice actions, including course completion. This study, therefore, examines whether EI predicts retention in an EE MOOC, operationalized as a choice action within the SCCT framework.

Entrepreneurship Education in Developing Contexts

While the intervention effects of online EE on students remain under-researched, general EE research suggests that the benefits seen in traditional settings may be replicated online. A critical review of hard outcome studies showed consistent positive results on university-based EE impacts (Rideout & Gray, 2013), highlighting higher rates of business start-ups and other entrepreneurial success than their comparison groups. Nonetheless, whether EE translates into entrepreneurial success largely depends on the local circumstances and structures within which it is delivered, wherein entrepreneurship can either be enabled or constrained (Urbano et al., 2019). Previous Malaysian studies on youth's EI accentuated the need to localize entrepreneurial-related interventions as their results showed that psychological traits, parental income, and the urban-rural context influenced youth's EI and perception of entrepreneurship (Nungsari et al., 2021, 2023). Inequalities also exist in larger contexts—the environmental conditions for potential entrepreneurs were found to be much more favorable in developed countries compared to developing economies, whose barriers include inefficient, unstable policies, a lack of effective EE in university and society, negative societal perception of entrepreneurs, and restrictive sociocultural norms towards market participation (Guerrero et al., 2021). This study thus holds implications that connect to the wider transformative potential of open education for emerging economies; indeed, Zhang (2022) describes how the emergence of cross-institutional, cross-cultural MOOC researchers yields the potential of reshaping education initiatives of entire

regions, but particularly impactful for the Global South, where internet connectivity and online learning proliferates rapidly each day (Zhu et al., 2020).

Collectively, these studies indicate that while EE has clear benefits, its outcomes in developing contexts are inextricably linked to the sociodemographic and structural conditions that shape learners' engagement. This highlights the necessity to examine both psychological elements and sociodemographic characteristics in elucidating who persists and completes EE MOOCs.

Methodology

Building on the above literature, the present study investigates how psychological and sociodemographic variables encourage learners' persistence in a voluntary EE MOOC. We employed a convergent mixed-methods design (QUAN + QUAL; Creswell, 2013) that analyzed survey responses from Malaysian youths who went through an EE MOOC. The survey data included demographic and psychological assessment information, which was used as input for the decision tree algorithm. The purpose was to determine how these factors influence and interact with one another in order to predict course completion. Subsequently, the textual data from the survey was inductively analyzed for their motives for course participation using qualitative content analysis, and a comparison was made between participants who completed the course ("Completed Participants" [CP]) and those who did not ("Dropout Participants" [DP]). The findings were collectively interpreted in the discussion section to gain a comprehensive understanding of the research questions (Creswell, 2013).

Materials and analysis code for this study are available from the corresponding author upon reasonable request.

Participants and EE MOOC Details

Our participants are 18- to 28-year-old Malaysian youths who voluntarily registered for an EE MOOC, which was active from February to October 2021 and allowed registration throughout this period. This EE MOOC was funded by Citi Foundation [G-IDS-20207103] and aimed to deliver entrepreneurial training to Malaysian youth and facilitate the starting point of their entrepreneurial journey. The course was promoted through social media platforms and by sending email invitations to Malaysian universities. With the course's SDL approach, participants were given the autonomy to complete 23 short course modules consisting of recorded lectures, local case studies, reading materials, and assignments at their own pace. As an incentive for course completion, eligible participants could apply to a business incubation program by submitting their business proposal before the course deadline.

The MOOC recorded a completion rate of 19.86% out of 569 participants. The data analyzed in this paper were taken from the participant's registration survey on the Qualtrics Online Survey platform prior to course enrolment. The informed consent form was provided within the registration survey, in which participants consented to the utilization of their data for research and programmatic objectives. After excluding 31 participants whose survey responses were flagged as invalid (Buchanan & Scofield, 2018; Curran, 2016), 538 participants remained, which included 427 dropouts (incomplete course progress) and 111 completed participants. To

achieve an evenly matched sample ($N = 222$), we used the R packages “optmatch” and “MatchIt” to randomly draw 111 dropouts from the larger pool and age-match them to the 111 completers, thereby ensuring comparability across groups. Table 1 presents our participants’ characteristics. The average age of participants is 22.144 ± 2.704 , while the median age is 22.

Table 1*Characteristics of Participants, N=222*

Variable	Completion Status				Total	
	Dropout, n=111		Completed, n=111			
	n	%	n	%	n	%
Gender						
Female	77	34.68%	69	31.08%	146	65.77%
Male	34	15.32%	42	18.92%	76	34.23%
Employment Status						
Not working	62	27.93%	72	32.43%	134	60.36%
Self-employed	8	3.60%	6	2.70%	14	6.31%
Full-time	19	8.56%	14	6.31%	33	14.86%
Part-time/Freelancing	22	9.91%	19	8.56%	41	18.47%
Student Status						
No	39	17.57%	36	16.22%	75	33.78%
Yes	72	32.43%	75	33.78%	147	66.22%
Residential State ^a						
Low-Income States	9	4.09%	18	8.18%	27	12.27%
Moderate-Low-Income States	15	6.82%	14	6.36%	29	13.18%
Moderate-High-Income States	28	12.73%	31	14.09%	59	26.82%
High-Income States	57	25.91%	48	21.82%	105	47.73%
Entrepreneurial Status						
Not thinking of starting a business	9	4.05%	14	6.31%	23	10.36%
Thinking about starting a business	23	10.36%	28	12.61%	51	22.97%
Taking steps of starting a business	62	27.93%	59	26.58%	121	54.50%
Have started a business in the last 3 years in any form, such as full time, part time, online, side hustle or freelance	17	7.66%	10	4.50%	27	12.16%
Household Income ^b						
Low (Less than RM2,200)	16	7.21%	16	7.21%	32	14.41%
Moderate-Low (RM2,200 - RM3,199)	18	8.11%	17	7.66%	35	15.77%
Moderate (RM3,200 - RM4,999)	29	13.06%	24	10.81%	53	23.87%
Moderate-High (RM5,000 - RM10,999)	28	12.61%	34	15.32%	62	27.93%
High (RM11,000 and above)	20	9.01%	20	9.01%	40	18.02%
Parental Educational Status						
Completed primary education	9	4.46%	10	4.95%	19	9.41%
Completed secondary education	32	15.84%	39	19.31%	71	35.15%
Completed pre-university education	5	2.48%	2	0.99%	7	3.47%
Completed vocational education	2	0.99%	2	0.99%	4	1.98%
Completed tertiary education	53	26.24%	48	23.76%	101	50.00%
Entrepreneurial Parents						
No	85	38.29%	79	35.59%	164	73.87%
Yes	26	11.71%	32	14.41%	58	26.13%

Note. ^a According to the median household income (Department of Statistics Malaysia, 2021), the states were grouped: High-Income (Kuala Lumpur, Putrajaya, Selangor), Moderate-High-Income (Johor, Melaka, Pulau Pinang, Negeri Sembilan), Moderate-Low-Income (Terengganu, Sabah, Pahang, Sarawak) and Low-Income (Perak, Kedah, Perlis, Kelantan).

^b MYR = Malaysian Ringgit, 1 USD was approximately equivalent to 4.14 MYR in 2021.

Data Collected

The participant's registration survey contained items that represent different SCCT components. Participant's individual factors were represented by certain sociodemographic information and psychological traits, while residential state, household income, parental educational status, and entrepreneurial parents formed the basis for contextual factors. Additionally, the survey collected participants' textual responses to these two questions: "What do you hope to achieve through this programme?" and "Which industry do you want to own a business in? Please list out answers with elaboration. If you do not have the intention to start a business, please state "N/A" as your answer." These questions were expected to elucidate participants' outcome expectations, interests, and choice goals per the SCCT theoretical framework. Besides theoretical relevance of the survey components, the survey was reviewed by the instructors of the EE MOOC for comprehensibility and program relevance, with the additional purpose of understanding participant profiles to inform future course design. Minor wording adjustments were made for enhanced clarity and face validity.

Psychological Batteries.

We measured EI using six items from Liñán and Chen (2009) with a seven-point Likert scale. Entrepreneurial self-efficacy was measured using six items, using five-point Likert scale (Wilson et al., 2007). Furthermore, we assessed self-esteem using ten items, half of which are negative items (Rosenberg, 1989). As for Likert scale, the items use a four-point Likert scale which starts from zero (strongly agree). The IE-4 (Kovaleva, 2012) comprised of four items which two items measure internal locus of control (ILOC) while the rest measure external locus of control (ELOC). A binary measure of risk-return preference was used (Barbosa et al., 2007; Reynolds, 2000). Participants will be coded as "0," as having a low risk tolerance, if they chose "A business that would provide a good living, but with little risk of failure, and little likelihood of making you a millionaire" while participants who choose "A business that was much more likely to make you a millionaire but had a much higher chance of going bankrupt" will be coded as "1."

After going through confirmatory factor analysis (CFA) without including LOC items as their number of items are below three, we removed one item from ESE and one item from RSES for having standardized factor loading below .40. A second CFA showed an adequate fit (CFI = .925; TLI = .915; SRMR = .059; RMSEA = .063) with the standardized factor loading of items ranging from .429 to .894. The average variance extracted (AVE) of each variable was at least .40, and the $\sqrt{\text{AVE}}$ was greater than the correlation between the variables. Composite reliabilities for each variable were above the cut-off value of .60 (Bagozzi & Yi, 1988) and .70 for assessing Cronbach's alpha. Although ESE and RSES have lower AVE, their reliability and discriminant validity scores were above the threshold of .60 (Fornell & Larcker, 1981) and thus convergent and discriminant validities are established (Table 2).

Table 2*Reliabilities, Average Variances Extracted and Correlations Between Variables*

Table 1. Means, Standard Deviations, Intercorrelations, and Cronbach's Alpha for Variables									
	Variable	α	CR	AV	1	2	3	4	5
1	Entrepreneurial Intention	.908	.910	.630	(.793)				
2	Entrepreneurial Self-Efficacy	.783	.792	.440	.427 ***	(.663)			
3	Self-esteem	.863	.869	.437	.361 ***	.468 ***	(.661)		
4	Internal Locus of Control	-	-	-	.384 ***	.395 ***	.352 ***	-	
5	External Locus of Control	-	-	-	- .147*	-.066	-.121	-.057	-
	Mean				5.399	3.783	1.927	3.838	2.633
	Standard Deviation				.950	.645	.469	.750	.739

Note. α = Cronbach's alpha, AVE = average variances extracted, CR = composite reliability, *** = correlation is significant at .001 (two-tailed), * = correlation is significant at .05 (two-tailed). Numbers within parentheses are the square roots of the AVEs.

For the decision tree model, we predict the likelihood of participants completing the online EE course (Choice action; 1 = Completed, 0 = Dropouts) using the above-mentioned psychological traits and the following sociodemographic characteristics: sex, student status, employment status, median household income of the residing Malaysian state, parental education level, household income, entrepreneur parents, and entrepreneurial experience.

Data Analysis

Decision Tree.

On RStudio software version 2023.06.1, the first author completed all quantitative procedures and analyses. Before analysis, she replaced outliers with computed values from the K-nearest neighbor method (Aguinis et al., 2013). Data normality was assumed since the z-score calculated from their skewness and kurtosis is below 3.29 (Kim, 2013).

To identify the more relevant factors related to MOOC completion, a decision tree model was chosen over logistic regression due to several advantages, such as simplifying complex relationships between variables, robustness to outliers, and easy handling of missing values, but both methods of analysis were done to compare model performance (Batterham et al., 2009; Song & Lu, 2015). Receiver operating characteristic (ROC) curves for the decision tree and the logistic regression were plotted to assess the performance of each approach by comparing the areas under the curve (Ying et al., 2022).

After standardizing all continuous variables, the “rpart” R package was used to model the decision tree. The minimum sample size for each node to split was $n = 15$, and branching was limited to five levels. The decision tree reveals the probability of a Malaysian youth completing the EE MOOC having the specific characteristics (first number below the nodes in Figure 2), as

well as the percentage of participants falling into each category (second number below the nodes in Figure 2). Notably, by following a path from the root node (the top) to a leaf node (the bottom), determine the group of participants whose probability of course completion is specified. In order to ascertain the factors that account for the completion of the EE MOOC in the decision tree, it is necessary to descend from the highest branch to the lowest branch, which corresponds to the characteristics of Malaysian youth included in each category.

Qualitative Content Analysis

The responses to the two survey questions were considered as a single unit of analysis for each participant and were examined using inductive content analysis (Elo & Kyngäs, 2008; Graneheim et al., 2017). As the initial step, the first and third authors thoroughly examined each textual input in order to comprehend the entirety of the content. The third author employed open coding to generate a comprehensive set of content-characteristic words, known as codes, in order to describe all facets of the content. These codes are organized in coding sheets where the code description and representative quotes were listed. The first author reviewed the coding sheets to validate the codes before applying the codes to a quarter of the data. The agreement rate between the first and third authors was determined by calculating the pooled Cohen's Kappa coefficient (De Vries et al., 2008). If $\alpha > .8$ is not achieved, a debriefing session will be conducted to determine areas of disagreement, and a revised version of the coding sheets will be produced. The third author will recode the data with this new version. The process was iterated three times until a consensus of $\alpha = .804$ was ultimately reached. The researchers viewed this reflective process as a necessary means to avoid pitfalls associated with an inductive approach, which is to prevent surface descriptions of the data and reduce preconceived biases (Graneheim et al., 2017).

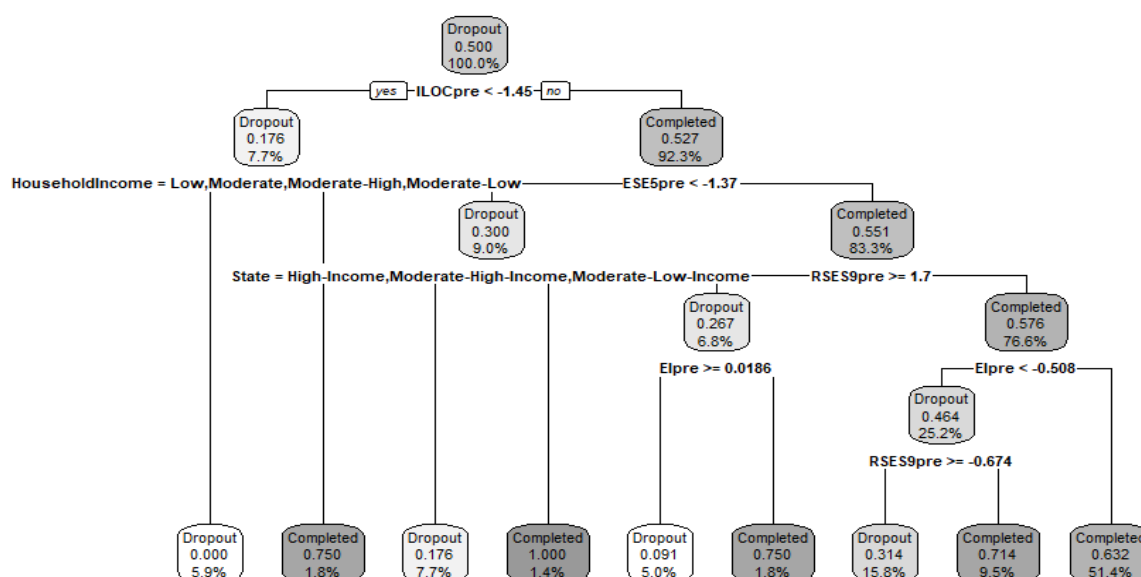
These codes were categorized into higher-order subcategories to initiate the abstraction phase; these subcategories were then the subject of group discussion until consensus was reached. Throughout the discussion, the subcategories were reviewed against the research question to maintain qualitative rigor. Subsequently, the researchers formulated general descriptions of the participants' motives for joining the EE MOOC from the codes and subcategories. Lastly, the main categories were developed and reviewed until consensus was achieved.

Results

Decision Tree

The resulting decision tree (Figure 2) has a total of 16 nodes among which nine are leaf nodes. Figure 2 indicates that six out of 13 variables are essential predictors in explaining EE MOOC completion rate, which are ILOC, ESE, RSES, EI, residing Malaysian state, and household income.

Figure 2
Decision Tree for Predicting EE MOOC Completion Rate in Malaysian Youth



Note. First number in each node box represents the probability of course completion in this branch, while the second number in each node box indicates the percentage of participants that end up in this branch. The color of the node boxes reflects the fitted value of the probability of course completion in each branch: darker hue of grey represents stronger probability of course completion while the least probability is accompanied by a lighter hue of grey.

The resulting decision tree revealed that internal LOC (ILOC) was the most strongly associated with course completion, where participants with extremely low ILOC values stood at 17.6% probability of completing the EE MOOC and 52.7% probability for those with higher ILOC. However, branching from ILOC, there were also various ranges of other indicators. Besides, there were several results worth noting from the decision tree. From the branch of low ILOC participants, a wealthy family background (>RM11,000/month) was needed to compensate for their deficit in ILOC to increase their probability to 75%. For participants in the medium-to-high ILOC group, the following influential predictors were ESE and RSES.

Interestingly, given the condition of being in the advantageous group of medium-to-high ILOC and high ESE (55.1%), a high RSES lowered the probability of course completion to 26.7%, which applied to other branches with RSES. Surprisingly, EI was not among the top predictors in the decision tree model. Other than household income, the resident Malaysian state also yielded an encouraging result that participants from low-income states harboring normal-to-high ILOC and low ESE have an extremely high chance (100%) of completing this course, albeit only 1.4% of our sample are in this category.

Model Performance

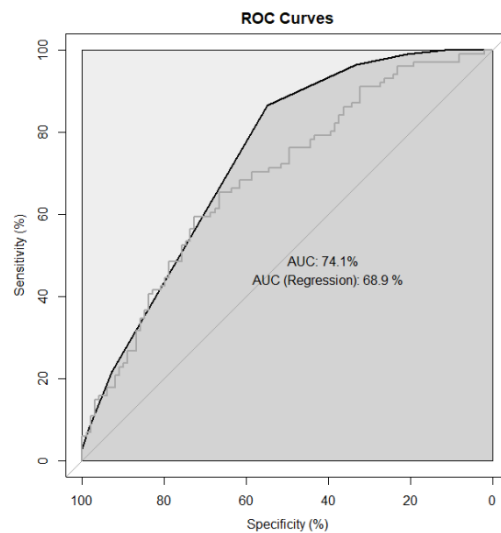
In order to examine the decision tree approach's performance in predicting course completion probabilities, it was compared to logistic regression. The regression provided no significant predictors, and only two variables showed a p-value below .10, which are

entrepreneurial status (OR_{Not-thinking vs Started-a-business} = .277 [.064, 1.191], $\chi^2 = 3.0$, $p = .084$) and ESE (OR = 1.675 [.925, 3.032], $\chi^2 = 2.9$, $p = .089$).

For both the decision tree and logistic regression models, ROC curves are presented and compared in Figure 2. The area under the decision tree ROC curve (74.134%) is significantly greater than the area under the logistic regression ROC curve (68.927%), $\chi^2[1] = 4.029$, $p = .045$. This result showed that the decision tree has significantly better predictive power than logistic regression.

Figure 3

Receiver Operating Characteristic Curves for the Decision Tree and the Logistic Regression Model in Predicting Entrepreneurial Education MOOC Completion



Note. The black line represents the ROC curve of the decision tree model while the ROC curve of the logistic regression model is shown with a grey line.

Qualitative Content Analysis

There were three final thematic categories that described Malaysian youths' motivation for enrolling in an EE MOOC. These categories underscore the similarities and distinctions between the CP and DP (Table 3). The excerpts were lightly edited for readability.

Table 3*Main Categories, General Descriptions, Sub-Categories, and Representative Quotes*

Main Category	General Descriptions	Sub-category	Representative Quote
Furthering Ambition	Formed / Forming Ambition	Meaningful	...currently studying business studies ... not depending 100% from it to guide me to be a great entrepreneur. I want to know others perspective and views, the fresh ideas...I want to create my dream to own my own company. To help more people in need...I'm attracted to open company either provide raw foods or frozen or I can just open my own Cafe and make it different...Besides that I got my own taste to decorate the restaurant... [Nordin]
		Developed business idea	
		Career prospects	I wish to upskill myself and gain insights into the corporate world. I also wish to improve my networking skills [Kai]
Seeking Answers	Unclear ambition	-	Fashion, music and arts ... would love to start business as I have passion in them but there are still so many uncertainties in starting a business thus I would like to learn more before I decide to become an entrepreneur [Layla]
Lower Drive	Ill-defined ambition	-	Just exploring for now. No idea yet. Something learning-based. [Kang]
			Learn something [Ying]
	Unmet needs	Desire social connection	... more connection with people , it's really good to emerge ourselves with people who has the same interest with us. [Jing Wei]
		Desire resource support	... pathway to venture out and gain practical knowledge such as grant application, collaborations and partnerships, government funding workshops, etc. [Krish]

Note. C = CP, D=DP

Furthering Ambition.

This category narrates how enrolling in this EE MOOC enabled our participants to further their pre-course ambitions that were in the process of being formed. For those who

wished to start a business, similar expressions of their goals recurred in both groups, such as “learn on how to start,” “how to manage,” and “maintain” a “successful business” through the online course. Both groups held similar motivations to start a business; CP expressed meaningful hopes to create a business that could “help people directly” and “solve a big problem in society,” while DP pursued ideas “for the betterment of society” or to “help underprivileged people.”

However, CP’s expressed ambitions differed from DP’s by having indicators of a developed business idea. These include the visualization of their business clientele, ideation of a backup business plan, and recognition of competitors in their targeted industry:

Jiyan: ... a unique cafe where I can serve food to people according to their health conditions, body weight, [their] diet plans and etc... can be a personal nutritionist at the same time! So I will be having a backup for the moment. Another plan which is plan B is opening a [24-hours] shop ... full of vending machine.

Besides being indicators of ideational development, these characteristics were often accompanied by other relatively detailed elaborations of the business plan, further solidifying their association with a fleshed-out ambition/idea. Jiyan’s excerpt continued with a delineation of the participant’s job scope along with the vending machines’ intended role within their Plan B:

Jiyan: ... some workers are being uncomfortable to work until late night. So this vending machines will take over their job...My job will only be filling the machines with goods, collecting money, refilling coins and cleaning or service the machines.

Other than entrepreneurial ambition, a portion of participants from both groups recognized the transferability of entrepreneurial skills and knowledge in the non-entrepreneurial career context. Although some generally expressed the desire to “gain new perspectives” and “knowledge” for “the future,” some participants explicitly mentioned that they “wish to upskill and gain insights into the corporate world” as some skills were deemed as “applicable to any field.”

More importantly, these developmental indicators situate their ambition ideation within an active process of evolution, from an ambition that is “forming” to one that is “formed.” As the action directly resulted from their ambitions; their participation in the EE MOOC is contextualised as an extension of this process.

Carlene: At the end of the program, I hope to be better equipped with knowledge on how businesses are created and developed, so that I could better assist with the Management if I work in Human Resources.

Seeking Answers.

However, not all successful participants apply to the motivational process based on a fleshed-out ambition. Many expressed ambiguous, unclear ambitions—seeking “insights,” “new knowledge,” or “awareness and education” for an undefined subject. Nevertheless, those with

unclear course learning goals compensated by seeking answers:

Hai Wen: These are somethings I would love to start business as I have passion in them but there are still so many uncertainties in starting a business thus I would like to learn more before I decide to become an entrepreneur.

In explicit acknowledgement of their uncertainty, CP sought “to get a clearer picture,” “have a better frame of guidance,” or understand the “thought process and decision making before attempting” —creating an alternative motivational conduit towards course completion.

Lower Drive. Similar to CP, ill-defined responses were manifestly present amongst DP as well, albeit with a larger presence. Facing the question of what their learning intentions were towards the course, one- or two-words answers were common: “Learn something,” “Satisfaction,” “Education,” “Community,” or “Knowledge.” This is reflected in the range of the excerpts’ wordcount (DP: 1-129; CP: 2-331). Even amongst more pointed answers, a high number were generic and unfocused:

Zhang: More skills and gained more experience; I'm still not sure about which industry I have interest on.

Chen: I am not thinking of starting a business; Entrepreneur knowledge, that I may use in future.

Compared to CP who sought answers to their uncertainty, however, DP had no such response, thus leaving the ambiguous status of their ambitions as is—with no resolution.

Another group of DP had clear but misguided course goals. Some saw the EE MOOC as a socializing opportunity – to “get more connection with people,” “network with other entrepreneurs,” or “engage with like-minded individuals.” Others requested resource-specific support, such as “seed funding” or “grant application” and “government funding” advice. Finally, participants who had already started a business sought support on their relatively more complicated issues, such as to “expand their business,” make their “business well-known,” or to “improve business analytics and social media presence.”

The format and curriculum of the EE MOOC left these expectations unfulfilled: In terms of the former, the only social feature on the platform interface of the course was a comment/chat section, which was underutilized. Meanwhile, the course content did not include or guarantee any material resource support, save for an opportunity to win seed funding for their business proposal. Finally, those who sought guidance on a more intermediate level perhaps found little value in the course content, which was catered towards beginners with a more introductory and theoretical level of entrepreneurship knowledge.

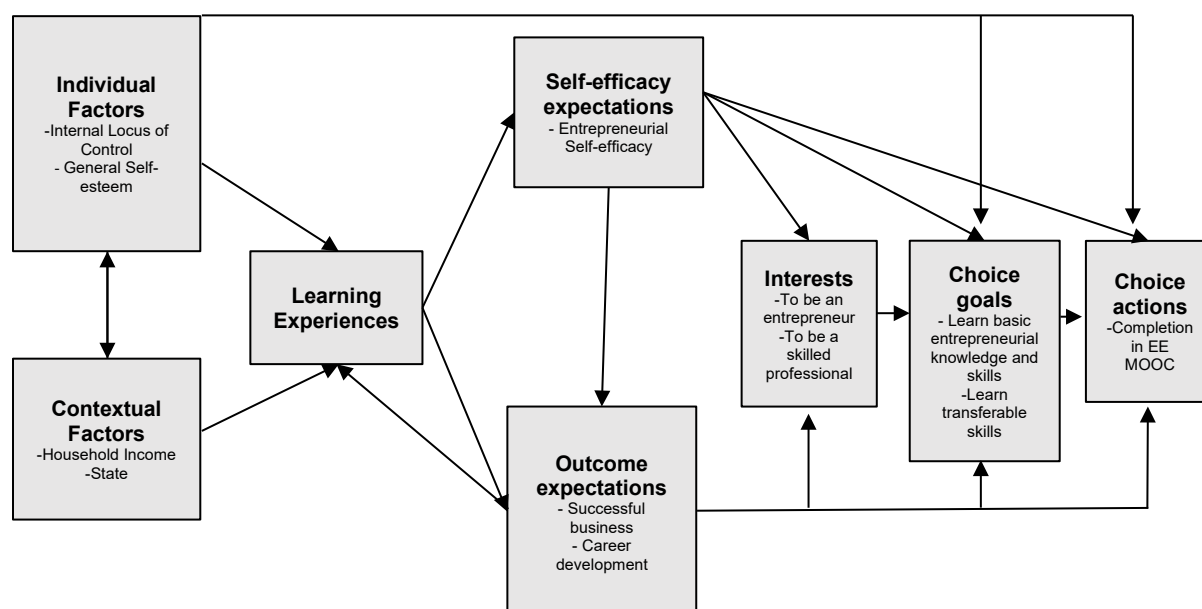
These unmet needs, combined with ill-defined ambitions, suggest an overall weaker character of motivation amongst DP to pursue course completion, thus culminating in their thematic essence: an environment of Lower Drive.

Re-Contextualization

In Figure 4, the results from the previous two sections are summarized in the context of this paper's theoretical framework.

Figure 4

Re-Contextualization of the Results in the Adapted SCCT Framework Illustrating the Journey Towards Completion in an EE MOOC



Discussion

This paper examined whether student retention in a voluntary EE MOOC could be explained by their sociodemographic characteristics and psychological variables using a decision tree model while contextualizing the results with the participants' reasons for enrolling in the course.

With the inputs from 222 Malaysian youths, the decision tree model successfully categorized the participants into distinguishable subgroups of participants with virtually zero probabilities of course completion to 100%. The importance of the individual factors in predicting completion status was dependent on the ILOC level before starting the EE MOOC. The decision tree model presented an optimistic view of the method, outperforming the logistic regression model regarding predictive power. A complex model with a large number of predictors will cause overfitting in regression-type analysis, and the solution is to either increase the sample size or revisit the predictor selection again (Babyak, 2004). However, the decision tree approach handles overfitting issues by setting branch-stopping rules (Song & Lu, 2015). Furthermore, essential factors that the regression may have overlooked were important predictors of the EE MOOC completion rate for certain subgroups of participants. However, the overlooked predictors in the regression model and the absolute probabilities (0 and 100%) of course

completion for the subgroups of participants could be due to the comparably low number of participants in contrast with previous studies using a decision tree approach (Batterham et al., 2009; Namazkhan et al., 2020; Reissova et al., 2020). To overcome this sample size limitation, we interpreted the decision tree model in the context of the participants' course enrollment motivations. The qualitative evidence not only triangulated the quantitative outcomes but also revealed alternative motivational pathways that the decision tree could not capture. This combination strengthens the credibility of the findings while highlighting the limitations of relying solely on statistical predictors.

This paper offers insight into the influences of personal agency and motivations on EE MOOC completion, which aligns with Rahmani et al.'s (2024) study that shows learner motivation has the largest impact on student retention. Particularly, the decision tree results highlighted ILOC to be the strongest predictor associated with EE MOOC completion, with medium-to-high ILOC participants being more likely to complete the course. Given that these individuals tend to perceive the outcomes of their lives to be determined by their own agentic actions and decisions (Suretha & Stanz, 2004), there is a likelihood that CP completed the course being motivated by a desire to improve their lives and knowledge at their own volition. It could be surmised that ILOC also encourages persistence in EE MOOC learning, in line with a study by Hart (2012), observing similar results in online learning in general. This notion is supplemented by our extracted themes from the textual data, which show that CP completed the EE MOOC to actively pursue their entrepreneurial goals, having reported more developed business ideas and a determination to find answers to their uncertainties, similar to the characteristics associated with successful learning (Liu & Chi, 2012). Inversely, DP have unclear entrepreneurship goals, suggesting lower motivations to study the subject and a lower likelihood of completing the EE MOOC. Thus, per SCCT assumptions (Lent et al., 2002), it could be inferred that when participants enter the EE MOOC with a strong goal in mind, it strengthens their personal conviction to complete the program as a stepping stone (i.e. choice action) towards "said" goal.

However, motivation to complete the EE MOOC may not necessarily be entrepreneurial-based. As shown in Figure 2, EI interestingly plays an unexpectedly smaller role in this present study. Despite EE generally having been observed to positively impact EI (Hoang et al., 2020; Nabi et al., 2017), the present study indicates that EI does not, in turn, necessarily translate into the likelihood of participants completing the EE MOOC and is possibly irrelevant to certain groups of participants. This finding is, unfortunately, incongruent with the EE MOOC developer's goal of promoting entrepreneurial activities. We have two possible explanations for this.

First, we postulate participants to have been motivated to complete the EE MOOC with more holistic goals—in effect, by considering entrepreneurship as a transferable skill set (e.g., communication, strategic thinking, and leadership) (Salceanu et al., 2021). This perspective is echoed by Jones (2010), who argues that EE is not solely about producing entrepreneurs but about equipping learners with lifelong skills that are valuable across occupations. Furthermore, our content analysis highlighted that several CPs planned to take the EE MOOC to advance their careers and learn business skills for that purpose. Additionally, participants with low-to-moderate self-confidence—indicated by their RSES—were found to have higher completion

rates, perhaps driven by their learning of transferable skills which has been recognized to increase self-confidence in learners (Winarsunu et al., 2023). This is supported by the notion that students with low prior skills and knowledge tend to derive greater benefits from education (Flores et al., 2012), providing larger motivational incentive to complete.

Secondly, strong EI might not be relevant to EE course completion. Participants with strong EI might find the course misaligned with their expectations, especially since digital platforms often lack the interaction and practice-based activities needed to sustain motivation (Chen et al., 2021). This helps explain why dropout participants were often characterized by unmet support needs, suggesting that both motivational gaps and course design features shape persistence. Moreover, EE exposure itself can prompt new reflections on entrepreneurship, which in some cases may dampen rather than strengthen EI and lead to dropout. Nabi et al.'s (2017) review highlights this heterogeneity, showing that students with prior exposure or already high intentions sometimes report weaker—or even negative—responses to EE. From an SCCT perspective, their experiences in the EE MOOC may have reshaped their outcome expectations and self-efficacy beliefs in ways that dampened their EI, reducing their motivation to persist. This nuance complicates the EE MOOC developer's goal of fostering entrepreneurial activity, as strong EI does not uniformly translate into course completion.

Similar to our SCCT model (Figure 1), this study also found interactions between sociodemographic background and individual attributes affect the participants' choice goal and actions (EE MOOC completion), leading to differing outcomes. In regard to household income, low-ILOC participants were unlikely to complete the EE MOOC unless they came from high-income families. The comparatively lower completion from their lower-income family counterparts indicates that the combination of low ILOC and socioeconomic status serve as a contextual barrier. In SCCT terms, contextual barriers may limit an individual's self-efficacy and outcome expectations (Flores et al., 2017), affecting their career goals and their desire to finish the EE MOOC. Indeed, as the qualitative content analysis on DP reported respondents desiring business-based guidance in addition to social and resource-based support, we hypothesize that low-income participants may be less motivated to complete the EE MOOC if it fails to meet their support-specific expectations.

Inversely, medium-to-high-ILOC participants residing in low-income states were overwhelmingly likely to complete the EE MOOC. This phenomenon may be driven by a desire to overcome a lack of business venture and knowledge-building opportunities in lower-income states, a similar situation faced by Chinese rural youth entrepreneurs, who find rural infrastructure, resources, and market access inferior to urban areas (Yuan et al., 2022). Thus, considering ILOC's role in overcoming contextual barriers is crucial to reconciling both sociodemographic factors' contradictory results. As per SCCT (Flores et al., 2017), low sociodemographic standing typically constrains an individual's self-efficacy and outcome expectations, but a strong ILOC may provide the “push” needed to motivate participants to overcome their sociodemographic barrier (Nungsari et al., 2021), allowing them to pursue greater opportunities expediently afforded by EE MOOCs.

This study acknowledges limitations in its scope and findings. Firstly, the study used data from a small voluntary sample size from a single EE MOOC, which allowed for important

observations but limited generalizability and introduced a risk of both the decision tree and regression models “overfitting” the data. Nonetheless, these early insights point to the value of entrepreneurial skills beyond strictly entrepreneurial contexts. While preliminary, these patterns highlight potentially fertile directions for future research with larger and more diverse samples, as well as across different educational settings. Additionally, the present study investigated the effects of background psychological and sociodemographic factors on course completion, but it did not consider participants’ relationship to the course’s pedagogy and content, which may have affected their retention. Course structure, teaching methods, and content quality are examples of factors well-known to influence retention (Jordan, 2015; Lee & Choi, 2011); by excluding these factors, we risk over-attributing dropout to individual traits rather than course-level features. Furthermore, the decision tree’s sole SCCT “interest” component was EI, and the overall results suggest that non-entrepreneurial motivations have a more significant impact on EE course completion. It is feasible to augment the accuracy rate of the model by incorporating additional non-EI “interest” variables in future studies. Finally, this study took place during COVID-19, when participants’ motivations and constraints were atypical. High dropout rate could partly reflect pandemic-related stressors or limited digital access (Mathrani et al., 2022), instead of enduring patterns of typical MOOC retention. Thus, future research could further clarify the effects of psychological and sociodemographic factors on EE MOOC completion, without the potential proximal influence of COVID-19.

Implications for Research

The discussion of this paper’s findings leads to two broad contributions to future research, which are the following: (a) the potential of using decision tree modelling to map out potential interactions in complex datasets to scrutinize in follow-up studies and (b) expands SCCT application in EE MOOCs’ completion rates.

While contemplating the usage of decision tree over regression, performing moderation analysis by incorporating interaction terms into the logistic regression equation can make it more similar to the decision tree model. However, determining which interaction to investigate poses challenges, especially in complex datasets with diversifying variables, necessitating a selection approach and reducing parsimony (Batterham et al., 2009). This decision tree approach identifies important interactions to be explored in a follow-up study, demonstrating its applicability in exploratory studies with data collected beyond research purposes. For example, student course registration data, client databases, and census data. Consequently, it provides the foundation for specific follow-up studies aimed at validating and expanding the results.

Additionally, the decision tree approach contributes to the discourse in SCCT literature with its novel application in EE MOOCs by mimicking the relationships between the components in the SCCT model to an extent (Lent & Brown, 2006). Firstly, the impact of psychological traits and sociodemographic factors on vocational-related educational pursuits is not uniform but context-dependent, as evidenced by the intricate conditions shown in Figure 2 that must be met prior to successful course completion. Furthermore, the potential for generalizing the findings beyond the Malaysian context is presented by the fact that SCCT endorses our findings. Secondly, our initial assumption that youth with EI would be a strong contributor to EE MOOC completion was flawed. This EE MOOC was designed to support youth’s EI and advance them towards their entrepreneurial goal. Nevertheless, the results

contradicted this notion, as the decision tree demonstrated the minor role of EI in facilitating course completion. In contrast, ILOC has the largest explanatory power in course completion. This highlights the role of personal agency that SCCT champions and offers avenues for nurturing certain traits in facilitating strong and clear goals. The textual data revealed an additional “interest” that emphasizes career development while sharing common choice goals and actions with those with EI “interest” (Figure 4) as they acknowledged the transferability of entrepreneurial skills.

Implications for Practice

Our study highlights three key considerations for the pedagogy and execution of EE MOOC. First, personal motivations—both entrepreneurial and non-entrepreneurial—influence EE MOOC retention, due to the versatility in the application of entrepreneurial skills. Depending on the course content creator’s intent, it would be practical for EE MOOC practitioners to consider framing their course content to be more holistic in its outcome. Teaching entrepreneurship as a transferable skill set that can be applied to business and other career scenarios (Salceanu et al., 2021), rather than merely the ability to start and run a company, may make the online EE course knowledge more appealing to a wider range of participant motivations, encouraging retention. In contrast, these findings also showed that EE MOOC alone is insufficient in promoting entrepreneurship and practitioners should consider designing a broader entrepreneurship program that incorporates other elements outside EE, as suggested in the sub-category “Unmet needs” from the content analysis (Chen et al., 2021). Second, ILOC—beliefs in personal agency and self-confidence—increases classroom participation, investigation, and active problem-solving (Hart, 2012). Thus, educational content that encourages participants to take ownership and responsibility for their future may strengthen their ILOC (Lowes & Lin, 2015), improve their self-regulation, and make them more proactive in course content (Liu & Chi, 2012). Lastly, contextual barriers affect the likelihood of participants completing the EE MOOC, highlighting the need for a strong entrepreneurial support network for youth from lower sociodemographic backgrounds, who often lack the opportunities, infrastructure, and resources to succeed in entrepreneurship (Yuan et al., 2022). Online EE practitioners may seek to strengthen their impact on lower sociodemographic communities by incorporating informal collaborative support networks, which include mentorship and collaborations between entrepreneurs, that serve as substantial alternatives to the “institutional voids” that characterize the entrepreneurial environment of developing nations (Guerrero et al., 2021).

Conclusion

Intending to assess EI’s role in student retention in a voluntary EE MOOC, the present study utilized survey data from 222 youths. Upon situating the decision tree outcomes within the framework of students’ course enrollment objectives, the results unexpectedly emphasize that EI alone does not suffice to motivate students to complete the course. Furthermore, the narrative derived from the textual data and the hierarchical significance of ILOC support the notion that, in addition to imparting educational content, the course design should actively consider students’ mindsets and motivations. Besides, youth’s internal traits intersect with their socioeconomic context to form differing reactions towards the EE MOOC’s contents. The study contributes to the current literature in terms of (1) methodological discussion of using decision tree modelling, (2) expanding the discussion of vocational-related educational pursuits as context-dependent, and

(3) highlighting the possible motivators for completing EE to be beyond the pursuit of an entrepreneurial career path, and entrepreneurial skills being transferable in workplace settings.

Declarations

Ethics Statement

This study was approved by their institution's review board (ASB-IRB-2021-2). All procedures involving human participants complied with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all participants.

Conflicts of Interest Statement

The authors declare no conflicts of interest related to the research, authorship, or publication of this article. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Funding

This work was supported by Citi Foundation [Grant ID: G-IDS-20207103].

References

- Aguinis, H., Gottfredson, R. K., & Joo, H. (2013). Best-practice recommendations for defining, identifying, and handling outliers. *Organizational Research Methods, 16*(2), 270–301. <https://doi.org/10.1177/1094428112470848>
- Babyak, M. A. (2004). What you see may not be what you get: A brief, nontechnical introduction to overfitting in regression-type models. *Psychosomatic Medicine, 66*(3), 411–421. <https://doi.org/10.1097/01.psy.0000127692.23278.a9>
- Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*(1), 74–94. <https://doi.org/10.1007/BF02723327>
- Barbosa, S. D., Gerhardt, M. W., & Kickul, J. R. (2007). The role of cognitive style and risk preference on entrepreneurial self-efficacy and entrepreneurial intentions. *Journal of Leadership & Organizational Studies, 13*(4), 86–104. <https://doi.org/10.1177/10717919070130041001>
- Batterham, P. J., Christensen, H., & Mackinnon, A. J. (2009). Modifiable risk factors predicting major depressive disorder at four year follow-up: A decision tree approach. *BMC Psychiatry, 9*, 75. <https://doi.org/10.1186/1471-244X-9-75>
- Buchanan, E. M., & Scofield, J. E. (2018). Methods to detect low quality data and its implication for psychological research. *Behavior Research Methods, 50*(6), 2586–2596. <https://doi.org/10.3758/s13428-018-1035-6>
- Cardon, M. S., & Kirk, C. P. (2015). Entrepreneurial passion as mediator of the self-efficacy to persistence relationship. *Entrepreneurship Theory and Practice, 39*(5), 1027–1050. <https://doi.org/10.1111/etap.12089>
- Chen, C. C., Greene, P. G., & Crick, A. (1998). Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? *Journal of Business Venturing, 13*(4), 295–316. [https://doi.org/10.1016/S0883-9026\(97\)00029-3](https://doi.org/10.1016/S0883-9026(97)00029-3)
- Chen, L., Ifenthaler, D., & Yau, J. Y.-K. (2021). Online and blended entrepreneurship education: A systematic review of applied educational technologies. *Entrepreneurship Education, 4*, 191–232.
- Coursera. (2024). *Coursera Reports Fourth Quarter and Full Year 2023 Financial Results*. Coursera. <https://investor.coursera.com/news/news-details/2024/Coursera-Reports-Fourth-Quarter-and-Full-Year-2023-Financial-Results/default.aspx>
- Creswell, J. W. (2013). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Pearson Education.

- Curran, P. G. (2016). Methods for the detection of carelessly invalid responses in survey data. *Journal of Experimental Social Psychology*, 66, 4–19. <https://doi.org/10.1016/j.jesp.2015.07.006>
- De Vries, H., Elliott, M. N., Kanouse, D. E., & Teleki, S. S. (2008). Using pooled kappa to summarize interrater agreement across many items. *Field Methods*, 20(3), 272–282. <https://doi.org/10.1177/1525822X08317166>
- Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107–115. <https://doi.org/10.1111/j.1365-2648.2007.04569.x>
- Emanuel, E. J. (2013). MOOCs taken by educated few. *Nature*, 503(7476), 342–342. <https://doi.org/10.1038/503342a>
- Flores, L. Y., Navarro, R. L., & Ali, S. R. (2017). The state of scct research in relation to social class: Future directions. *Journal of Career Assessment*, 25(1), 6–23. <https://doi.org/10.1177/1069072716658649>
- Flores, R., Ari, F., Inan, F. A., & Arslan-Ari, I. (2012). The impact of adapting content for students with individual differences. *Journal of Educational Technology & Society*, 15(3), 251–261.
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 18(1), 39–50. <https://doi.org/10.1177/002224378101800104>
- Fouad, N. A., & Santana, M. C. (2017). SCCT and underrepresented populations in STEM fields: Moving the needle. *Journal of Career Assessment*, 25(1), 24–39. <https://doi.org/10.1177/1069072716658324>
- Garratt-Reed, D., Roberts, L. D., & Heritage, B. (2016). Grades, student satisfaction and retention in online and face-to-face introductory psychology units: A test of equivalency theory. *Frontiers in Psychology*, 7, 673. <https://doi.org/10.3389/fpsyg.2016.00673>
- Graneheim, U. H., Lindgren, B.-M., & Lundman, B. (2017). Methodological challenges in qualitative content analysis: A discussion paper. *Nurse Education Today*, 56, 29–34. <https://doi.org/10.1016/j.nedt.2017.06.002>
- Guerrero, M., Liñán, F., & Cáceres-Carrasco, F. R. (2021). The influence of ecosystems on the entrepreneurship process: A comparison across developed and developing economies. *Small Business Economics*, 57(4), 1733–1759. <https://doi.org/10.1007/s11187-020-00392-2>
- Hart, C. (2012). Factors associated with student persistence in an online program of study: A review of the literature. *Journal of Interactive Online Learning*, 11(1), 19–42.
- Hoang, G., Le, T. T. T., Tran, A. K. T., & Du, T. (2020). Entrepreneurship education and entrepreneurial intentions of university students in Vietnam: The mediating roles of self-

- efficacy and learning orientation. *Education + Training*, 63(1), 115–133.
<https://doi.org/10.1108/ET-05-2020-0142>
- Holder, B. (2007). An investigation of hope, academics, environment, and motivation as predictors of persistence in higher education online programs. *The Internet and Higher Education*, 10(4), 245–260. <https://doi.org/10.1016/j.iheduc.2007.08.002>
- Jones, C. (2010). Entrepreneurship education: Revisiting our role and its purpose. *Journal of Small Business and Enterprise Development*, 17(4), 500–513.
<https://doi.org/10.1108/14626001011088697>
- Jordan, K. (2015). Massive open online course completion rates revisited: Assessment, length and attrition. *The International Review of Research in Open and Distributed Learning*, 16(3), 341–358. <https://doi.org/10.19173/irrodl.v16i3.2112>
- Kim, H.-Y. (2013). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics*, 38(1), 52–54.
<https://doi.org/10.5395/rde.2013.38.1.52>
- Kizilcec, R. F., Davis, G. M., & Cohen, G. L. (2017). Towards equal opportunities in moocs: Affirmation reduces gender & social-class achievement gaps in China. *Proceedings of the Fourth (2017) ACM Conference on Learning @ Scale*, 121–130.
<https://doi.org/10.1145/3051457.3051460>
- Kovaleva, A. (2012). *The IE-4: Construction and validation of a short scale for the assessment of locus of control* (Vol. 9). GESIS - Leibniz-Institut für Sozialwissenschaften.
<https://doi.org/10.21241/ssoar.37119>
- Krueger, N. F., Reilly, M. D., & Carsrud, A. L. (2000). Competing models of entrepreneurial intentions. *Journal of Business Venturing*, 15(5), 411–432.
[https://doi.org/10.1016/S0883-9026\(98\)00033-0](https://doi.org/10.1016/S0883-9026(98)00033-0)
- Lee, Y., & Choi, J. (2011). A review of online course dropout research: Implications for practice and future research. *Educational Technology Research and Development*, 59(5), 593–618. <https://doi.org/10.1007/s11423-010-9177-y>
- Lent, R. W., & Brown, S. D. (2006). Integrating person and situation perspectives on work satisfaction: A social-cognitive view. *Journal of Vocational Behavior*, 69(2), 236–247.
<https://doi.org/10.1016/j.jvb.2006.02.006>
- Lent, R. W., & Brown, S. D. (2019). Social cognitive career theory at 25: Empirical status of the interest, choice, and performance models. *Journal of Vocational Behavior*, 115, 103316.
<https://doi.org/10.1016/j.jvb.2019.06.004>
- Lent, R. W., Brown, S. T., & Hackett, G. (2002). Social cognitive career theory. In *Career Choice and Development 4*, pp. 255–311. Jossey-Bass.

- Levenson, H. (1981). Differentiating among internality, powerful others, and chance. In H. M. Lefcourt (Ed.), *Research with the Locus of Control construct* (pp. 1–15). Academic Press.
- Liguori, E., & Winkler, C. (2020). From offline to online: Challenges and opportunities for entrepreneurship education following the COVID-19 pandemic. *Entrepreneurship Education and Pedagogy*, 3(4), 346–351. <https://doi.org/10.1177/2515127420916738>
- Liñán, F., & Chen, Y. (2009). Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. *Entrepreneurship Theory and Practice*, 33(3), 593–617. <https://doi.org/10.1111/j.1540-6520.2009.00318.x>
- Liu, M.-C., & Chi, M.-H. (2012). Investigating learner affective performance in web-based learning by using entrepreneurship as a metaphor. *Journal of Educational Technology & Society*, 15(3), 202–213.
- Liu, X., Lin, C., Zhao, G., & Zhao, D. (2019). Research on the effects of entrepreneurial education and entrepreneurial self-efficacy on college students' entrepreneurial intention. *Frontiers in Psychology*, 10, 869. <https://doi.org/10.3389/fpsyg.2019.00869>
- Lowes, S., & Lin, P. (2015). Learning to learn online: Using locus of control to help students become successful online learners. *Journal of Online Learning Research*, 1(1), 17–48.
- Mathrani, A., Sarvesh, T., & Umer, R. (2022). Digital divide framework: Online learning in developing countries during the COVID-19 lockdown. *Globalisation, Societies and Education*, 20(5), 625–640. <https://doi.org/10.1080/14767724.2021.1981253>
- Mescon, T., & van Rest, E. (2021, March 15). Entrepreneurship is an opportunity for education. AACSB. <https://www.aacsb.edu/insights/articles/2021/03/entrepreneurship-is-an-opportunity-for-education>
- Moore, J. C., & Fetzner, M. J. (2019). The road to retention: A closer look at institutions that achieve high course completion rates. *Online Learning*, 13(3). <https://doi.org/10.24059/olj.v13i3.1650>
- Nabi, G., Liñán, F., Fayolle, A., Krueger, N., & Walmsley, A. (2017). The impact of entrepreneurship education in higher education: A systematic review and research agenda. *Academy of Management Learning & Education*, 16(2), 277–299. <https://doi.org/10.5465/amle.2015.0026>
- Namazkhan, M., Albers, C., & Steg, L. (2020). A decision tree method for explaining household gas consumption: The role of building characteristics, socio-demographic variables, psychological factors and household behaviour. *Renewable and Sustainable Energy Reviews*, 119, 109542. <https://doi.org/10.1016/j.rser.2019.109542>
- Ng, C. (2019). Shifting the focus from motivated learners to motivating distributed environments: A review of 40 years of published motivation research in Distance Education. *Distance Education*, 40(4), 469–496. <https://doi.org/10.1080/01587919.2019.1681892>

- Nguyen, B. T. (2011). *Face-to-face, blended, and online instruction: Comparison of student performance and retention in higher education* [University of California, Davis]. <https://www.learntechlib.org/p/123046/>
- Nungsari, M., Chin, J. W., Ngu, K., Abdullah, M. F. S., & Flanders, S. (2023). Dreams vs reality: Urban and rural female youth aspirations. *Journal of Career Assessment*, 23(1), 79–100. <https://doi.org/10.1177/10690727231177911>
- Nungsari, M., Ngu, K., Chin, J. W., & Flanders, S. (2021). The formation of youth entrepreneurial intention in an emerging economy: The interaction between psychological traits and socioeconomic factors. *Journal of Entrepreneurship in Emerging Economies*, 15(2), 333–359. <https://doi.org/10.1108/JEEE-08-2021-0312>
- Rahmani, A. M., Groot, W., & Rahmani, H. (2024). Dropout in online higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, 21(1), 19. <https://doi.org/10.1186/s41239-024-00450-9>
- Ray, A., Bala, P. K., & Dasgupta, S. A. (2019). Role of authenticity and perceived benefits of online courses on technology based career choice in India: A modified technology adoption model based on career theory. *International Journal of Information Management*, 47, 140–151. <https://doi.org/10.1016/j.ijinfomgt.2019.01.015>
- Reissová, A., Šimsová, J., Sonntag, R., & Kučerová, K. (2020). The influence of personal characteristics on entrepreneurial intentions: International comparison. *Entrepreneurial Business and Economics Review*, 8(4), 29–46. <https://doi.org/10.15678/EBER.2020.080402>
- Reynolds, P. D. (2000). National panel study of U.S. business startups: Background and methodology. In *Advances in Entrepreneurship, Firm Emergence and Growth* (Vol. 4, pp. 153–227). Emerald (MCB UP). [https://doi.org/10.1016/S1074-7540\(00\)04006-X](https://doi.org/10.1016/S1074-7540(00)04006-X)
- Rideout, E. C., & Gray, D. O. (2013). Does entrepreneurship education really work? A review and methodological critique of the empirical literature on the effects of university-based entrepreneurship education. *Journal of Small Business Management*, 51(3), 329–351. <https://doi.org/10.1111/jsbm.12021>
- Rosenberg, M. (1989). *Society and the adolescent self-image* (Revised edition). Wesleyan University Press.
- Salceanu, C., Octavian, S. C., & Grigore, M. (2021). The impact of entrepreneurship education in developing soft skills for students from non-economic faculties. *Bulletin of the Transilvania University of Brasov Series V Economic Sciences*, 21(1), 153–162. <https://doi.org/10.61801/OUAESS.2021.1.20>
- Song, Y., & Lu, Y. (2015). Decision tree methods: Applications for classification and prediction. *Shanghai Archives of Psychiatry*, 27(2), 130–135. <https://doi.org/10.11919/j.issn.1002-0829.215044>

- Stephen, J. S., Rockinson-Szapkiw, A. J., & Dubay, C. (2020). Persistence model of non-traditional online learners: Self-efficacy, self-regulation, and self-direction. *American Journal of Distance Education*, 34(4), 306–321. <https://doi.org/10.1080/08923647.2020.1745619>
- Stritto, M. E. D., Aguiar, N., & Andrews, C. (2023). From online learner readiness to life-long learning skills: A validation of the learning skills journey tool. *Online Learning*, 27(4), Article 4. <https://doi.org/10.24059/olj.v27i4.3880>
- Suretha, E., & Stanz, K. (2004). Locus of control and online learning. *SA Journal of Industrial Psychology*, 30(1), 63–71. <https://doi.org/10.4102/sajip.v30i1.139>
- Toledo, I., Albornoz, C., & Schneider, K. (2020). Learning analytics to explore dropout in online entrepreneurship education. *Psychology*, 11, 266–284. <https://doi.org/10.4236/psych.2020.112017>
- Trevelyan, R. (2011). Self-efficacy and effort in new venture development. *Journal of Management & Organization*, 17(1), 2–16. <https://doi.org/10.5172/jmo.2011.17.1.2>
- Urbano, D., Aparicio, S., & Audretsch, D. (2019). Twenty-five years of research on institutions, entrepreneurship, and economic growth: What has been learned? *Small Business Economics*, 53(1), 21–49. <https://doi.org/10.1007/s11187-018-0038-0>
- Visser, L., Plomp, T., Amirault, R. J., & Kuiper, W. (2002). Motivating students at a distance: The case of an international audience. *Educational Technology Research and Development*, 50(2), 94–110. <https://doi.org/10.1007/BF02504998>
- Wilson, F., Kickul, J., & Marlino, D. (2007). Gender, entrepreneurial self-efficacy, and entrepreneurial career intentions: Implications for entrepreneurship education. *Entrepreneurship Theory and Practice*, 31(3), 387–406. <https://doi.org/10.1111/j.1540-6520.2007.00179.x>
- Winarsunu, T., Azizaha, B. S. I., Fasikha, S. S., & Anwar, Z. (2023). Life skills training: Can it increases self esteem and reduces student anxiety? *Heliyon*, 9(4), e15232. <https://doi.org/10.1016/j.heliyon.2023.e15232>
- Ying, G., Maguire, M. G., Glynn, R. J., & Rosner, B. (2022). Tutorial on biostatistics: Receiver-operating characteristic (roc) analysis for correlated eye data. *Ophthalmic Epidemiology*, 29(2), 117. <https://doi.org/10.1080/09286586.2021.1921226>
- Yuan, C.-H., Wang, D., Hong, L., Zou, Y., & Wen, J. (2022). Coming back home to start up a business? A comparison between youth from rural and urban backgrounds in China. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.962419>
- Zhang, W., Li, Y., Zeng, Q., Zhang, M., & Lu, X. (2022). Relationship between Entrepreneurship education and entrepreneurial intention Among college students: A meta-analysis. *International Journal of Environmental Research and Public Health*, 19(19), Article 19. <https://doi.org/10.3390/ijerph191912158>

Zhu, M., Sari, A. R., & Lee, M. M. (2020). A comprehensive systematic review of MOOC research: Research techniques, topics, and trends from 2009 to 2019. *Educational Technology Research and Development*, 68(4), 1685–1710.
<https://doi.org/10.1007/s11423-020-09798-x>

Epistemic Network Models of Students' Cognitive Engagement and Teachers' Feedback in Online Research Writing Courses

Alvin B. Barcelona
Philippine Normal University

Abstract

Understanding cultural systems in online learning with voluminous data, such as the engagement of students and teachers, has proven to be challenging. This predicament catalyzed the need for an emerging methodology to assess learning and complex thinking in online environments using statistical tools to analyze qualitative data. Quantitative Ethnography (QE) blends qualitative and quantitative approaches and uses statistical tools in analyzing qualitative data. This study advanced Epistemic Network Analysis (ENA), a QE tool, to analyze the engagement of teachers and students in online research courses of six groups of students. Observation of synchronous classes and asynchronous activities was carried out, 4,137 utterances were coded, and network models of engagements were generated. The findings show that the ENA engagement models among teachers and students in synchronous and asynchronous sessions differed significantly, with the teachers giving more frequent and varied feedback during synchronous classes. The network models of engagement in synchronous classes reveal the co-occurrence of students' cognitive engagement and teachers' feedback. When students try to connect with the lesson, they are given corrective feedback, and when they extend their understanding of the content, they are given affective feedback. On the other hand, when students are given prompts during asynchronous sessions, they try to connect. When they simply agree, they are given informative-procedural feedback, and when they emancipate their understanding, they receive affective feedback. This study illuminates the methodological advantages of ENA as an ethnographic tool that mixes qualitative and quantitative approaches in understanding cultural systems and processes in online education.

Keywords: Epistemic network analysis, cognitive engagement, teacher feedback, online research writing course

Barcelona, A. (2025). Epistemic network models of students' cognitive engagement and teachers' feedback in online research writing courses. *Online Learning* 30(1), pp. 323-349. <https://doi.org.10.24059/olj.v30i1.4793>

While the COVID-19 pandemic has had a catastrophic impact on the world, such as interrupted learning and learning loss in education, it has paved the way to breakthrough realizations, innovations, and opportunities. The forced closure of schools and the health emergency crisis have caused a shift and transformation in educational models and pedagogies, realizing that learners can also learn anywhere and anytime through online learning. The future of education after the pandemic is poised to continue online learning and using digital technologies because of its benefits, such as accessibility, flexibility, efficiency, and practicality (Bright & Vogler, 2024; Ravichandran & Kohli, 2022). Online learning will continue to flourish in the education sector. Even before the pandemic caused an unimaginable change, online learning is believed to be the next education leap forward (Meier, 2015). At present, while there are some schools and universities who reverted to traditional face-to-face learning, there are still some education institutions that are offering various courses using completely online, hybrid, and hyflex modalities.

Dhawan (2020) describes online learning as the learning experiences in synchronous or asynchronous environments using devices such as computers and mobile phones with internet access. The continuity of online learning modality calls for the need to persistently investigate factors and areas that affect its effectiveness. Two of the many challenges point to the low engagement of students (Mamun et al., 2016; Hu & Li, 2017; Hollister et al., 2022; Kristiana et al., 2023; Means & Neisler, 2023) and limited teachers' feedback practices (Hysaj & Haroon, 2022; Hilbert et al., 2023; Hodge & Chenelle, 2018). Some online learners are challenged to maintain their motivation, communication, and maintain student-teacher, student-student, and student-content engagement (Gilbert, 2015) and teachers mentioned that workload time constraints affect their feedback practices in online learning (Harnin et al., 2022). Contemporary online learning includes interactions between teachers and students to help them gain knowledge and grow personally and professionally in virtual classroom settings (Altowairiki, 2023).

Farrell and Brunton (2020) defined student engagement as students' emotional, behavioral, and cognitive connection to their studies, which has been shown to influence their learning achievement. Cognitive engagement (CE) is one of several dimensions of student engagement. It is defined as students' personal investment in learning activities, which includes a commitment to mastery learning, using study strategies, and self-regulation (Pietarinen et al., 2014). In online learning environments, it is operationalized as the combination of students' knowledge, thinking process, effort, and commitment to connect with the lesson and the class. Students can manifest this engagement by participating actively in the class, employing critical thinking and problem-solving skills, and utilizing teacher feedback during online classes.

The impact of teachers on the learning engagement of students is profound as they assume a pivotal role in fostering student engagement (Pedler et al., 2020) and designing a caring and stimulating educational environment (Conklin et al., 2024; Shernoff et al., 2016). Teachers are expected to create a strong sense of community so that students will always feel connected with their peers, instructors, and the content (Everett, 2015), particularly in online learning, where students need to be vigorously and dynamically involved compared to traditional classrooms. In online learning, teachers communicate, connect, and engage with students by providing feedback. Teacher feedback is believed to be the driving force that creates awareness among students about their performance. Shute (2008) defines feedback as communication

information given to students to correct their behaviors to improve their learning. Feedback can facilitate students' reflection on their achievements, strengths, and weaknesses and how they may correct and improve their performance. An effective feedback system can increase students' self-efficacy, positively impacting their learning engagement and achievement.

Teachers' feedback and students' cognitive engagement are two dynamic constructs in teaching and learning that researchers have studied extensively worldwide. Most studies, however, focus on face-to-face learning environments, and only a few have paid attention to online learning. This is explicable since online learning had been regarded as an alternative learning modality until the global health crisis changed the landscape of education. Investigating the connection between teacher feedback and students' cognitive engagement is pertinent during exploration and abrupt change. Providing online feedback to students differs from traditional feedback provided in classroom settings; non-verbal communication is absent in written online feedback (Leibold & Schwarz, 2015). Teachers' extent of control over students' engagement is quite slack because they do not share physical proximity (DeWitt, 2020).

Given the complexity and demands of studying the relationship between students' cognitive engagement and teacher feedback, the researcher utilized Epistemic Network Analysis (ENA), a novel quantitative ethnography tool that can quantify, visualize, and interpret network data. It uses techniques that identify and measure connections among elements in coded data and represents them in dynamic network models (Shaffer et al., 2017). This study employed ENA to construct models that associate patterns in any system, such as the interaction of teacher feedback and cognitive engagement in the context of online research courses.

This study aims to expand the existing but limited body of knowledge about the connection between teacher feedback and cognitive engagement among students in online research courses. This study aims to contribute to the emerging field of Quantitative Ethnography by using an innovative tool called Epistemic Network Analysis to develop models that can quantitatively summarize the engagement of teachers and students in an online learning environment. The primary question that was answered in this inquiry was: What epistemic network models represent the co-occurrence of teachers' feedback and cognitive engagement of students in online synchronous and asynchronous research courses?

Review of Literature

Teacher Feedback and Cognitive Engagement of Students

Feedback is imperative to the teaching and learning process as it can cultivate positive learning gains and experiences when used effectively and appropriately by teachers and students. It is a piece of communicative information given to students to correct their performance and behavior to improve their learning (Shute, as cited in Ocak & Karafil, 2020). Teacher feedback (TF) is multi-dimensional, serving varying purposes (Anthony et al., 2019), connected to the formal function of assessment (Eriksson et al., 2018), and can promote student-teacher relationships, student academic involvement, and self-regulation (Fonseca et al., 2015).

Along with teacher feedback, this study focused on cognitive engagement, described as students' investment in learning activities (Pilotti et al., 2017). In addition, it is a term used to describe students' beliefs about the importance of schooling, learning goals, and future aspirations. It can be seen through learners' strategies to deeply understand the material and manage learning processes such as planning and seeking information that require self-regulatory and metacognitive techniques. It may be manifested when students do extra work and perform beyond expectation. Thus, CE involves motivation, self-regulated learning, and learning strategies (Fredricks & McColskey, 2012).

Teachers' involvement in online learning frequently entails providing feedback that appeals to the students' affective domains, demonstrating empathy and an interest in understanding them. Arapakis et al. (2008) demonstrate how affective feedback in the classroom can encourage students to engage in processes such as connecting with teachers. When combined with cognitive feedback, affective feedback positively impacts student engagement. According to Lu and Law (2012), task engagement increases when teachers provide guidance on how to participate more effectively. However, anecdotes indicate that teachers provide more feedback during live online sessions than offline ones. Zhohar and Smith, as cited in Leibold and Schwarz (2015), found that students frequently complain about insufficient positive feedback in online courses. According to Pappas (2015), delayed feedback is a common challenge in asynchronous learning, and feedback should be returned within a week to help students address areas for improvement as soon as possible (Leibold and Schwarz, 2015). Furthermore, Borup (2021) discovered that text-based feedback is time-consuming, frequently resulting in delays and generic responses. Despite these issues, the effectiveness of electronic feedback is still under investigation (Ene & Upton, 2018).

In contrast, studies show that students engage more effectively during offline sessions in distance education. Garrison and Innes, as cited in Malik et al. (2017), discovered that students in asynchronous sessions actively sought out the content provided by teachers and engaged in meaningful learning tasks. According to Pappas (2015), asynchronous modalities benefit introverted students who are uncomfortable participating in live discussions by allowing them to share insights without fear of judgment. Engaging students in online learning presents unique challenges for educators, who must constantly seek ways to foster connection and keep students from feeling isolated (Sebastien, 2021).

Epistemic Network Analysis (ENA): A Quantitative Ethnography Tool

ENA is a set of techniques that identify and measure connections among coded data elements and represent them in dynamic network models (Shaffer et al., 2017). According to the proponents of the quantitative ethnographic tool from the Wisconsin Center for Education Research of the University of Wisconsin-Madison, ENA is a versatile method that can address quantitative and qualitative research questions concerning patterns of association of data hypothesized to be meaningful. This study hypothesizes teacher feedback and students' cognitive engagement to have a meaningful association.

To understand how ENA can help the researcher realize the objectives of this study, it is vital to understand the theoretical assumptions and bases of this methodology. ENA was initially developed to create cognitive networks, consisting of the association among knowledge, skills,

values, habits of mind, and other elements that illustrate the complex cognitive process (Shaffer et al., 2016). ENA is a conceivable analytical tool because it considers the connection among coded elements rather than their mere presence or absence in isolation. Most studies about teacher feedback and students' cognitive engagement in the past have treated these variables in isolation, like investigating the extent to which teacher feedback is practiced in classes and exploring the levels of students' cognitive engagement in a particular discipline.

ENA was utilized to measure thinking and skills among participants in epistemic games. Hatfield (2015) developed an epistemic frame in a journalism game where students assumed journalists' roles and interacted with students and mentors in this practicum activity. Teachers' Technological Pedagogical Content Knowledge (TPACK) was examined using ENA by comparing the salient elements of the knowledge network generated by different groups of teachers (Zhang et al., 2019). Another insightful application of ENA was found in the study of Fougat et al. (2018), who investigated students' written formative and summative assignments in Denmark. ENA was used to develop pedagogical visualizations of discursive networks in the written assignment of students. The findings show that ENA could differentiate students' cognitive connections when grouped according to their performance. High-performing students demonstrate better relationships than middle-performing students with a higher mean network. Similarly, middle-performing students formed better connections than low-performing students.

Methods

Research Design

Quantitative ethnography is the main research design of this inquiry. This research design was used in modelling the relationship and interaction of teacher feedback and students' cognitive engagement in online learning because it is eminently suited to describing and exploring phenomena in digital, virtual, online, and networked environments. Ethnography is a flexible and responsive methodology sensitive to emergent phenomena and research questions (Howard & Mawyer, 2015). Observation of synchronous and asynchronous classes and interviews of selected participants were conducted almost in the same phase.

ENA is a quantitative ethnography tool that uses statistics to analyze networks of cognitive interaction. While data collection started by coding textual and verbal data—considered qualitative—the primary method used was technically quantitative. It refers to the numerical translation, transformation, and conversion of qualitative data (Sandelowski et al., 2019). In quantizing the ethnographic data in this research, interviews and observations were coded for analysis. Thus, the network models of online learning engagement in this study were a product of mixed data, which affirmed the nature of quantitative ethnography.

Research Locale and Setting

The research locale of this study is one private senior high school in Quezon City, Philippines. While obtaining data from more than one locality may contribute to one study's generalizability or external validity, ENA is a robust tool that works well even with a small sample size from one setting. The sample determination of this study is research-based. A number of studies from the past years conducted ENA studies involving a small group from one setting (Andrist et al., 2019; Bressler et al., 2019; Cai et al., 2017). The research setting was

online because the research courses are facilitated using online learning platforms. Live or recorded online discussions in Google Meet or Zoom were observed for synchronous learning activities. The learning management system used by the teachers and students was the data collection setting for asynchronous learning activities.

Participants and Sampling

The researcher chose the senior high school because it is assumed that the interaction of teacher feedback and students' cognitive engagement was more evident compared to the lower levels. Also, three strands were included in this study, namely Science, Technology, Engineering and Mathematics (STEM), Accountancy, Business, and Management (ABM), and Humanities and Social Sciences (HUMSS). The total number of students involved in the observation of online classes is 266, while the total number of teachers requested to participate is three. Also, five students and three teachers were interviewed. The tables below summarize the demographic profile of the participants.

Table 1

Student- Respondents for the ENA Modeling

Strand and Section	Number of Students in Class	Total Strand Population	Percentage
ABM Group 1	47	92	34.58%
ABM Group 2	45		
HUMSS Group 1	46	87	32.71%
HUMSS Group 1	41		
STEM Group 1	42	87	32.71%
STEM Group 2	45		
Total:		266	100%

The six groups of students were enrolled in online research courses under the same teacher. This allows the comparison of the network models using Epistemic Network Analysis. Purposive sampling was the researcher's sampling technique for the qualitative data-gathering phase for every research question. According to Patton (2002, as cited in Palinkas et al., 2015), purposeful sampling is widely used in qualitative research to identify and select information-rich cases for the most effective use of limited resources. In this phase, the researcher considered homogeneity purposive sampling to describe a particular subgroup in-depth, reduce variation, simplify the analysis, and facilitate group interviewing. This is useful to augment the information provided by the statistical network model of teacher feedback and students' cognitive engagement in online learning. Moreover, network modelling using ENA is good enough when a model's number of units (number of respondents) exceeds the number of nodes (codes). Since

there are 11 nodes in this study, a network model of online learning engagement can be constructed when there are at least eleven units (respondents).

Data Gathering Procedure

The researchers sought the approval of the concerned school administrators of the intended locality to conduct the study. The letter of request was sent to the concerned school official, where the primary purpose of the study, demands of data gathering procedures, and the ethical issues and considerations related to the conduct of this research were articulated.

Also, informed consent among participants was solicited by the researcher at the onset of the data collection procedure. In this process, participants were informed about the study's objectives and their expected participation. In this agreement, it was discussed that only the researcher was allowed to observe online classes and access the accounts of the participating teachers in the school's Learning Management System. The faces of the participants and any form of their identification were held private and strictly confidential by the researcher. After approval and informed consent were obtained, the researcher commenced gathering data. The actual procedure consisted of two phases.

The data gathering procedure took place during the Academic Year 2022-2023, from March to June 2023. Data collection occurred in intervals based on the class schedule and the availability of the discourses to be observed and analyzed. In the first phase, the researcher focused on analyzing teachers' and students' discourses during synchronous classes to explore how teacher feedback and students' cognitive engagement co-occur in online discussions. A total of 36 classes were observed: 21 classes were observed live, while the remaining classes were reviewed through videotaped sessions provided by the teacher-participants. Classes were observed from Monday to Thursday, and teachers and students were interviewed on Fridays.

The second phase focused on analyzing the discourses of teachers and students during asynchronous activities, which were observed and collected simultaneously by the researcher. The researcher accessed the discourses through the Learning Management System (LMS) used by the concerned school. A total of 36 sessions or activities were observed and coded. Although the researcher observed 72 sessions in total, only the parts of the lessons where meaningful engagement between teachers and students was observed were transcribed and coded. Not all sessions contained significant engagement among the participants. Some participants with meaningful engagements during asynchronous sessions were interviewed according to their preferred schedule.

Data Analysis

This study used Epistemic Network Analysis to analyze ethnographic data in online research classes. Using visual graphs and statistics, ENA was used to describe and understand the structure of engagement among teachers and students. Before running ENA, a crucial step is to prepare the qualitative data and carefully transform and quantitize raw utterances. A coding scheme was observed in preparing the dataset.

Discourse Analysis and Coding Scheme

Discourse analysis focuses on how language is used between people in written and spoken contexts. It looks at a running conversation involving a speaker and listener. In this particular study, discourse analysis focusing on the interaction of teacher feedback and students' cognitive engagement was investigated in both synchronous and asynchronous learning activities.

Since ENA was used to model the structure of the relationship between the two variables, one preliminary process is transcribing and coding unit of discourse based on the empirically based types of Teacher Feedback (TF) by Savvidou (2018) and Cognitive Engagement (CE) levels by Casimiro (2016). In qualitative research, transcription provides researchers with texts that are precise; these enable researchers to read, analyze, and interpret data. (Tiwari et al., 2018). Coding is labelling and organizing qualitative data to identify themes and their relationships (Medelyan, 2020).

The researcher transcribed spoken and written data from both synchronous and asynchronous learning events. Each unit of discourse was coded using predetermined categories of teacher feedback and students' cognitive engagement, which were applied in the ENA modelling. Since modelling may be influenced by bias, selectivity, and personal judgment, the coders relied on clear indicators and descriptors to guide the coding process and ensure consistency. The following tables summarize the coding schemes for both teacher feedback (TF) and cognitive engagement (CE) based on the literature review.

Table 2

Teacher Feedback Discourse Codes and Descriptions (Savvidou, 2017)

Discourse Codes	Descriptions	Sample Utterances
Affective	a. Salutations, Phatic Expressions	<i>It is nice to see all of you again virtually. I am excited to discover what is in store for us in 2021.</i>
	b. Vocatives	<i>Thank you for your submission, Tracy.</i>
	c. Complimenting and expressing appreciation	<i>Your manuscript exceeded my expectations. All your hard work paid off!</i>
	d. Empathetic	<i>I understand you faced a personal problem last week, but you must submit your project tomorrow.</i>
	e. Supportive	<i>Just let me know if you have further questions.</i>

	f. Self-disclosure	<i>When I was doing my thesis five years ago, I had a terrible experience.</i>
2. Corrective	Positive or negative evaluation of Students' response	<i>Your explanation is substantial and logical.</i>
3. Informative Content	Comments on the content of the course	<i>Reliability has something to do with measurement errors.</i>
4. Informative Procedural	Directs students to do a specific procedure related to the task	<i>You should revise your study's conceptual framework and explain how your study's variables are associated with each other.</i>
5. Reflective	Encourages reflection among students on how their understanding of the lesson is related to their personal experiences and exercise metacognitive thinking	<i>How can you possibly strengthen the rigor of your research methodology?</i>

In Table 2, teacher feedback codes and descriptions are presented. Savvidou (2017) developed a hierarchy of codes on how teachers engage with students. Affective feedback involves salutations, phatic expressions, vocatives, compliments, and empathetic, supportive, and self-disclosure examples. This feedback is what teachers give in different aspects of the class that have varied purposes, such as showing students support. Corrective feedback is also widespread when teachers evaluate the correctness of students' responses. Also, teachers usually provide students not only with affective and corrective feedback but with informative feedback, such as informative content and informative procedures. Lastly, teachers provide reflective feedback that encourages reflection among students and how their understanding of the lesson is related to their personal experiences. Table 3 below summarizes the levels of cognitive engagement among students.

Table 3

Levels of Cognitive Engagement, Codes, and Descriptions (Casimiro, 2016)

Discourse Codes	Descriptions	Sample Utterances
1. Non- Response	Zero or Minimal Engagement	<i>No response or unrelated response</i>
2. Simply Agreeing	a. Mere agreement and acknowledgment with the teacher's feedback	<i>This is noted, and I will follow your advice.</i>

	b. Desire to connect with the teacher or with others for their presence to be felt in class	<i>We already submitted our work.</i>
3. Connecting	Attempt to respond but based on the answer purely on personal opinion or experience and may lack scholarship.	<i>I included this part because I thought this would work since my classmate used the same argument.</i>
4. Extending	Responds to questions based on scholarly evidence and show interest by asking further questions or clarifications along the same line of argument	<i>I included this part because this will explain the reason for such a relationship. Do I need to improve this further?</i>
5. Expanding	Responds to questions but add new ideas to the discussion, apply new concepts to a new situation, or consider relevant implications	<i>I included this part because this will explain the reason for such a relationship. Moreover, I also did triangulation to verify the initial results. I will apply the same to the succeeding questions for consistency and clarity.</i>
6. Emancipating	Evidence of mastery of the content and skills by applying critical thinking and making personal convictions; opens to intellectual conflict without fear of being judged	<i>I included this part because this will explain the reason for such a relationship. Moreover, I also did triangulation to verify the initial results. I was able to compare what I did to the works of others, and I can say that this strengthens the findings of my study. I would love to hear what I can do further to improve my work.</i>

In Table 3, cognitive engagement codes among students were explained. Casimiro (2016) categorized nonresponse as minimal engagement from students. Simply agreeing manifests an engagement as a desire to connect but is weak. Connecting is a kind of engagement where students attempt to respond but base the answer purely on personal opinion or experience and may lack scholarship. The following three levels of engagement are believed to be superior to the first three. Extending happens when students respond to questions with scholarly evidence and a desire to learn more by asking further questions. Expanding takes place when students add more information, and emancipating shows students' evidence of mastery of the content and skills by making personal convictions without any signs of intellectual apprehension.

Since the codes are pre-defined concepts derived from existing theoretical and empirical studies, the coders employed a priori coding. According to Cai et al. (2019), a priori coding—also referred to as theoretical, deductive, or top-down coding—begins with a theory or set of constructs, and then searches for corresponding ideas within the data, rather than starting with the ideas found in the data itself. The tables presented serve as the codebooks used in the coding process. Three coders, including the researcher and two other practitioners, carried out the rigorous and critical task of coding. They held numerous virtual meetings to ensure a shared understanding of the codes. This step was essential, as the coders were expected to generate valid insights and apply the codes consistently. Additionally, Krippendorff's alpha (also known as κ -alpha) was calculated to verify that each relevant utterance in the discourse was coded accurately and consistently. The reliability coefficients ranged from 0.8028 to 0.9492.

Epistemic Network Analysis

ENA is an analytic tool with its own language and set of procedures exclusive to itself. Thus, understanding how ENA was used in modelling the co-occurrence of teacher feedback and students' cognitive engagement in online learning is helpful in understanding the mathematics behind ENA.

In the case of teacher-student interaction, the epistemic frame of teacher feedback (TF) is characterized by f_i , where i = appreciative, corrective, informative-content, informative-procedure, and reflective, and characterized cognitive engagement (CE) of students where j = non-response, simply agreeing, connecting, extending, expanding, and emancipating. For every time t , where $t = 1, 2, 3, \dots, n$, and any teacher or student a , there will be D^a_t that is a snapshot or segment of the interaction of the kind TF and CE made by teachers and students. Thus, the connection of the epistemic frame elements of f_i and f_j for teacher and student a at time t is given by the adjacency matrix below: $\mathbf{M} = 1$ if both f_i and f_j are both in D^a_t

Since online learning exposure in this study is viewed as synchronous and asynchronous, each online activity's epistemic network can be generated by summing each pair of frame elements. Thus, for the epistemic network of teacher feedback and students' cognitive engagement in synchronous activity, where $t = 1, n$, we will have the cumulative adjacency matrix F^a :

$$F^{a,t [1,n]} = \sum_1^n M^{a,n}$$

Moreover, other statistical measures need to be calculated to understand better the epistemic frames of teacher feedback models and students' cognitive engagement, such as the centrality or connectedness of the individual elements f_i and f_j . The relevance of centrality in ENA is that it describes how tightly bounded an epistemic frame element is to the other frame elements (Svarovsky, 2011). In this study, the weight of the connectedness of teacher feedback and cognitive engagement of students in the epistemic network, F is given by the sum of the square's centrality:

$$C(Fi) = \sqrt{\sum_j (F_{i,j})^2}$$

From this result, the relative centrality, R of a particular epistemic frame is calculated using the formula:

$$R(f_i) = \frac{C(f_i)}{C_{max}(F)} \times 100$$

Modelling Network Data Using ENA

ENA produces an adjacency matrix in modelling network data for every stanza-based interaction. The adjacency matrix is simply a way of summarizing the strengths of the relations between objects. For this study, the researcher is concerned about the co-occurrence of teacher feedback and cognitive engagement of students for teacher-student interaction and the co-occurrence of cognitive engagement among students. A code of 1 is written if both codes occur in one stanza, while zero if both codes do not appear in the same stanza. Moreover, the diagonal is blocked because a particular code cannot establish a co-occurrence of relationship to itself. Every unit in a stanza has one adjacency matrix. Below is an example of the said matrix. Table 4 further explains the adjacency matrix relevant to ENA modelling of engagement among teachers and students in online learning.

Table 4

Adjacency Matrix in ENA Modeling of Interaction of Teacher Feedback and Students' Cognitive Engagement Codes

Codes	Affective	Corrective	Informative-Content	Informative-Procedural	Reflective	No-Response	Simply Agreeing	Connecting	Extending	Expanding	Emancipating
Affective		0	0	0	0	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
Corrective	0		0	0	0	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
Informative-Content	0	0		0	0	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
Informative-Procedural	0	0	0		0	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
Reflective	0	0	0	0		0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
No-Response	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1		0 or 1	0 or 1	0 or 1	0 or 1	0 or 1
Simply Agreeing	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1		0 or 1	0 or 1	0 or 1	0 or 1
Connecting	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1		0 or 1	0 or 1	0 or 1
Extending	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1		0 or 1	0 or 1
Expanding	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1		0 or 1
Emancipating	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	0 or 1	

Table 4 displays the adjacency matrix in ENA modelling the interaction between the teacher feedback and students' cognitive engagement codes. To construct a network model from data in ENA format, ENA converts the code columns into an adjacency matrix for each stanza in the data and adds the adjacency matrices together into a *cumulative adjacency matrix* for the network.

The researcher initially consulted with the Epistemic Network Laboratory of the University of Wisconsin-Madison and sought their assistance on how to format data correctly, as the ENA web tool requires datasets to have a specific shape. The Excel template was prepared, and the units, conversations, stanzas, and codes were identified.

s

The unit of analysis is the participants, who are the teachers and senior high school students. Conversations are collections of lines within which ENA models connections between concepts. There were different conversations where the ENA models were constructed, namely the type of instructional distance delivery, courses, and strands of students. In modelling teacher feedback and students' cognitive engagement, the *moving stanza* method was used, which means that ENA modelled connections within the conversation by dividing it into multiple stanza windows. In this study, the researcher used two-moving stanzas for student-teacher engagement and four-moves for student-student engagement. In this particular method it only models connections between lines that are in close temporal proximity within a conversation. Moreover, the researcher used the entire conversation to model the interaction of cognitive engagement among students, provided that this engagement is facilitated by teacher feedback within a conversation.

ENA constructs dynamic network models among coded data and can be interpreted visually and through summary statistics. The network models showed the structure of connection among different nodes (codes) using the lines that connect them. Also, ENA models measure weighted density that can easily be depicted by looking at each line's thickness. The structure or pattern of connecting among nodes is an added value to ENA, which other network methodologies cannot describe. In the analytic space, network models can be compared, such as those conversations between two different strands and the types of online learning tasks.

Also, the centroid of each network can be used to compare different networks simultaneously. Centroids of networks close to each other may have similar patterns of connections among codes. ENA assigned a fixed position for each node, and the position of these nodes was used to interpret the projection space created by the X- and Y- axes. This is where the researcher made meaningful interpretations about each dimension.

Results

Epistemic Network Models of Teachers' Feedback and Students' Cognitive Engagement in Online Synchronous and Asynchronous Research Writing Tasks

Before presenting the generated ENA models of online learning engagement of teachers and students, the succeeding tables describe the total number of utterances and their codes

observed, transcribed, and categorized by the researcher across three courses. Table 1 describes the total number of observed utterances in asynchronous tasks.

Table 5

<i>Number of Utterances in Synchronous and Asynchronous Tasks</i>			
Course	Type of Online Learning Task		Total
	Synchronous	Asynchronous	
Qualitative Research	764 18.47%	624 15.08%	1388 33.55%
Quantitative Research	679 16.41%	643 15.54%	1322 31.95%
Culminating Research Project	736 17.79%	691 16.71%	1427 34.50%
Total:	2,179 52.67%	1,958 47.33%	4,137 100.00%

Table 5 shows 4,137 lines of utterances transcribed and coded from 72 sessions (3 classes x 4 sessions x 6 learning tasks). It can be gleaned from the data that 1,427 lines or 34.50% were observed in the Culminating Research Project course, 1,388 or 33.55% in the Quantitative Research course, and 1,322 or 31.95%, in the Qualitative Research course. In addition, 2,179 codes, or 52.67% were obtained from synchronous classes, while 1,958 codes or 47.33% were taken from asynchronous activities. Table 2 outlines the number of utterances among the participants.

Figure 1

Epistemic Network of Engagement in Synchronous and Asynchronous Research Writing Courses

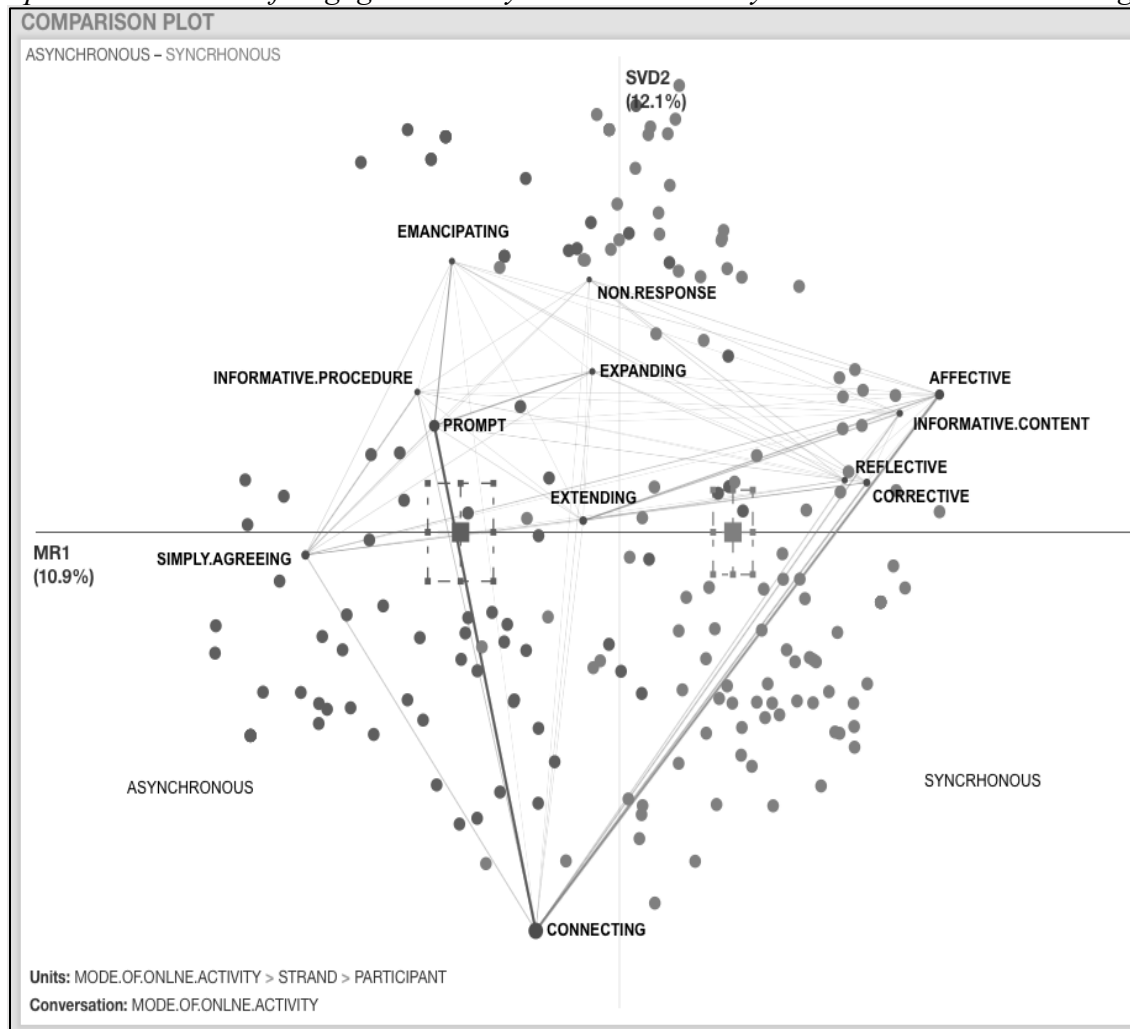


Figure 1 shows the ENA model of engagement of teachers and students in asynchronous and synchronous activities. The presented network model shows the projection space capturing the structure of engagement of teachers and students in both synchronous (lines on the right side of the y-axis) and asynchronous (lines on the left side of the y-axis) activities. The unconnected dots are units of the network: the students and teachers. The dots linked by the lines are called the *nodes*: the teacher feedback codes and students' cognitive engagement codes. These nodes have fixed positions in the projection space for all the datasets to allow meaningful group comparisons. The lines connecting two nodes describe their relationship; thicker lines mean stronger relationships. The squares are the centroids of each conversation, which is the center of the network diagram. Mathematically, the centroid's position depends on the network units' weighted connections.

The ENA model explains 10.9% variance along the x-axis and 12.1% variance along the y-axis of the structure of engagement between teachers and students. The goodness of fit of the network model also has a co-registration of $r = 0.79$ on the x-axis and $r = 0.78$ on the y-axis, which means that the model has a good fit. In addition, it is very apparent that the structures of connections between teachers and students in synchronous and asynchronous learning activities are different, with the network centroid of asynchronous classes positioned on the left side and the centroid of the synchronous classes fixed on the right side. The results of the t-test along the x-axis (MR1) confirm that the structure of connections of teacher-student engagement significantly differs between the two modes of online activities [$t(126.37) = 14.14$; p – value = 0.00)], with effect size, $d = 2.26$, which indicates a very large effect. However, no significant difference was detected along the y-axis (SV2) where [$t(161.84) = 14.14$; p – value = 1.00)].

Analyzing the projection space, ENA positioned most of the codes of engagement in synchronous sessions on the right side. Most teacher feedback nodes (affective, corrective, informative-content, and reflective) are situated in Quadrant 1 of the plane. This implies that teachers provided more feedback in synchronous sessions than in asynchronous sessions. Also, higher cognitive engagement nodes among students are positioned in Quadrant 2, meaning that students in synchronous sessions displayed higher cognitive engagement (extending, expanding, and emancipating) during live online sessions. On the other hand, ENA positioned the engagement of teachers and students on the left side of the projection space. It can be seen there that the most prominent engagement is prompt-connecting and prompt-emancipating. Teacher feedback is less evident in asynchronous sessions.

Epistemic Network Analysis also presents visual and statistical information to detect differences in the relationships of two codes. The succeeding table verifies the visual information presented in the generated ENA model.

Table 6

Weighted Connections Between Students' Cognitive Engagement and Teachers' Feedback in Online Learning

Pair of Nodes	Synchronous	Asynchronous	Difference	Where is the connection stronger?
Connecting-Corrective	0.21	0.10	0.11	Synchronous
Connecting-Informative Content	0.14	0.08	0.06	Synchronous
Extending-Affective	0.15	0.06	0.09	Synchronous
Extending-Informative Content	0.12	0.04	0.08	Synchronous
Prompt-Connecting	0.20	0.41	-0.21	Asynchronous

Simply Agreeing-Affective	0.14	0.19	-0.05	Asynchronous
Prompt-Emancipating	0.01	0.11	-0.10	Asynchronous
Simply Agreeing-Informative Procedural	0.03	0.10	-0.07	Asynchronous

The table above confirms the visual representation of the co-occurrence of students' cognitive engagement and teachers' feedback in online learning. Among the prominent interactions between the two codes are students' connecting and teachers' corrective feedback (0.11) for synchronous sessions and teachers' prompt and students' connecting (0.21) in asynchronous sessions.

The ENA visual model and summary statistics provide useful information in describing students' and teachers' engagement in online learning. The comparison plot shows a significant shift along the x-axis in the network connections in synchronous and asynchronous online activities. The individual and combined models (Figures 1-3) elucidate that students make cognitive connections in both modes of learning, but teacher feedback is more evident and varied during synchronous sessions. The first quadrant of the projection space (upper right) shows the concentration of the kinds of feedback teachers provided. The lines on the right side of the y-axis show that teachers give more affective, corrective, informative content, and reflective feedback for every cognitive engagement of the students. Also, it is interesting to note that students engage in synchronous sessions by connecting, extending, and, at times, not responding. The following are some examples of actual engagements of students and teachers in synchronous and asynchronous sessions:

Table 7

<i>Excerpt of Connecting- Affective Corrective Engagements in Synchronous Classes</i>			
Line	Participant	Utterance	Type of Engagement
1975	Student 5 - HUMSS	They are connected to each other. Maybe one variable is controlled by the other?	Connecting
1976	Teacher	Okay. Nice point. Yes, you are raising your hand, Student 6.	Affective
1977	Student 6- HUMSS	When one variable changes, the other variable changes too.	Connecting
1978	Teacher	Alright. Good answer. That is right. To understand the concept of correlation, let us relate it to real-life situations...	Affective- Corrective

In Table 7, the excerpt from the metadata illustrates incidences of connecting affective and corrective nodes between teachers and students, which transpired to be the most observed

engagement in synchronous classes. Summarized frequencies presented in Tables 9 and 10 reveal that connecting (43.48%), affective (25.60%), and corrective (19.80%) are prominent in isolation. When paired, connecting-corrective is the most prominent occurrence of engagement among teachers and students based on the visual model in Figures 1 and 2 and statistical information in Table 6.

The ENA model uncovers students' inclination to connect during synchronous sessions despite their physical distance from their teachers and classmates. Line 1975 shows that Student 5 from HUMSS attempted to connect by responding to the prompt about what it means when two variables are said to be correlated. This is followed by affective feedback from the teacher. The actual utterances are numbered. Line 1977 demonstrates Student 6 from HUMSS making similar connections with the teacher, providing affective-corrective feedback. The entire metadata and the ENA models highlight this engagement in synchronous classes. The interview data from students and teachers further explain this engagement. "One participant shared that they have a moderate level of engagement in synchronous classes. They tried their best to connect with their teachers by answering their questions and sharing their opinions when they asked for" (HUMSS Student 3).

Another student also revealed that they connect with their teachers the way they used to connect with them during face-to-face classes. Some students are very engaged in synchronous classes even if they are uncertain about the answers to teachers' questions. "Sometimes, I feel like synchronous class looks almost the same as face-to-face class because I can notice that we are doing our best to respond to our teachers even if we are unsure of our answers..." (Student 5, ABM).

When the interview participants were asked how teachers responded when they tried to connect with the lesson and their teachers, they said their teachers usually encouraged them to recite and participate by recognizing their answers and giving compliments. This made the students participate even more. One of the student participants shared, "Our teachers motivate us to recite. I noticed they always have something good to do, even if our answers are incorrect. We are more comfortable making connections because our teachers will appreciate our answers" (Student 2, STEM).

The teacher-participants also reveal interesting insights about the feedback they give during synchronous classes. They value students' engagement, even in the simplest form, because students' provocation to be passive is more likely in the online setup. They highlighted the value of giving affective and corrective feedback in synchronous classes. "Feedback that appeals to students' emotions is more impactful. Simple phrases and statements such as 'thank you for your participation' or 'nice answer' are very crucial in online learning" (Teacher 2).

Table 8

Excerpt of Prompt-Emancipating Engagements in Asynchronous Classes

Line	Participant	Utterance	Type of Engagement
908	Teacher	Analyze and describe how each text presents, organizes, and links ideas and how effectively each text uses language and follows mechanics (e.g., spelling, punctuation, and abbreviation.) Cite specific examples in your explanation.	Prompt
909	Student 12-STEM	I think that the text comes from a very personalized opinion about a website that the writer was very fond of, and struggles to clarify the bold understanding of what they were trying to get at but still provides ideas, like text 1, but just looks pretty surface level and could get somewhere but just struggled to put it together.	Emancipating
1070	Teacher	Analyze and describe how each text presents, organizes, and links ideas and how effectively each text uses language and follows mechanics (e.g., spelling, punctuation, and abbreviation.) Cite specific examples in your explanation.	Prompt
1071	Student 20-HUMSS	The author couldn't achieve ideas that are logically and accurately arranged. The text had no separate paragraph for the introduction, body, and conclusion, making it difficult to organize the author's thoughts.	Emancipating

According to the students, the asynchronicity of learning activities gives them time to reflect on the lessons and make substantial engagements with their teachers. Some students perceived real-time communications in synchronous classes as quite threatening as they needed to give immediate responses, like face-to-face engagements. The more flexible opportunity to engage oneself in asynchronous prompts allows some learners to develop higher levels of cognitive engagement. The interview data supports these arguments. One participant shared “I am not confident to respond abruptly when asked, so I am more comfortable engaging offline because I am given time to compose my answers” (Student 5). Another student supports this: “Because of the nature of offline tasks, I have more time to apply critical thinking skills and express my personal opinions without fear of being judged by my classmates in synchronous classes” (Student 7).

Students who may be introverted but are diligent and committed can reap benefits in asynchronous classes. Some students need more time to activate their cognitive processes. During offline activities, they were given significant time to compose their submissions, reflect

on improving their submissions, and engage more actively. Offline tasks were seen to be less threatening to students in general.

The teacher-participants admitted they fell short in giving feedback to students' submissions and inquiries offline. Participating teachers shared that they did their best to provide feedback to students' cognitive engagements through the school's learning management system and social media. However, they recognize the possibility of not providing prompt, specific, and encouraging feedback. These interview data are very evident in the presented ENA models, where the teachers seem to struggle to provide varied, informative, and reflective feedback that can empower students in asynchronous activities. This is explained by one of the teacher-participants.

We value the importance of providing feedback to students. We check students' work, but as much as we want to be generous in providing detailed, comprehensive, and reflective feedback, the amount of work we do offline, like checking students' submissions, is tremendous. (Teacher 2)

Discussion

The ENA model demonstrates that teachers' and students' engagements differ from synchronous and asynchronous sessions in an online research course. The same findings can be extracted from the study of Yuyun (2022) and Chafouk and Marjanei (2024), where higher engagements were found in synchronous sessions. It shows that when students try to connect with the content, teachers provide affective feedback mainly. Arapakis et al. (2008) underpin this connection between students and teachers inside the classroom, where affective feedback can motivate students to seek information, such as connecting with the teachers. However, while affective feedback positively affects students' engagement, feedback targeting cognitive dimensions is more valuable. Lu and Law (2012) argue that affective feedback fails to increase task engagement because it usually contains little task-related information.

The Epistemic Network Analysis reveals insightful patterns of teachers giving more consistent and varied feedback in synchronous sessions than in asynchronous sessions. Looking closely at the observed engagement in asynchronous sessions, the ENA models illuminate nodes that occur in temporal sequence. The models show that prompt-connecting, simply agreeing-affective, and prompt-emancipating are dominant nodes. The occurrences of teachers' prompts in asynchronous classes are expected since students' learning activities to reinforce lessons learned in synchronous classes are given offline. The thick lines on the left side of y-axis in the model reveal that the co-occurrence of teachers' prompts and students' connecting appears numerous times. However, it is interesting that the teacher's feedback on students' cognitive connections in asynchronous sessions is not as evident as in the synchronous sessions. This affects teachers' presence in asynchronous sessions, where teachers are expected to provide stylistic and substantive feedback to students (Watson et al., 2023).

The ethnographic data collected and analyzed in the present study reveal analogous results with the existing literature. The multi-case evaluation study about asynchronous courses of Garrison and Innes, as cited in Malik et al. (2017) showed that student participants in

asynchronous sessions sought the content uploaded by their teachers and tried to engage themselves in meaningful learning tasks. Also, Pappas (2015) elucidated that some introverted participants may feel uncomfortable engaging in live online discussions dominated by some assertive peers. The modality of asynchronous classes helps learners eliminate social anxiety and make meaningful engagements, such as *emancipating*. These parallel findings fortify students' opportunities as they make higher cognitive engagement in offline tasks.

Previous studies also underpin the observed teachers' disinclination in providing feedback in asynchronous classes in the past years. Zhohar and Smith, as cited in Leibold and Schwarz (2015), stressed that students complain that teachers do not provide enough positive feedback in online courses. Pappas (2015) underscored that instant feedback is one of the disadvantages of asynchronous learning. Also, Borup (2021) revealed that providing feedback via text is time-consuming, which causes feedback delays and forces teachers to give generic feedback. Feedback should not be delayed; assignment feedback is best returned to learners in less than one week so that students can be informed about the learning areas that need improvement before the next course assignment (Leibold & Schwarz, 2015). Comparing asynchronous and synchronous engagements of teachers and students is particularly important for providing insights toward the design of learning environments, like in the context of online research courses (Riel et al., 2022).

Limitations

Understanding the study's limitations can help the readers interpret the findings with appropriate caution. First, the captured engagement of teachers and students occurred in online research courses for senior high school students that used a teleconferencing platform for synchronous sessions and a learning management system for asynchronous sessions. The features of the teleconferencing platforms (e.g., chat functions and screen sharing) might have facilitated certain types of engagement while hindering others. Second, the courses focused on research writing that might explain the engagement between teachers and students. Third, while using ENA maximizes the rigor of both quantitative and qualitative methods, selecting predetermined codes of teachers' feedback and students' cognitive engagement might have limited the captured spectrum of engagement. There is no need for a larger sample size, as ENA studies work well with a small sample size. Future researchers may attempt to understand better the subcomponents of the significant predictors of students' cognitive engagement in online learning so that schools may further enhance students' self-regulated behaviors, train teachers to improve their virtual presence, and improve their engagement in online learning.

Conclusions and Implications

In synchronous sessions, the epistemic frame of students' engagements provides anecdotes of students trying to connect and extend their ideas related to the course with their teachers. The ENA models have proven that the participating teachers provided varied feedbacking styles and content ranging from affective, corrective, and informative content. While reflective feedback is essentially less evident, it shows that online teachers are responsive to the cognitive engagements given by students during live sessions. Thus, the epistemic frame among students and teachers shows that students attempt to respond and connect that may or may not lack scholarship (connecting), with evidence of interest in asking further questions along the same line of argument (extending) and teachers providing combined affective and cognitive-

related feedback. The epistemic frame suggests that direct and real-time engagements offer teachers more opportunities to give their students meaningful feedback that can increase their overall connection to the course, genuine engagement, and academic achievement.

In asynchronous sessions, the epistemic frame reveals an interesting structure of students' cognitive engagement ranging from simply agreement (low), connecting (moderate), and emancipating (high), with "connecting" being the most prevalent response to teachers' prompts. Looking more closely at the ENA models using an epistemic lens unveils that teachers' feedback is limited during asynchronous sessions, mostly constrained to affective and informative content. Thus, the epistemological frame of engagement in asynchronous sessions shows that students flexibly demonstrated varying cognitive responses, from mere agreement to mastery of the content and skills by applying critical thinking and making personal connections. At the same time, teachers' feedback is less evident and limited to affective and informative content.

As a whole, ENA was found to be useful in modelling the differences in the structure of engagement among teachers and students. Different network models were created, and visual plots and summary statistics proved useful in quantitizing, transforming, and analyzing qualitative data. ENA confirms the difference in the structure of engagement among teachers and students, where teachers made more frequent and substantial feedback. The use of mixed-methods approach to analyzing cultural data, such as students' and teachers' engagement in online learning, proves to be promising in processing, describing, and analyzing educational data.

References

- Altowairiki, N. F. (2023). Universal design for learning infusion in online higher education. *Online Learning*, 27(1), 296–312. <https://doi.org/10.24059/olj.v27i1.3080>
- Andrist, S., Collier, W., Gleicher, M., Mutlu, B., & Shaffer, D. W. (2015). Look together: Analyzing gaze coordination with epistemic network analysis. *Frontiers in Psychology*, 6, Article 1016. <https://doi.org/10.3389/fpsyg.2015.01016>
- Anthony, M., Van Dusen, B., & Jones, L. (2019). Connections between feedback and student happiness and engagement in high achievement classrooms. In *Proceedings of the 41st Annual Meeting of the North American Chapter of the Psychology of Mathematics Education (PME-NA)* (pp. 583–590). <https://files.eric.ed.gov/fulltext/ED606800.pdf>
- Arapakis, I. (2008). Affective feedback: An investigation of the role of emotions in the information seeking process. In *Proceedings of the 31st Annual International ACM SIGIR Conference on Research and Development in Information Retrieval* (pp. 395–402). ACM. <https://doi.org/10.1145/1390334.1390416>
- Bressler, D. (2019). Using epistemic network analysis to examine discourse and scientific process during a collaborative game. *Journal of Science Education and Technology*, 28(6), 553–566. <https://doi.org/10.1007/s10956-019-09784-2>
- Bright, K., & Vogler, J. S. (2024). Learning online vs. learning in person: A mixed-methods approach to understanding how student preferences and perceptions have evolved since the pandemic. *Online Learning*, 28 (4), (56-78). <https://doi.org/10.24059/olj.v28i4.4565>
- Cai, Z., Liao, Q., Yao, Y., & Hu, J. (2019). *nCoder+: A semantic tool for improving recall of nCoder coding*. Springer Nature Switzerland
- Casimiro, L. (2016). Cognitive engagement in online intercultural interactions: Beyond analytics. *International Journal of Information and Education Technology*, 6(6), 440–446. <https://doi.org/10.18178/ijiet.2016.6.6.758>
- Chafouk, O., & Marjanei, D. (2024). Comparing the impact of synchronous and asynchronous online learning on student retention and satisfaction. *European Journal of Education Studies*, 11(11). <https://doi.org/10.46827/ejes.v11i11.5605>
- Conklin, S., Ovarzun, B., Kim, S., & Dikkers, A.G. (2024). Exploring the relationships of learners and instructors in online courses. *Online Learning*, 28 (4), (257-281). <https://doi.org/10.24059/olj.v28i4.4051>
- Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, 49(1), 5-22. <https://doi.org/10.1177/0047239520934018>

- DeWitt, P. (2020, April 19). Six reasons why students aren't showing up for virtual learning. *Education Week*. <https://www.edweek.org/leadership/opinion-6-reasons-students-arent-showing-up-for-virtual-learning/2020/04>
- Eriksson, E., Gidlund, U., & Sundberg, D. (2018). A qualitative study of the primary teachers' classroom feedback rationales. *Educational Research*, 60(2), 168–185. <https://doi.org/10.1080/00131881.2018.1451755>
- Everett, D. (2015). Adding value: Online student engagement. *Information Systems Education Journal*, 13(2), 20–27. <https://files.eric.ed.gov/fulltext/EJ1137356.pdf>
- Farrell, O., & Brunton, J. (2020). A balancing act: A window into online student engagement experiences. *International Journal of Educational Technology in Higher Education*, 17(5). <https://doi.org/10.1186/s41239-020-00199-x>
- Fredricks, J. A., & McColskey, W. (2012). The measurement of student engagement: A comparative analysis of various methods and student self-report instruments. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 763–782). Springer Science + Business Media. https://doi.org/10.1007/978-1-4614-2018-7_37
- Fonseca, J., Canhoto, J., & Pinto, P. (2015). Changing teachers' feedback practices: A workshop challenge. *Australian Journal of Teacher Education*, 40(8), 88–101. <https://doi.org/10.14221/ajte.2015v40n8.6>
- Fougat, S. (2018). Epistemic network analysis of students' longer written assignments as formative/summative evaluation. In *LAK '18: Proceedings of the 8th International Conference on Learning Analytics and Knowledge* (pp. 411–415). ACM. <https://doi.org/10.1145/3170358.3170414>
- Gillett-Swan, J. (2017). The challenges of online learning: Supporting and engaging the isolated learner. *Journal of Learning Design*, 10(1), 20–30. <https://doi.org/10.5204/jld.v10i1.302>
- Gilbert, B. (2015). Online learning: Revealing the benefits and challenges (Master's thesis, St. John Fisher College). *Education Masters*, Paper 303. https://fisherpub.sjf.edu/education_ETD_masters/303
- Harnin, K. N., Padmadewi, N. N., Dewi, N. L. P. E. S., & Suwastini, N. K. A. (2022). Teachers' perception and practices on giving feedback on students' work during online learning. *SAE (Journal of Indonesian Student Assessment and Evaluation)*. <https://doi.org/10.21009/JISAE>
- Hatfield, D. (2015). The right kind of telling: An analysis of feedback and learning in a journalism epistemic frame. *International Journal of Gaming and Computer-Mediated Simulations*, 7(2), 1–23. <https://doi.org/10.4018/IJGCMS.2015040101>
- Hibert, A., Phillips, M., Gašević, D., Pantic, N., MacLean, J., & Tsai, Y. S. (2023). Dialogic feedback in online teaching: Implications for teacher education. In *People, partnerships*

- and pedagogies: *ASCILITE 2023 conference proceedings*. Australasian Society for Computers in Learning in Tertiary Education (ASCILITE).
- Hodge, E., & Chenelle, S. (2018). The challenge of providing high-quality feedback online: Building a culture of continuous improvement in an online course for adult learners. *Transformations: The Journal of Inclusive Scholarship and Pedagogy*, 28(2), 195–201. <https://doi.org/10.1353/tmf.2018.0013>
- Hollister, B., Nair, P., Hill-Lindsay, S., & Chukoskie, L. (2022). Engagement in online learning: Student attitudes and behavior during COVID-19. *Frontiers in Education*, 7. <https://doi.org/10.3389/educ.2022.851019>
- Howard, A., & Mawyer, A. (2015). *Ethnography in the digital age*. http://alanhowardanthro.net/Documents/Ethnography_in_the_Digital_Age.pdf
- Hu, M., & Li, H. (2017). Student engagement in online learning: A review. In *2017 International Symposium on Educational Technology (ISET)* (pp. 39-43). IEEE. <https://doi.org/10.1109/ISET.2017.17>
- Hysaj, A., & Haroon, H. A. (2022). Online formative assessment and feedback: A focus group discussion among language teachers. In R. A. R. Oliveira, G. Craveiro, & F. J. García-Peñalvo (Eds.), *Proceedings of the International Conference on Learning and Collaboration Technologies*. Springer.
- Kristiana, I. F., Prihatsanti, U., Simanjuntak, E., & Widayanti, C. G. (2023). Online student engagement: The overview of HE in Indonesia. *International Review of Research in Open and Distributed Learning*, 24(3). <https://doi.org/10.19173/irrodl.v24i3.7260>
- Leibold, N., & Schwarz, L. M. (2015). The art of giving online feedback. *The Journal of Effective Teaching*, 15(1), 34-46. <https://files.eric.ed.gov/fulltext/EJ1060438.pdf>
- Lu, J., & Law, N. (2012). Online peer assessment: Effects of cognitive and affective feedback. *Instructional Science*, 40(2), 257–275. <https://doi.org/10.1007/s11251-011-9177-2>
- Mamun, A., Lawrie, G., & Wright, T. (2016, September). Factors affecting student engagement in self-directed online learning module. In *Proceedings of the Australian Conference on Science and Mathematics Education (ACSME)*. Brisbane, Australia.
- Meier, E. (2015). Beyond a digital status quo: Re-conceptualizing online learning opportunities. *Occasional Paper Series*, 2015(34). <https://educate.bankstreet.edu/occasional-paper-series/vol2015/iss34/2>
- Means, B., & Neisler, J. (2023). Bridging theory and measurement of student engagement: A practical approach. *Online Learning*, 27(4), 26-47. <https://doi.org/10.24059/olj.v27i4.4034>

- Medelyan, A. (2020, October 13). *Coding qualitative data: How to code qualitative research*. Thematic. <https://getthematic.com/insights/coding-qualitative-data>
- Ocak, G., & Karafil, B. (2020). Development of teacher feedback use evaluation scale. *International Journal of Progressive Education*, 16(1), 110–125. <https://doi.org/10.29329/ijpe.2020.228.8>
- Pedler, M., Keddie, A., & Dunn, K. (2020). The teachers' role in student engagement: A review. *Australian Journal of Teacher Education*, 45(3). <https://doi.org/10.14221/ajte.2020v45n3.1>
- Pilotti, M. A. (2017). Factors related to cognitive, emotional, and behavioral engagement in the online asynchronous classroom. *International Journal of Teaching and Learning in Higher Education*, 29(1), 145–153.
- Ravichandran, N., & Kohli, C. (2022). The future of online learning: An outlook based on recent worldwide pandemic experience. *International Dialogues on Education Journal*, 8(1), 89-120. <https://doi.org/10.53308/ide.v8i1.250>
- Riel, J., Lawless, K. A., & Oren, J. B., (2020). Comparisons of synchronous and asynchronous discussions in an online roleplaying simulation to teach middle school written argumentation skills. *Online Learning*, 26(4), 146-167. <https://doi.org/10.24059/olj.v26i4.3468>
- Sandelowski, M., Voils, C., & Knafl, G. (2009). On quantitizing. *Journal of Mixed Methods Research*, 3(3), 208-222. <https://doi.org/10.1177/1558689809334210>
- Savvidou, C. (2018). Exploring the pedagogy of online feedback in supporting distance learning students. In A. Ozturk (Ed.), *Advanced learning and teaching environments: Innovation, contents, and methods* (pp. 93-108). IntechOpen. <https://doi.org/10.5772/intechopen.74645>
- Shaffer, D. W. (2017). A tutorial on epistemic network analysis: Analyzing the structure of connections in cognitive, social, and interaction data. *Journal of Learning Analytics*, 3(3), 9–45. <https://files.eric.ed.gov/fulltext/EJ1126800.pdf>
- Shernoff, D. J., Mehta, S., Atkins, M. S., & Tseng, V. (2016). Student engagement as a function of environmental complexity in high school classrooms. *Learning and Instruction*, 43, 52-60. <https://doi.org/10.1016/j.learninstruc.2016.01.002>
- Shute, V. (2008). Focus on formative feedback. *Review of Educational Research*, 78(1), 153-189. <https://doi.org/10.3102/0034654307313791>
- Tiwari, A., et al. (2018). *Transcription process in qualitative research*. <https://www.happyscribe.com/blog/transcription-qualitative-research/>

- Wang, Y., Liu, W., & Kee, Y. H. (2018). The nature of learning tasks and knowledge acquisition: The role of cognitive engagement in physical education. *European Physical Education Review*, 24(2), 137–152. <https://doi.org/10.1177/1356336X17724173>
- Watson, S., Sullivan, D. P., & Watson, K. (2023). Teaching presence in asynchronous online classes: It's not just a façade. *Online Learning Journal*, 27(2). <https://doi.org/10.24059/olj.v27i2.3231>
- Yuyun, I. (2023). Investigating university student engagement in online learning: A case study in EFL classroom. *Indonesian Journal of Applied Linguistics*, 12(3), 634-653. <https://doi.org/10.17509/ijal.v12i3.46035>
- Zhang, S., Koehler, M. J., & Mishra, P. (2019). Exploring primary school teachers' technological pedagogical content knowledge (TPACK) in online collaborative discourse: An epistemic network analysis. *British Journal of Educational Technology*. <https://doi.org/10.1111/bjet.12791>

Online or Face-to-Face? The Modality of a Learning Strategies Course and Impacts on Grades, GPA, Retention, and Persistence for Developmental Students

Allison O. Lassiter
Kansas State University

Abstract

As some research indicates that developmental students are more at risk in online learning (Jaggers & Xu, 2010; Xu & Jaggers, 2013), it is important to provide additional supports for students enrolled online. One of the ways to support developmental students is in providing learning strategies or college success coursework. At the institution of study, a one-credit hour learning strategies course is available to students online and in person and is provided at no cost to developmental students transitioning to credit-bearing coursework. Therefore, a concern is whether the students in the online course are disadvantaged by the modality, particularly during the pandemic when choice was limited. This research indicates that students who take the learning strategies course face-to-face do have better grades overall, but do not have a significantly higher GPA or persistence and retention rate. Outcomes are essentially the same for students before and during the pandemic. Overall, outcomes suggest that students are not materially harmed by taking the learning strategies course online with the caveat that grades may be higher in face-to-face coursework.

Keywords: Correlational research, developmental education, learning strategies, online learning, academic outcomes, pandemic

Lassiter, A.O. (2025). Online or face-to-face? The modality of a learning strategies course and impacts on grades, GPA, retention, and persistence for developmental students. *Online Learning* 30(1), pp. 350-372. <https://doi.org.10.24059/olj.v30i1.4287>

According to the National Center for Education Statistics, 36% of undergraduate students took at least one distance education course in 2019 (National Center for Education Statistics, 2023). During 2020, students in distance education rose to 75%. Though meta-analyses of online education defend the equivalence of online and face-to-face outcomes, during the pandemic online learning was introduced to a population that was unfamiliar with it and, in some cases, unprepared for it. This is particularly important for developmental students who are likely to have a deficit in study strategies and nonacademic skills which can be exacerbated online (Jaggars & Bickerstaff, 2018; Jenkins et al., 2009; Karp et al., 2017).

Though online learning has developed strong foundations over the past two decades, the average student and teacher were not prepared to make the switch to online learning that COVID-19 made necessary. K-12 schools were subject to a national experiment in how to take a platform that has, for the most part, not existed online, to one that was either supplemented by online material, hybrid in delivery mode, or entirely online. Colleges, though more prepared for this transition, still had to require instructors who were untrained into an online environment they were unprepared to manage. Distance education course enrollment increased by a dramatic 93% by the end of 2020 as compared to the fall 2019, and overall enrollment dropped as well, particularly at community colleges (Lederman, 2021). Fifty-nine percent of colleges included in Lederman's report also indicated that they plan to sustain their distance education offerings post-pandemic (Lederman, 2021). However, Means and Neisler (2020) found in a national survey of college students that students' satisfaction in spring 2020 sharply declined from 51% satisfaction before their course went online to 19% after. Students cited motivation as the primary issue with the shift, with 79% of students indicating this was a problem (Means & Neisler, 2020). Other issues they cited were the loss of the presence of the instructor and peers, hands on learning experiences, and discussion. However, students did feel the expectations were still clear, they knew where to get help and they felt their instructors knew them (Means & Neisler, 2020). In a government sponsored survey, Mukhtar and colleagues determined that the advantages of e-learning were in the flexibility, accessibility, and student-centered learning environment, specifically self-directed and asynchronous learning (Mukhtar et al., 2020). In addition to the disadvantages noted by Means and Neisler (2020), lack of feedback from students, attention span, and cheating were also cited as issues (Mukhtar et al., 2020). The pandemic allowed researchers the unprecedented ability to evaluate the impacts of online education without selection bias as many students who would not have ordinarily chosen to study online became online students. As such, the future of online education will be shaped by the lessons that we learn from these years.

Literature Review

Online Education Effectiveness

When considering online education as a whole, the consensus is that online education is effective when controlling for other factors. Those other factors are particularly important to consider for developmental education students. Since the topic has far reaching impacts, there have been a number of large-scale analyses conducted to determine whether online education offers similar outcomes to face-to-face instruction. For the most part, these conclude that online education is as effective or even more effective than face-to-face education (Bowen et al., 2014; Cavanaugh & Jacquemin, 2015; Hachey, 2020; Means et al., 2010; Means et al., 2013; Shachar & Neumann, 2010). It would seem this is the end of the discussion, but many other studies have found that other characteristics such as course

design, demographics, and academic preparedness play a role and that online education may not be equally useful for all.

Asynchronous Online Courses, Synchronous Online Courses, and Compared Face-to-face Courses

The delivery format of instruction is a factor in student success, retention, persistence, and graduation. Therefore, it is relevant to examine differences between asynchronous online, synchronous online, and face-to-face (F2F) educational outcomes. Most of the data indicates that online learning and face-to-face learning can have similar outcomes when controlling for mediating variables (Carol & Burke, 2010; Cavanaugh & Jacquemin, 2015; Ebner & Gegenfurtner, 2019; Means et al., 2010; Nguyen, 2015; Somenarain et al., 2010). Asynchronous and synchronous online models can also demonstrate similar knowledge outcomes and positive instructor perceptions as well if course design is effective and motivation is present (Presley et al., 2023).

On the other hand, Xu and Jaggars (2011) found online and face-to-face modalities for introductory math and English indicated a negative correlation between online modality and both retention and course performance. In follow up research, Xu and Jaggars (2012) also observed persistence and achievement were negatively correlated in the online format as well. Their research is specifically targeted at community college students which makes their work particularly relevant to the students in this study. They also note that “time management and independent learning skills” might be “critical to success,” (Xu & Jaggars, 2012, p. 55). With the majority of research pointing to no major impact or harm from online coursework, it is practical to continue to provide online courses in order to meet the needs of particular students, but it is also important to stay alert for possible negative outcomes as well.

Online Education and Developmental Learners

If online education can be effective, then the question becomes: *Who does this methodology have a propensity to fail?* In the community college setting, the research of Xu and Jaggars finds that young, Black, male students who were not academically proficient previously are specifically less successful in online environments (Xu & Jaggars, 2013). Though research on developmental learners specifically is virtually non-existent (Rutschow & Schneider, 2012), Petrides and Nodine (2005) remark that student readiness, face-to-face interactions, access, and diverse student needs are all factors that should be evaluated before recommending online coursework to developmental learners. Like Xu and Jaggars (2013), they note that soft skills such as time management, literacy, and independent learning are all necessary to online learning and are not skills which developmental learners typically have mastered. This emphasis on soft skills is similar to other research that emphasizes self-regulation, self-efficacy, motivation, and self-empowerment (Jantz, 2010; Martin et al., 2014; Wadsworth et al., 2007) Wadsworth and colleagues (2007) also found that concentration, information processing, and self-test skills impacted final grade outcomes. Research by Weems (2002) and Carpenter (2004) find that academic results are somewhat similar in developmental online courses, but that dropout rates are higher online.

Petride and Nodine (2005) and Castillo (2013) indicate that differing populations can lead to different outcomes, as adult, nontraditional students have differing needs than those of the younger, more academically at-risk students, though both end up in developmental education. For older students, the flexibility of online education may be essential. However, Castillo generally argues that there is a larger risk in offering this type of course online, citing a partnership between San Jose State University and an online education provider that offered

introductory level classes and was ultimately named a failed experiment due to low pass rates (Castillo, 2013). Though this research is not centered on developmental education courses, since the population this study focuses on are developmental education students, it is relevant to note that online and face-to-face courses could have different outcomes.

Online Classrooms: Best Practices

There is a breadth of information about best practices in the online classroom ranging from course design to technology implementation; one best practice is that course design must be deliberate (Fish & Wickersham, 2009; Maddix et al., 2012). Often teachers simply upload PowerPoints or handouts from their in-person classes which is ineffective. Research shows that students find online videos as the preferred method of distance education if traditional courses are not possible (Downing, 2020). Another best practice is faculty support and collaboration (Fish & Wickersham, 2009). Given the amount of work and expertise that is required in building effective online courses, faculty collaboration could go a long way in curating meaningful content. Providing student support in terms of technology use, time management, and study strategies is cited as another best practice (Fish & Wickersham, 2009). Students with greater academic preparation historically do better than those with subpar preparation (Jaggars & Xu, 2010). Therefore, many recommend providing this type of academic support and preparation for students to ensure equitable access. One of the ways to do this is in providing learning strategies courses that help students adjust to college academic expectations, college life, and college study strategies (Linder et al., 2018). Another form of providing student support is creating social presence and facilitating in the online environment (Fish & Wickersham, 2009; Downing, 2020; Maddix et al., 2012). Social presence is a student's sense that a professor is real, tangible, and available to them. Finally, reflection on and analysis of the effectiveness of the course and its outcomes are essential. Self-evaluation is crucial for growth and improvement and, as such, is a best practice in online education too. Therefore, since there can be a wide array of methods in online instruction, outcomes can be difficult to classify when the modality can fluctuate so widely.

Social Presence in the Online Classroom

A key issue of online learning is the social presence of the instructor. Though this is defined in a variety of ways, most definitions include students' perceptions of the instructor as "real" and accessible. However, some studies extrapolate teacher presence and social presence, defining teacher presence as the instructor interactions with students and content and social presence as including the community of the course (Garrison et al., 2001). These are not separate metrics as Shea and colleagues (2019) indicate in their research, but rather strong teacher presence is correlated with stronger community whether in facilitation or instructional design. A meta-analysis of studies on social presence indicates positive correlations between social presence and satisfaction and social presence and perceived learning (Kimbark et al., 2017). This is consistent with other findings (Gunawardena & Zittle, 1997). In a study of Chinese university students during the COVID-19 pandemic, the authors found that interaction, course satisfaction, and academic self-efficacy were related (She et al., 2021). Additionally, self-efficacy was related to engagement and that engagement correlated with satisfaction.

Teacher facilitation, instructional design and organization were also correlated with students' positive sense of learning communities (Shea et al., 2019). Recent research has also indicated that teaching presence can have an impact on learning outcomes directly (Martin et al., 2022). Whether it is simply perception of the course or in actual learning outcomes, social or teacher presence should not be discounted. If a belief that a teacher is available and

engaged can lead to stronger satisfaction, this satisfaction can lead to stronger learning outcomes overall (Oja, 2011). However, a student's perceptions of social presence can still fall short of being statistically significant to learning outcomes (Hostetter & Busch, 2006). For the purpose of online course design, it is important to note that social presence matters in some tangible ways and even if learning outcomes are not clearly measurable, there are enough other positive outcomes to support robust teacher facilitation, building strong learning communities and careful course design.

Learning Strategies Coursework Online

Students may need a particular sort of readiness in order to succeed online (Petrides & Nodine, 2005; Xu & Jaggars, 2013), and developmental education research suggests that these nonacademic skills contribute to developmental students' readiness (Jaggars & Bickerstaff, 2018; Jenkins et al., 2009; Karp et al., 2017). One of the methods colleges have been employing to provide these skills are college success or learning strategies courses. Research has demonstrated the positive academic impacts of these courses to be higher persistence rates, increased credential attainment, and higher GPA and grades for students who have taken these learning strategies or success courses (Fowler & Boylan, 2010; Kimbark et al., 2017; Tuckman & Kennedy, 2011; Zeidenburg et al., 2007). If learning strategies coursework skills are necessary in bridging achievement gaps both overall and online, then it would be important to see if modality impacts academic outcomes in these courses. However, there is very little research on learning strategies courses and course modality, and what there is does not measure academic outcomes (Abts, 2012). This is problematic since the research on online education is still mixed. Most meta-analyses note that online education has essentially equitable impacts, especially when controlling for other variables. However, the research on developmental learners and online modalities is sparse. The little there is reports negative impacts, and the research on learning strategies courses with regard to modality is even more untapped. It is important then to evaluate if this coursework's efficacy is impacted by the way it is delivered.

Framework

The overarching framework for this study is one proposed by Kolenovic, Linderman, and Karp (2013). They propose three constructs to increase graduation rates: academic momentum, support services, and college belonging. Though academic momentum is important for the acceleration of developmental education programs, it is not as relevant for the purposes of this study. As such, the support services and college belonging components of this framework will be the primary focus as they are the mission of the learning strategies coursework and are of particular importance.

Support services are critical for students to obtain degrees. In Kolenovic and colleagues' (2013) research over the Accelerated Study in Associate Programs (ASAP) in the CUNY community college system, advising was a significant predictor of graduation. Though only 28% of the sample had completed developmental coursework prior to beginning ASAP, the significance of advising support might even be more crucial for this population. In fact, ASAP has additional requirements in their Start program for developmental students, including a learning strategies course (The City University of New York, 2017). According to O'Gara and colleagues (2017), these learning strategies courses are an integral part of these support services. Not only did these courses help them obtain study skills, but they also

learned about the services the college offered and developed relationships (O’Gara et al., 2009).

Not only are support services integral but so are the relationships formed Tinto (1975; 2006) and Astin (1997, 1999), and Bean and Eaton’s (2001) research on belonging dovetail here to support the concept that relationships are essential for increasing persistence. Astin (1999) claims that time is the most valuable resource a college student has and as such, when students invest more time on campus than off, they are more likely to be committed to the process of obtaining a degree. Similarly, Bean and Eaton (2001) found that students who spent time internally interacting with faculty, staff, and peers were more persistent than students who spent time invested externally with family, non-college friends, and external employers. Tinto (1975) equates this to the process of cost-benefit analysis, where students weigh the benefits of their goal attainment with the literal cost of college, and the social cost of withdrawing from their current communities. When those communities are found within the institution granting their degree, there is less social cost to attending college. Bean and Eaton (2001) also found that the explicit instruction of study skills, time management, and resource utilization increased students’ coping skills which can impact persistence and retention when students are faced with unexpected challenges.

The research of Tinto (1975, 2006), Astin (1997, 1999) and Bean and Eaton (2001) falls primarily before the rise of robust and almost ubiquitous online course offerings, which begs the question: *How do colleges engage students who never step foot on campus?* To indicate that no online students will be engaged would be inaccurate, so research on social presence is key to filling this gap. Social presence or teacher presence seek to measure the ways in which online students engage with their online peers and instructors. In a world of increasing social engagement online, we cannot discount the ability of online communities to give a sense of belonging. Social presence research indicates that students can and do connect and engage in online classrooms, and this connection can drive some real-world outcomes in terms of engagement, perceptions, and achievement (Garrison et al., 2001; Gunawardena & Zittle, 1997; Kimbark et al., 2017; Martin et al., 2022; She et al., 2021; Shea et al., 2019). As such, it is important to consider the design and facilitation of online coursework as a way to bridge the physical barrier of college attendance and contribute to this momentum.

Learning strategies courses provide both academic and social support for students, ultimately giving students more potential for increased GPA which can lead to increased persistence and then ultimately, higher graduation rates (Pascarella & Terenzini, 2005). Research on learning strategies and college success courses specifically for developmental students indicate that students have greater credit acquisition and persistence, creating greater academic momentum. Therefore, learning strategies courses should be considered as a means to increase these rates and as such, it is responsible to evaluate whether the modality in which they are offered will produce similar outcomes.

Methodology

Participants

Participants were developmental education students who have taken the learning strategies course from fall 2018-spring 2022 either synchronously online or asynchronously online. During this time frame, the course was offered to developmental students for free as a means of encouraging students who were more at risk to obtain support. As such, there is likely a more representative sample than other semesters. Data was obtained from archives

held by the institution. Developmental students are those who are required to take a developmental English, reading, or math course before enrolling in the general education course or students in the English for Academic Purposes sequence. For the Spring 2020 semester, students who completed the course before the college shut down in March were also included, but those who took the course after the shutdown in the spring of 2020 were removed from the sample (N=10). These students were required to take the course online regardless of preference and were therefore removed as they had the potential to skew the sample.

From Fall 2018 to Spring 2022, there were 354 students overall: 200 taking the course face-to-face and 154 taking the course online or hybrid. Before the pandemic, 59 students took the course online and 142 face-to-face. During the pandemic, 95 students took the course online and 58 face-to-face. I collected race, gender, age, Pell grant status, full/part time, and degree-seeking demographics and included those in the multiple regression analysis, in addition to whether or not the student was currently enrolled in developmental education, previously enrolled, or never enrolled. Outcomes for students from 2018-2019 were collected and compared by course modality as well as outcomes from 2020-2022. Outcomes included are grade in the course, GPA during and following semester, retention, and persistence. The course was offered both online and in person even during the pandemic.

Table 1

Summary Statistics: Modality

Variable	N	Mean	Standard Deviation	min	max
Face-to-face Modality	354	56%	.4964624	0	1
Scholarship Recipient	354	38%	.4849902	0	1
Degree Seeking	354	90%	.3063667	0	1
Received Pell Grant	354	35%	.4777336	0	1
Term Full Time Status	354	58%	.494403	0	1
Black	354	10%	.2950703	0	1
American Native	354	.3%	.0531494	0	1
Asian	354	4%	.1951706	0	1
White	354	49%	.5005079	0	1
Hispanic	354	16%	.3680668	0	1
Pacific	354	.6%	.0750581	0	1

International	354	8%	.2658072	0	1
Not Reported	354	5%	.2080316	0	1
Two or More Races	354	9%	.2830695	0	1
Female	354	67%	.5067998	0	3
Grade	328	2.865854	1.422942	0	4
GPA Prior Sem.	273	2.846117	.8638365	0	4
GPA Following Sem.	298	2.829564	.8456819	0	4
Retain	354	84%	.3654375	0	1
Retain/Transfer/ Graduate	354	88%	.3238269	0	1

Note: All binary variables express their mean in terms of percentage. For GPA and Grade, the mean indicates the GPA on a 4-point scale or the grade with 4 indicating an A, 3 a B, and so on.

Procedure

Multiple regression analysis for 201819 was performed on grades, GPA during and after, retention and persistence disaggregating by course modality. I ran separate analyses on Fall 2020 to Spring 2022 semesters. As noted above, I eliminated 10 students who took the learning strategies course from March 2020–May 2020 as they were unable to choose their modality. I included race, gender, age, Pell grant status, full/part time, and degree seeking as control variables and disaggregated results by developmental and non-developmental students.

Results

I ran four multiple regression analyses with y being grades, GPA, retention and persistence and $b1$ whether the student was face-to-face in their learning strategies course. The regression equation is $Y=b0+b1+b2\dots b14+E$. The intention is to determine if face-to-face instruction is correlated with differing outcomes, however I only know if the student was face-to-face in this course (not if they are entirely online), so I can only draw correlations between modality for the learning strategies course and outcomes.

Grade in Course and Modality: Overall

As demonstrated in the tables below, students' grades in the course are significantly higher at $p<.05$ and over a half letter grade higher if they are face-to-face versus online or hybrid modalities. This is true prior to the pandemic but becomes slightly insignificant at just over $p<0.053$ for the pandemic years. Age and gender have a statistically significant impact here as well, indicating that overall course grade is higher for older students and female students. American natives and two or more races are also significant, but since both have very low n values, I would be hesitant to draw any conclusions from this. American natives only account for .3% of the overall sample. Two or more races is much higher at 9%, but this still is a small value in a 354-person sample.

Table 2*Regression Table of Grade Correlated with Course Modality*

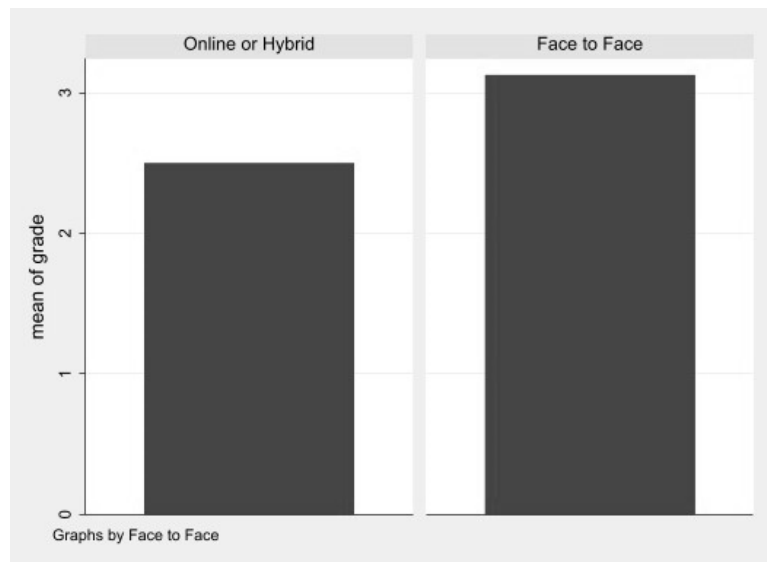
	Grade in Course	Grade in Course Pre-Pandemic	Grade in Course Pandemic
Face-to-face	.683*** (.164)	.85*** (.234)	.519* (.266)
Black	-.251 (.303)	-.383 (.421)	-.256 (.47)
Asian	-.097 (.446)	.042 (.686)	-.257 (.624)
Hispanic	-.144 (.225)	-.303 (.268)	-.069 (.421)
Pacific	-.203 (.291)	-.263 (.306)	-.074 (.382)
International	.201 (.219)	-.038 (.379)	.363 (.327)
Not Reported	.042 (.326)	-.061 (.475)	.216 (.475)
Two or More Races	-.658** (.309)	-.43 (.382)	-.984* (.508)
American Native	1.031*** (.21)		.787* (.416)
Age during 176 term	.018** (.008)	.004 (.01)	.035** (.014)
Full Time 176 term	.311* (.174)	.411* (.229)	.216 (.3)
Degree Seeking	-.221 (.239)	-.511* (.263)	.24 (.404)
Female	.46** (.182)	.458 (.283)	.441* (.244)

R-squared

Note: Using a four-point scale (4=A and 0=F), results indicate the impact of being face-to-face versus online and hybrid on course grade.

Figure 1

Bar Graph Comparison of Grade by Modality Overall



GPA and Modality: Overall

Another outcome examined was GPA. Using the regression equation $Y = b_0 + b_1 + b_2 \dots b_{14} + E$, GPA the semester during the course and the semester after the course was used for Y. The purpose of examining GPA was to extrapolate these results to see if the learning strategies were applied more effectively face-to-face or online and hybrid as measured by differing impacts on GPA overall. Since the course is one credit hour and is taken at varying points in the semester, it does have the potential to impact GPA the semester of enrollment especially since the strategies are applied to a co-requisite course. It is also important to see if the strategies have a long lasting impact in subsequent semesters. Therefore, I also include GPA after for those students who re-enrolled at the institution. It is, however, limited to those who re-enrolled. GPA and taking the course face-to-face are not significantly correlated overall. The pandemic does not change this result significantly. As with grade, age is a significant covariate. Full time enrollment and degree seeking also become significant for the semester of course enrollment. Full time enrollment as a positive bias is consistent with belonging research. However, for GPA the semester after, the correlation between full-time status and higher performance disappears in the pandemic years and skews the overall outcome. The reason for this disappearance could be reflective of the overall cultural upheaval at the time. Degree-seeking is inconsistent and anecdotally, I have found many students are assigned or assign themselves Associates of Liberal Arts and are qualified as degree-seeking even if they do not have a clear educational outcome in mind or particular interest in obtaining an Associate in Liberal Arts. However, since this is not the case for all students, I have continued to include degree-seeking as a control variable. The results here would indicate that being degree-seeking had a negative bias in GPA the semester of enrollment.

Table 3*GPA Semester of Course Enrollment and Modality*

	GPA Semester of Course Enrollment	GPA Semester of Course Enrollment Pre-Pandemic	GPA Semester of Course Enrollment Pandemic
Face-to-face Modality	.11 (.102)	.244* (.146)	.132 (.173)
Black	-.239 (.176)	-.37 (.256)	-.208 (.278)
Asian	.312 (.235)	.478 (.334)	.198 (.34)
Hispanic	-.234 (.15)	-.265 (.183)	-.199 (.259)
Pacific	.008 (.118)	.115 (.188)	-.194 (.239)
International	.068 (.159)	-.081 (.225)	.043 (.247)
Race Not Reported	.039 (.222)	-.073 (.363)	.042 (.282)
Two or More Races	-.308 (.204)	.009 (.244)	-.767** (.327)
American Native	.137 (.133)		-.031 (.261)
Age during 176 Term	.023*** (.005)	.02*** (.007)	.027*** (.009)
Full Time during 176 Term	.29*** (.107)	.464*** (.142)	.15 (.182)
Degree Seeking	-.358** (.161)	-.374* (.212)	-.318 (.23)
Female	.182 (.126)	.062 (.194)	.332** (.146)

Observations	353	201	152
R-squared	.099	.139	.14

Robust standard errors are in parentheses

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 4

GPA the Semester After and Modality

	GPA Following Course Enrollment	GPA Following Course Enrollment Pre-Pandemic	GPA Following Course Enrollment Pandemic
Face-to-face Modality	.041 (.102)	.035 (.147)	.171 (.169)
Black	-.307* (.169)	-.143 (.216)	-.579* (.318)
Asian	.423* (.224)	.671*** (.256)	.297 (.329)
Hispanic	-.152 (.148)	-.245 (.171)	-.032 (.274)
Pacific	-.039 (.118)	-.222 (.169)	-.036 (.252)
International	-.063 (.177)	-.214 (.251)	-.098 (.285)
Race Not Reported	.037 (.211)	-.141 (.436)	.004 (.259)
Two or More Races	-.314* (.189)	-.054 (.249)	-.722*** (.274)
American Native			
Age during 176 Term	.02*** (.005)	.019** (.007)	.023** (.009)
Full Time during 176 Term	.16 (.107)	.386*** (.144)	-.095 (.179)

Degree Seeking	-.186	-.257	-.099
	(.143)	(.171)	(.226)
Female	.17	-.017	.352**
	(.134)	(.208)	(.154)
Observations	298	170	128
R-squared	.083	.124	.163

Robust standard errors are in parentheses

*** $p < .01$, ** $p < .05$, * $p < .1$

Retention and Persistence and Modality

The next two areas of interest are retention and persistence. In the equation $Y = b_0 + b_1 + b_2 \dots b_{14} + E$, y is retention or persistence. Retention is described as re-enrollment the next semester at LMCC. Persistence is defined as either re-enrollment at LMCC, transfer to another school that semester, or graduation. Persistence and retention are linked to GPA and as such offer an additional metric in determining if students find themselves capable and equipped (Pascarella & Terenzini, 2005). Online courses also could suffer from a lack of social presence and as such, could impact students' sense of belonging according to Tinto (1975, 2006) and Astin (1997, 1999). Retention is insignificantly related to modality. Persistence is also insignificantly related to modality. The covariates Pacific or islander and American native do have a significant bias for re-enrollment. This is true for persistence as well. As stated before, these n values are very small, so no clear conclusions can be drawn, but further research is suggested to see if face-to-face modalities better serve these populations. For persistence, full-time enrollment is also a significant covariate. This is consistent with findings that full-time students persist overall at higher rates, though it does not indicate that there is a particular loyalty to LMCC. This would not support a link between belonging and persistence. Degree seeking also is significant in persistence, but as a negative bias again possibly indicating the same variable issue noted in GPA or possibly indicating that face-to-face enrollment was not related.

Table 5

Retention and Modality

	Re-enrollment at college the following semester	Re-enrollment at college the following semester Pre-Pandemic	Re-enrollment at college the following semester Pandemic
Face-to-Face Modality	.027	.063	.005
	(.042)	(.061)	(.068)
Black	-.036	-.123	.052
	(.079)	(.113)	(.106)
Asian	.023	-.029	.05

	(.1)	(.161)	(.137)
Hispanic	.002	.025	-.045
	(.059)	(.067)	(.11)
Pacific	.161***	.214***	.134
	(.048)	(.08)	(.081)
International	.001	-.033	.015
	(.078)	(.123)	(.105)
Race Not Reported	-.035	-.229	.146***
	(.101)	(.181)	(.052)
Two or More Races	.095*	.064	.121
	(.054)	(.076)	(.083)
American Native	-.848***		-.867***
	(.05)		(.091)
Age During 176 Term	0	-.001	0
	(.002)	(.003)	(.004)
Full Time During 176 Term	.071	.025	.126*
	(.043)	(.056)	(.067)
Degree Seeking	-.074	-.002	-.131
	(.061)	(.093)	(.08)
Female	.02	.038	-.009
	(.037)	(.054)	(.055)
Observations	354	201	153
R-squared	.038	.042	.097

Robust standard errors are in parentheses

*** $p < .01$, ** $p < .05$, * $p < .1$

Table 6

Persistence and Modality

	Retained, Transferred or Graduated	Retained, Transferred or Graduated Pre-Pandemic	Retained, Transferred or Graduated Pandemic

Face-to-Face Modality	.032	.028	.031
	(.036)	(.047)	(.062)
Black	.052	.023	.082
	(.047)	(.057)	(.094)
Asian	-.031	-.092	.019
	(.104)	(.164)	(.14)
Hispanic	.017	.001	.031
	(.048)	(.055)	(.094)
Pacific	.083**	.085	.138*
	(.041)	(.059)	(.079)
International	-.034	-.016	-.038
	(.069)	(.097)	(.099)
Race Not Reported	-.03	-.171	.125**
	(.087)	(.161)	(.058)
Two or More Races	.05	.009	.099
	(.051)	(.07)	(.078)
American Native	.09**		.13
	(.044)		(.088)
Age During 176 Term	.001	0	.002
	(.002)	(.002)	(.003)
Full Time During 176 Term	.109***	.066	.14**
	(.038)	(.047)	(.062)
Degree Seeking	-.1**	-.008	-.195***
	(.049)	(.082)	(.05)
Female	-.02	.016	-.073
	(.029)	(.039)	(.048)
Observations	354	201	153
R-squared	.044	.035	.098

Robust standard errors are in parentheses

*** $p < .01$, ** $p < .05$, * $p < .1$

Discussion

Overall, modality is correlated most significantly and consistently with grades. Students who take the learning strategies course face-to-face achieve at least half a letter grade higher than their hybrid and online counterparts. This was consistent for pre-pandemic years as well. During the pandemic, this became slightly insignificant (at $p < 0.1$).

GPA is not significantly correlated, however. The purpose of including GPA was to extrapolate these results beyond the confines of the course to determine if the learning strategies had a differing impact on GPA as a result of the modality, particularly since this course is designed to assist students in their other coursework. It seems that the overall impact is non-existent or negligible, even if a student's grades in the course are higher. Grades might have had less of an impact due to the course's overall weight as a one-credit - hour course rather than the typical three-credit-hour courses. In addition, though the face-to-face and online courses are very similar, some of the assignments in the face-to-face course are done in class with the support of an instructor. There are also a few assignments that are added in the online course in order to check that students watched recorded lectures or read the syllabus or otherwise engaged with the instruction. As such, the students had more opportunities to get a zero or poor grade. Of course, the inverse is also true.

Overall, the only firm conclusion that can be drawn is that grades are correlated with modality in normal, non-pandemic years. Students who are in-person are more likely to have higher course grades with coefficients of .68 and higher. In a scale of 4 points, that is a significant increase. Though this does not impact a student's GPA as the course is only worth one credit hour; it is possible that our three-credit-hour courses could impact GPA more significantly, and as such, we should be aware of the potential harms and benefits modality could bring for developmental students. It should be noted that some research indicates that the way a course is facilitated can cause significant changes in grade outcomes. In a study of an online geology course that utilized the same instructional design and material, the teacher's engagement via announcements, feedback, and other interactions had a pertinent difference in the number of failing students (d'Alessio et al., 2019). Therefore, it might be in our best interest to make sure that research-based, online teaching methods that promote clear social and teacher presence are utilized in the facilitation of all of our online courses.

Persistence and retention are not correlated with modality either. This indicates that students are equally well served in both formats, and that belonging may either be replicable in the online format or that belonging is less of a factor in students' persistence and retention (Astin, 1997; Kimbark et al., 2017). It is possible that the instructors in our online courses actually do create a sense of belonging that allows both modalities to have similar outcomes in GPA, persistence, and retention. Our instructors primarily have education degrees and backgrounds which could indicate a familiarity with multidimensional engagement. Additionally, the purpose of the learning strategies course is not explicitly to create a sense of belonging and community. It is possible with a cohort model or an emphasis on connection, these results would differ and modality would play a different role. As previously mentioned, this course is the only course of which we know the modality, so other courses in the students' programs may be of differing modalities, thus impacting retention and persistence differently. As such, it would be irresponsible and incorrect to directly claim that this research refutes the value of belonging or social presence in retention and persistence. I can simply claim that this does not add to the support of that vein of research.

Recommendations

In light of this research, I recommend that in order to best serve our developmental students, we should make sure that the modality a student chooses is a good fit for them. This can only be determined on an individual basis and would likely fall on the counseling and advising staff. The College Success department that offers these courses should make sure to clearly communicate these findings so that the counseling and advising staff is prepared to help students make the correct choice. I would err on the side of encouraging students to choose the face-to-face modality when possible. However, I would also recommend an audit of our engagement with students in our asynchronous course if d'Alessio and colleagues (2019) are correct in stating that teachers who sent fewer announcements, and gave less feedback ended up with more failing students, assuming that this would transfer to this context. It may also be pertinent to determine if a different method of online instruction (specifically synchronous) would produce different outcomes. However, anecdotally I can say that these courses were not popular when previously offered and if Presley and colleagues (2023) are correct in noting similar outcomes for synchronous and asynchronous courses, then this might not be worthwhile. Overall, since both modalities have similar outcomes for GPA, persistence, and retention, I would also encourage the college to continue to offer a variety of options for our students so that they have as many pathways to success as possible.

Limitations

As mentioned previously, I do not know the full modality of the students in this sample, simply in this course. As such, the conclusions I can draw must be limited to how students fare in online or face-to-face sections of this one-credit-hour learning strategies course. Additionally, I can only draw conclusions as to how students at this single institution are impacted. This research also did not specifically examine race, gender, poverty, or other subgroups individually but rather included them as control variables. Further research on these specific subgroups are impacted by our coursework would be valuable, particularly in light of Xu and Jagger's research indicating that young Black men are most likely to be unsuccessful in online courses (2013). The choice of a quantitative approach, while giving a wide view of the current climate, does not give the narrative picture that qualitative or mixed methods could have accomplished.

Conclusion

Courses aimed at providing academic support and strategies are relatively common at many universities and community colleges. As their aim is to increase access for students, it is imperative to determine whether the modality is equally effective. Since some research indicate developmental students may be more vulnerable (Xu & Jagers, 2011), this population is particularly worthy of examination.

This research indicates that online and face-to-face students have similar outcomes in GPA, retention, and persistence. This supports the claim that online and face-to-face courses have similar outcomes (Nguyen, 2015).

The one exception to this is in overall course grade. Students in this sample enrolled in face-to-face courses had higher course grades than their counterparts in online and hybrid modalities. Several factors could play a role in this. Online courses tend to have slightly more assignments to measure course participation which offer more opportunities for both failure and success. Additionally, while all assignments are self-directed in the online course, face-to-face students complete several of their assignments in class with support from their

professor. This immediate, corrective feedback might well have a meaningful impact on academic performance.

This research contributes to the ongoing discussion of how best to support developmental learners and provide access to tools and resources that could mitigate gaps in educational preparation. Since online learning is becoming near ubiquitous and as it provides educational access to many developmental learners who would otherwise be barred from higher education, it is important to note that these courses are generally equitable. This research is of particular use for colleges that are expanding online course offerings or evaluating those offerings and utilize learning strategies courses to support students, particularly developmental students.

Declarations

The author declares no conflict of interest in regard to research, authorship, and/or publication of this article.

The author asserts that IRB approval was obtained from Kansas State University as well as from the institution that provided the archival data.

The author received no financial support or grants for the research, authorship, and/or publication of this article.

References

- Abts, M. (2012). Effectiveness of online community college success courses. [Doctoral dissertation, University of Nebraska]. *ProQuest Dissertations*, February. 1–165.
- Astin, A. W. (1997). How “good” is your institution’s retention rate? *Research in Higher Education*, 38(6), 647–658.
- Astin, A. W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development*, 40(5), 518–529.
- Bean, J. P. (1980). Dropouts and turnover: The synthesis and test of a causal model of student attrition. *Research in Higher Education*, 12(2), 155–187.
<https://www.jstor.org/stable/40195329>
- Bean, J., & Eaton, S. B. (2001). The psychology underlying successful retention practices. *Journal of College Student Retention: Research, Theory & Practice*, 3(1), 73–89.
<https://doi.org/10.2190/6R55-4B30-28XG-L8U0>
- Berge, Z. (2008). Changing instructor’s roles in virtual worlds. *Quarterly Review of Distance Education*, 9(4), 407–414.
- Bowen, W. G., Chingos, M. M., Lack, K. A., & Nygren, T. I. (2014). Interactive learning online at public universities: Evidence from a six-campus randomized trial. *Journal of Policy Analysis and Management*, 33(1), 94–111. <https://doi.org/10.1002/PAM.21728>
- Carpenter, T. G., Brown, W. L., & Hickman, R. C. (2004). Influences of online delivery on developmental writing course. *Journal of Developmental Education*, 28(1), 14–35.
- Carroll, N., & Burke, M. (2010). Learning effectiveness using different teaching modalities. *American Journal of Business Education*, 3(12), 65–76.
- Castillo, M. (2013). At issue: Online education and the new community college student. *The Community College Experience*, 19(2), 35–46.
- Cavanaugh, J., & Jacquemin, S. (2015). A large sample comparison of grade-based student learning outcomes in online vs. face-to-face courses. *Online Learning Journal*, 19(2), 25–32. <https://doi.org/10.24059/olj.v19i2.454>
- d’Alessio, M. A., Lundquist, L. L., Schwartz, J. J., Pedone, V., Pavia, J., & Fleck, J. (2019). Social presence enhances student performance in an online geology course but depends on instructor facilitation. *Journal of Geoscience Education*, 67(3), 222–236.
<https://doi.org/10.1080/10899995.2019.1580179>
- Downing, C. E. (2020). Best practices in online education. *International Journal of Information, Business and Management*, 12(3), 42–46.
<https://doi.org/10.1097/01.NME.0000816536.38164.eb>
- Ebner, C., & Gegenfurtner, A. (2019). Learning and satisfaction in webinar, online, and face-to-face instruction: A meta-analysis. *Frontiers in Education*, 4(September), 1–11.
<https://doi.org/10.3389/feduc.2019.00092>

- National Center for Education Statistics. (2023). Postbaccalaureate Enrollment. *Condition of Education*. U.S. Department of Education, Institute of Education Sciences. <https://nces.ed.gov/programs/coe/indicator/chb>.
- Fish, W. W., & Wickersham, L. E. (2009). Best practices for online instructors reminders. *Quarterly Review of Distance Education*, 10(3), 279–284.
- Garrison, D.R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, 2(2), 87–105. [https://doi.org/10.1016/S1096-7516\(00\)00016-6](https://doi.org/10.1016/S1096-7516(00)00016-6).
- Gunawardena, C.N., & Zittle, F.J. (1997). Social presence as a predictor of satisfaction within a computer-mediated conferencing environment. *American Journal of Distance Education*, 11(3), 8-26. <https://doi.org/10.1080/08923649709526970>
- Hachey, A. C., Conway, K. M., Wladis, C., & Karim, S. (2022). Post-secondary online learning in the U.S.: An integrative review of the literature on undergraduate student characteristics. *Journal of Computing in Higher Education* 34, 708-768. <https://doi.org/10.1007/s12528-022-09319-0>
- Hostetter, C. & Busch, M. (2006). Measuring up online: The relationship between social presence and student learning satisfaction. *The Journal of Scholarship of Teaching and Learning*, 6(2), 1-12.
- Jaggars, S. S., & Bailey, T. (2010). Effectiveness of fully online courses for college students: Response to a Department of Education meta-analysis. *Community College Research Center, Teachers College, Columbia University*. 1-18. <https://ccrc.tc.columbia.edu/publications/effectiveness-fully-online-courses.html>
- Jaggars, S. S., & Xu, D. (2010). Online learning in the Virginia community college system. *Community College Research Center Teachers College, Columbia University*. September, 1-47. <https://ccrc.tc.columbia.edu/publications/online-learning-virginia.html>
- Jantz, C. (2010). Self-regulation and online developmental student success. *MERLOT Journal of Online Learning and Teaching*, 6 (4), 744-752.
- Kimbark, K., Peters, M.L., & Richardson, T. (2017). Effectiveness of the student success course on persistence, retention, academic achievement, and student engagement. *Community College Journal of Research and Practice*, 41(2), 124-138. <https://doi.org.10.1080/10668926.2016.1166352>
- Kolenovic, Z., Linderman, D., & Karp, M. M. (2013). Improving student outcomes via comprehensive supports: Three-year outcomes from CUNY's Accelerated Study in Associate Programs (ASAP). *Community College Review*, 41(4), 271–291. <https://doi.org/10.1177/0091552113503709>
- Lederman, D. (2021, September 16). Detailing last fall's online enrollment surge. *Inside Higher Ed*. <https://www.insidehighered.com/news/2021/09/16/new-data-offersense-how-COVID-expanded-online-learning>

- Linder, K.E., Hayes, C. M., & Thompson, K. (2018). *High-impact practices in online education: Research and best practices*. Stylus Publishing.
- Maddix, M. A. (2012). Generating and facilitating effective online learning through discussion. *Christian Education Journal*, 9(2), 372-385.
<https://doi.org/10.1177/073989131200900209>
- Martin, K., Galentino, R., & Townsend, L. (2014). Community college student success: The role of motivation and self-empowerment. *Community College Review*, 42(3), 221–241. <https://doi.org/10.1177/0091552114528972>.
- Means, B., and Neisler, J. (2020). *Suddenly online: A national survey of undergraduates during the COVID-19 pandemic*. Digital Promise.
<https://www.everylearnereverywhere.org/resources/suddenly-online-national-undergraduate-survey/>
- Means, B., Toyama, Y., Murphy, R., & Bakia, M. (2010). Evaluation of evidence-based practices in online learning a meta-analysis and review of online learning studies. *U.S. Department of Education, Office of Planning, Evaluation, and Policy Development*.
- Means, B., Toyama, Y., Murphy, R., & Baki, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, 115(3), 1-47. <https://doi-org.er.lib.k-state.edu/10.1177/016146811311500307>
- Mukhtar, K., Javed, K., Arooj, M., & Sethi, A. (2020). Advantages, limitations and recommendations for online learning during COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, 36(COVID19-S4), S27–S31.
<https://doi.org/10.12669/pjms.36.COVID19-S4.2785>
- National Center for Education Statistics. (2023). *Postbaccalaureate enrollment*. Condition of Education. U.S. Department of Education, Institute of Education Sciences.
<https://nces.ed.gov/programs/coe/indicator/chb>
- Nguyen, T. (2015). The effectiveness of online learning: Beyond no significant difference and future horizons. *MERLOT The Journal of Online Learning and Teaching*. 11(2). 309-319.
- O’Gara, L., Karp, M. M., & Hughes, K. L. (2009). Student success courses in the community college: An exploratory study of student perspectives. *Community College Review*, 36(3), 195–218. <https://doi.org/10.1177/0091552108327186>
- Oja, M. (2011). Student satisfaction and student performance. *Journal of Applied Research in Community College*, 19(1). 47-53.
- Pascarella, E.T. & Terenzini, P. T. (2005). *How college affects students*. John Wiley & Sons, Inc.
- Petrides, L., & Nodine, T. (2005). Online developmental education: Who’s ready? *Community College Journal*, 76(2), 42-46.
- Presley, R., Cumberland, D. M., & Rose, K. (2023). A comparison of cognitive and social presence in online graduate courses: Asynchronous vs. synchronous modalities. *Online Learning Journal*, 27(2), 245–264. <https://doi.org/10.24059/olj.v27i2.3046>

- Richardson, J. C., Maeda, Y., Lv, J., & Caskurlu, S. (2017). Social presence in relation to students' satisfaction and learning in the online environment: A meta-analysis. *Computers in Human Behavior*, 71, 402–417. <https://doi.org/10.1016/j.chb.2017.02.001>
- Rutschow, E. Z., Cullinan, D., & Welbeck, R. (2012). Keeping students on course: An impact study of a student success course at Guilford Technical Community College. *MDRC*, i–67. <https://www.mdrc.org/publication/keeping-students-course>
- Shachar, M. & Neumann, Y. (2010). Twenty years of research on the academic performance differences between traditional and distance learning: Summative meta-analysis and trend. *MERLOT Journal of Online Learning and Teaching*, 6(2), 318-334.
- She, L., Ma, L., Jan, A., Nia, H. S., & Rahmatpour, P. (2021). Online learning satisfaction during COVID-19 pandemic among Chinese university students: The serial mediation model. *Frontiers in Psychology*, 12(October). <https://doi.org/10.3389/fpsyg.2021.743936>
- Somenarain, L., Akkaraju, S., & Gharbaran, R. (2010). Student perceptions and learning outcomes in asynchronous and synchronous online learning environments in a biology course. *Journal of Online Learning and Teaching*, 6(2), 353-356.
- Tinto, V. (1975). Dropout from higher education : A theoretical synthesis of recent research. *Review of Educational Research*, 45(1), 89–125. <https://doi.org/10.2307/1170024>
- Tinto, V. (2006). Research and practice of student retention: What next? *Journal of College Student Retention: Research, Theory & Practice*, 8(1), 1–19. <https://doi.org/10.2190/4YNU-4TMB-22DJ-AN4W>
- The City University of New York. (2021). CUNY Start <http://www1.cuny.edu/sites/cunystart/program/cuny-start/>
- Wadsworth, L. M., Husman, J., Duggan, M. A., & Pennington, M. N. (2007). Online mathematics achievement: Effects of learning strategies and self-efficacy. *Journal of Developmental Education*, 30(3), 6-14.
- Weems, G. H. (2002). Comparison of beginning algebra taught onsite versus online. *Journal of Developmental Education*, 26(1). 10-18.
- Xu, D., & Jaggars, S. S. (2011). The effectiveness of distance education across Virginia's community colleges: Evidence from introductory college-level math and English courses. *Educational Evaluation and Policy Analysis*, 33(3), 360–377. <https://doi.org/10.3102/0162373711413814>
- Xu, D., & Jaggars, S. (2012). The impact of online learning on students' course outcomes: Evidence from a large community and technical college system. *Economics of Education Review*, 37, 46-57. <https://doi.org/10.1016/j.econedurev.2013.08.001>
- Xu, D., & Jaggars, S. S. (2013). Adaptability to online learning: Differences across types of students and academic subject areas. (CCRC Working Paper No. 54). *Community College Research Center, Teachers College, Columbia University*. <https://ccrc.tc.columbia.edu/publications/adaptability-to-online-learning.html>

Zeidenberg, M., Jenkins, D., & Calcagno, J. C. (2007). *Do student success courses actually help community college students succeed?* (CCRC Brief No. 36). Community College Research Center, Teachers College, Columbia University.
<https://doi.org/10.7916/D8D50WBQ>

Going Online: Decision Processes of Community College Students Enrolling in Online Degree Programs

Michael S. Hill
University of the Pacific

Cassandra M.D. Hart
University of California, Davis

Abstract

This paper examines the decision-making process of students who enroll online at two California community colleges to learn how fully-online students gather information about potential institutions and programs, which alternatives were considered, and which sources were most useful to them in choosing programs. We draw on interviews with 25 students intending to attend fully online; interviews were conducted prior to the COVID-19 pandemic. These findings suggest that students are aware of the availability of online classes and make the choice to attend at a given institution based on convenience, finances, and familiarity with the college. The students that we interviewed almost all enrolled in programs that were proximate to their homes, despite their intent to complete their academic programs online. Colleges should think carefully about how information and support are provided to those students wishing to complete classes and find creative ways to engage students and provide campus resources virtually.

Keywords: Online students; college enrollment; postsecondary institutions; fully-online programs

Hill, M. S. & Hart, C. M. D. (2025). Going online: Decision processes of community college students enrolling in online degree programs. *Online Learning*, 30(1), pp. 373-398.
<https://doi.org/10.24059/olj.v30i1.4883>

Post-secondary online degree programs and courses have grown substantially over the last two decades (Allen & Seaman, 2013; Deming et al., 2012). Before the pandemic, more than half of all U.S. postsecondary institutions had students enrolled in online classes (Jaggars, 2011; Parsad et al., 2008), and a significant portion of students were completing their degrees fully online. At public two-year institutions, 15% of students enrolled exclusively online as of 2019 (Hill, 2021); this rose to 32% of students by 2022 (Hill, 2024). Fully-online program enrollment has historically been particularly attractive for adult learners (Ortagus, 2017); for instance, while only 15.6% of undergraduates under age 23 were enrolled in fully-online programs as of the 2019–2020 academic year, nearly 44% of undergraduates aged 30 and older were enrolled in such programs (United States Department of Education, n.d.b.).

Despite this growth, little is known about the factors that influence decisions around where to attend college for students who prefer fully online degree programs. In this paper, we examine the decision-making processes of students who intended to enroll fully online, drawing on interviews with 25 students at two California community colleges. Interviews were conducted between March 2019 and January 2020, so all participants actively opted into online enrollment rather than being forced into it due to COVID. We explored student perceptions and experiences related to two questions:

1. What sources of information do students draw on when deciding where to enroll in exclusively-online programs?
2. What factors do students who enroll in fully online degree programs most commonly weigh in deciding which college to attend?

Review of Related Literature

Our study joins literature on two main areas of research: the factors and information sources that students consider when choosing colleges, and unique considerations of students considering online course options.

College Choice

Much of the research on college choice proceeds from Hossler & Gallagher's (1987) framework, which posits three basic stages leading up to a student's college decision. The first stage is *predisposition*, the point at which an individual makes the overall decision to attend college (Hossler & Gallagher, 1987). However, our project touches more closely on the final two phases: *search* and *choice*.

In Hossler & Gallagher's (1987) second stage, the *search* stage, students begin to engage with sources of information, communicate with institutions, and seek advice and recommendations from trusted sources like family, friends or high school counselors (Cabrera & La Nasa, 2000; Hossler & Gallagher, 1987). Other possible sources include college websites, search engines, and college rating and review websites (Capranos & Dyers, 2020). The search process may not be exhaustive; instead, a short list of institutions under consideration may come from recommendations from friends and family, student predisposition or familiarity with a particular institution, or perceptions of financial constraints (Cabrera & La Nasa, 2000).

In Hossler & Gallagher's (1987) final stage, *choice*, students consider the alternatives and make the decision to attend a specific college for a specific program. An extensive set of literature has centered on the choice stage of the college decision. Prior studies suggest individuals make decisions based on perceived constraints surrounding the decision and subjective assumptions about costs and benefits associated with the result of the decision (Hardin, 1993; Perna, 2006; Tierney & Venegas, 2009). Accordingly, decisions are subjectively rational given the information, assumptions, and constraints that influence an individual rather than objectively rational for all individuals in all similar settings (Perna, 2006). When settling on a college, students consider a variety of college-specific factors including institutional quality, specific major, finances, and campus life (Cabrera & La Nasa, 2000; United States Department of Education, 2009).

While work around traditional students assumes that this stage occurs prior to choice—e.g., that the search process narrows down a list of options and a set of front-runner colleges are selected from among that list—there is evidence of less sequencing in the search/choice process for nontraditional students (e.g., students who are older rather than searching for colleges right out of high school; Bers & Smith, 1987). These students may have a distinct process because of the differing life circumstances they may face; for instance, students entering college in their mid-twenties or beyond may choose their institutions with an eye to maintaining their regular routines, such as caring for families that they do not want to move or continuing in jobs that they do not want to leave (Hearn & Long, 2023).

Looking at a sample of nontraditional students, Bers & Smith (1987) found that students compressed the search and choice steps into a single process, searching until they determined they had a choice that was adequate for their needs rather than conducting an exhaustive search. Because online classes may be especially attractive for older, nontraditional students with competing obligations (Author, 2019; Ortagus, 2017), similar models may hold for online students.

Most prior research related to college choice has focused on students attending face-to-face. To settle on an enrollment decision in this context, students first consider the constraints faced given their particular life situation and the assumed benefits of each of the considered options (Iloh & Tierney, 2014; Somers et al., 2006). Constraints can include preferences and predispositions to a particular subject area, schedules, finances, family and work responsibilities, distance to campus, geographical considerations, and opportunity costs (Barnes-Teamer, 2003; Illoh & Tierney, 2014). If a college meets prior established criteria related to convenience and cost, students may continue to weigh other options or may decide that college is acceptable and forego considering other options (Bers & Smith, 1987; Perna, 2006).

Choices of Online Students

Though established models (e.g., Chapman, 1981; Hossler & Gallagher, 1987) have been developed to understand student choices around college attendance, there has been little attention paid to students who choose to enroll in programs that are fully online. Instead, literature focused on choice-making around modalities tends to focus on students who are evaluating whether to take individual classes online versus face-to-face. When students opt to take a class online over face-to-face alternatives, convenience and schedule flexibility are often key factors in the

decision (Benbunan-Fich & Hiltz, 2003; Bright & Vogler, 2024; California Community Colleges Chancellor's Office, 2017; Clinefelter & Aslanian, 2017; Farris et al., 2003; Flowers & Cotton, 2003; Jaggars, 2014; Ruffalo Noel Levitz, 2016; Author, 2019). These factors may be especially prominent in the considerations of older students (Bers & Smith, 1987), who are over-represented in fully-online programs (United States Department of Education, n.d.b.; Ortagus, 2017). However, few believe that online courses fundamentally provide more effective instruction or superior learning (Clinefelter & Aslanian, 2017; Farris et al., 2003; Jaggars, 2014; Public Agenda, 2013; Ruffalo Noel Levitz, 2016). This suggests that online learners' choices may be influenced by constraints that lead them to take online classes even though that might not be preferred in the absence of those constraints.

While this work begins to establish reasons for taking *individual courses* online, very few studies address the process of decision-making used by students who chose to forego face-to-face classes totally and enroll *fully online*. Three exceptions are recent survey-based studies (Lansing, 2017; Clinefelter et al., 2019; Capranos & Dyers, 2020), which found that similar to students interested in attending programs at in-person institutions, cost, reputation, and curriculum were priorities for online-intending students. We extend this literature by using qualitative methods to gain additional nuance around the sources of information and college selection process of students seeking to specifically enroll in broad-access institutions and attend fully online.

Methods

To better understand the decision-making process of fully-online students, we conducted a series of interviews focusing on student experiences and thought processes leading up to the point of enrollment. The views represented in this paper are drawn from online students at two California community colleges, which we call "Poppy College" and "Sage College" or, collectively, the "home colleges."

Poppy College is part of a multi-college district serving a large metropolitan area that encourages cooperation and collaboration between colleges through a set of agreements guaranteeing transferability of courses within the district. Students at any one college may take online or face-to-face classes at other colleges in the district in pursuit of their academic goals. Poppy College's enrollment is among the top third of community colleges in the state, with more than 30,000 students enrolled per semester (California Community Colleges Chancellor's Office DataMart, n.d.). As of fall 2019, roughly one-third of Poppy students took at least some online courses, with about 15% enrolling exclusively online (authors' calculations from the Integrated Postsecondary Data System [IPEDS], United States Department of Education, n.d.). The student body was around 40% White and 30% Latino/Hispanic, with smaller shares identifying as Black and Asian/Native Hawaiian/Pacific Islander (Appendix Table A1).

Sage College is also near a large urban area, with an enrollment roughly half the size of Poppy's. Online course-taking is very common at Sage, with about half of students taking at least some coursework online and nearly one-quarter enrolling exclusively online as of fall 2019 (authors' calculations, IPEDS data). The student population was split evenly between White and Latino students (roughly 40% each), with small shares identifying as Black or Asian/Pacific Islander (Appendix A, Table 1).

Participants

Distance education staff at each institution distributed an eligibility screener to online students. Delivery differed at each institution, consistent with the requirements of the local research offices. At Poppy, the screener was emailed to all students who had been enrolled exclusively online, in any number of classes, during both the Fall 2018 and Spring 2019 semesters. The eligibility screener identified prospective participants who were 18 years old or older, were either currently pursuing a degree or credential or had earned a degree or credential in the last year, and who reported having taken all courses fully online in pursuit of those credentials. Students who indicated they were only taking some of their classes online were ineligible to participate.

Sage College required that we recruit participants through class announcements rather than email, so the distance education office requested all online instructors to post an announcement with a link to the screener in their classes. The screener was modified to select a sample comparable to Poppy's by asking students how many semesters they had taken online courses and asking them what share of courses taken for their degree or credential programs were taken fully-online. To be eligible to participate, students were required to have taken online courses in at least two different academic terms, and to have indicated that all courses taken for their degree or credential programs were taken fully online. Notwithstanding these, a handful of students disclosed taking occasional face-to-face classes during our interviews. For instance, one student wanted to be 100% online but was required to take at least one face-to-face course to receive military tuition benefits, while others took occasional face-to-face courses when online sections were unavailable. Because these students indicated that their intention was to be fully online, and the face-to-face classes were taken out of necessity, we included them in our sample.

We received responses and contact information from 80 eligible students from Poppy College and 21 from Sage College. Initially students were contacted based on screener response order, but as the sample grew, priority was placed on male students in an attempt to balance and provide a purposeful sample (Seidman, 2013). Despite this effort, few men responded to the invitation to be interviewed and, as a result, males are underrepresented in our sample (see Table 1). To anonymize data, we use participant numbers rather than names.

Ultimately, we interviewed 15 students from Poppy College and 10 from Sage College. We scheduled and completed the interviews at Poppy during the spring 2019 semester, and interviews from Sage between fall 2019 and winter 2020. The last interview was in January 2020, so all interviews occurred prior to the onset of the COVID-19 pandemic in the U.S.

Demographic information was collected from each participant in surveys either during the consent process or, for some early participants, after the interview was completed. In some cases, missing demographic data was extrapolated from information provided in interview transcripts. Appendix A, Table 1 provides demographic characteristics of interview participants. Participants were disproportionately female (over 75% in both sites) and spanned a wide range of ages from under 22 to over 40. Most participants were White or Latino. Compared to the student populations at their respective colleges, students in our sample tended to be older, nontraditional students.

Table 1
Participant Table

Participant	College	Gender	Age Range
Student 1	Poppy	Female*	Not provided
Student 2	Poppy	Male	25-29
Student 3	Poppy	Female	40+
Student 4	Poppy	Male	40+
Student 5	Poppy	Female*	30–39*
Student 6	Poppy	Female	18–20
Student 7	Poppy	Female*	Not provided
Student 8	Poppy	Female	25–29
Student 9	Poppy	Female	25–29
Student 10	Poppy	Female	18–20
Student 11	Poppy	Female	25–29
Student 12	Poppy	Female	25–29
Student 13	Poppy	Female	21–24
Student 14	Poppy	Female	30–39
Student 15	Poppy	Male	40+
Student 16	Sage	Female	40+
Student 17	Sage	Female	25–29
Student 18	Sage	Female	25–29
Student 19	Sage	Female	25–29
Student 20	Sage	Female	30–39
Student 21	Sage	Female	18–20
Student 22	Sage	Male	30–39
Student 23	Sage	Female	25–29
Student 24	Sage	Female	30–39
Student 25	Sage	Female	40+

Note. Source: participant survey.

*Survey not returned; data imputed based on observation during the interview (sex) or specifically mentioned during the interview (age).

Data Collection and Analysis

Participants were interviewed individually over Zoom, with most interviews lasting around 30 to 45 minutes (see Appendix B for the semi-structured interview protocol). Each student who completed an interview received a \$50 Amazon gift card. Interviewers disclosed relevant background characteristics to participants: In terms of positionality, the first author was a former community college student and taught both face-to-face and online in community colleges prior to and throughout graduate school, while the second author's sole experience with online learning was as a researcher. We attempted to keep our own positionalities in mind while conducting and analyzing the interviews (Seidman, 2013).

Each interview was recorded and transcribed for analysis. Notes taken during the interview process were used to build analytical memos (Saldaña, 2013) summarizing interviewers' post-interview reactions and reflections.

Transcripts were coded in Dedoose using a two-cycle process (Saldaña, 2013). First cycle coding followed a structural approach (Saldaña, 2013) to identify responses that connect to broader themes related to the interview questions. Through the identification of these responses and relationships between themes, structural coding provides a foundation for second cycle coding and is considered to be well suited for interview transcripts (Saldaña, 2013). First cycle codes were broadly grouped as relating to the two research questions around sources of information and factors influencing students' choice of college. Upon completion of the first cycle coding process, codes were reviewed, consolidated and revised to reflect themes in the data. During this process, observations and reflections related to the interviews, codes, and embedded themes that we observed as we coded the transcripts were recorded as analytic memos (Saldaña, 2013). These analytic memos were used to further focus on specific themes in the second cycle of coding.

Second cycle coding further organized themes identified during the initial cycle, honing and refining the ideas reflected in the data using an elaborative coding approach (Saldaña, 2013). Elaborative coding uses codes and themes in the data to support, strengthen, or modify frameworks and findings from prior work (Saldaña, 2013). Second cycle codes were developed based on Hossler and Gallagher's (1987) framework for college choice and refined through an iterative process of coding and consultation between the research team. Appendix A, Table 2 provides a list of the codes used in this paper.

Trustworthiness

We established trustworthiness of analyses (Miles et al., 2020) through several steps. To pursue confirmability, we maintained records of our processes, such as maintaining codebooks, to ensure clarity of interpretation in coding and consistency over time. Our use of two sites served the purpose of establishing transferability by identifying patterns common to both sites; we also discuss our findings in light of prior studies in the discussion. At the same time, we identified some unique patterns in each college that were echoed across multiple participants in one site but not the other, allowing us to assess when the cases deviated from each other; identifying these deviations improves our confidence in the credibility that analyses also capture factors unique to each college. We further established credibility by triangulating some of the accounts of participants, for instance by visiting websites mentioned as sources of information in students' college search processes. To ensure dependability, we collaborated in establishing codes and refining codes, and we wrote contemporaneous memos on the interviews capturing initial impressions which were used in establishing and reviewing themes.

Findings

Sources of Information and Information-Gathering Processes

Students reported gathering information from multiple sources as they weighed which college to attend. Many Poppy and Sage students narrowed in on their eventual colleges, as well as a few other potential options, based on external sources—sources other than information provided by the colleges themselves. After narrowing their college options, students seeking additional information about specific institutions began to rely more on internal sources, consulting college websites or college staff members.

“I Had Some Friends...Who Had Gone There”: External Sources of Information

Many students, particularly those who grew up in the local regions, were familiar with Poppy and Sage based on the experiences of friends, family, or acquaintances who had attended the college. Student 20 reported being exposed to Sage during high-school college trips: “...in high school we also did a field trip senior year to [Sage] to do the assessments and everything to see where we would place into college.” This familiarity made applying to Sage a natural fit for her.

Other respondents were advised to consider Poppy and Sage based on positive experiences of friends or family. Student 21 had a family legacy at Sage, including an aunt who worked at a prestigious four-year institution and who strongly advised her to complete her general education requirements at Sage: “She recommended, pretty much everyone in my family has started at Sage in one way or another. In one generation or another, we’ve all gone to Sage at least for our general eds. So that’s where I got my advice to go there first.” Similarly, Student 13 was steered towards Poppy partly by a colleague: “When I was researching my options, she told me about [Poppy], the program that she went through,” and Student 13 ultimately enrolled in the same program. Student 10 also tapped into broader networks including “church members and even counselors and doctors” to gain information about experiences attending Poppy College: Hearing from these community members made her “confident and comfortable in wanting to apply and not feel like I was making a bad decision in the school that I was choosing.” For these students, having first-hand recommendations from trusted sources made them more confident that Sage and Poppy were strong options.

Multiple students who had strong recommendations for Poppy or Sage from friends or family reported that they did not seriously consider other options given their confidence that those colleges would provide good experiences. As one student put it, “I just knew that this [attending Poppy] is the direction I wanted to go. It was the only option that I really ever considered” (Student 2). For these students, as for nontraditional face-to-face students in Bers & Smith’s (1987) work, the search and choice phases were compressed into a single stage.

For others who searched more broadly, many used the Internet to seek schools that fit the criteria that they had in mind. Like many students, Student 8 reported using “a lot of Google, for sure” to find the “best online programs”. Some students used Google to find more specialized web sources. For instance, Student 14 described an especially helpful website, likely the California Virtual Campus Course Exchange based on the description, she found through Google. The site “connects online students with certain courses they need....[If] you’re like, ‘okay I need argumentation and debate’ ...[the website] will list every school in the state that offers it online.” Student 14 was then able to use the site to locate online classes across the state to meet her needs, including outside of her home institution. Indeed, Student 14 was among a handful of students who used external sites—such as the website described or another called assist.org—to shop across the entire California Community Colleges system for classes needed for an academic program or for transfer, regardless of the student’s distance to the campus.

Student 3 described a similar methodical approach using external information to collect information on multiple colleges before deciding on a college. She reviewed published course pathways for accounting certificates to get a sense of degree requirements at each institution.

Additionally, she looked at course descriptions at multiple colleges to determine whether certain institutions offered higher-quality or more rigorous programs than others. She went to websites for specific courses to check textbooks lists to ensure that if she attended a community college, she would still be using texts comparable to those used at more prestigious institutions. While these two students were particularly methodical in using external information to gather information about their program options, they were outliers among the sample.

More commonly, students relied on sites where former students familiar with institutions reported on their experiences. Several participants, for instance, reported scouting out RateMyProfessor.com to gain information on prior students' experiences with online classes in programs they were considering. Other sites also provided respondents with valuable advice on the college-going process; Student 23 received help from a website for military spouses connected with the base where her husband was stationed: "I posted in the wife page, I was like, 'What colleges do you recommend?' And everyone was pretty equal between Sage and [another nearby college]." Given that military families are likely to lack access to the local networks that provided many students with information on the programs available at local colleges, these types of pages may provide important sources of social capital in navigating the process of local college choice.

"If Your Website's Not Amazing, How Good is Your Online Program?": Online Information from the Home Colleges

Students leaned heavily on each college's website to learn about their programs and online offerings. The quality of these websites was important to whether students felt it was easy to find the information they needed. For instance, while Poppy provided information about online courses through their dense course catalog, they also featured a website through the distance education department that listed all fully-online degrees and programs available at the school. Student 8 described finding this "much more intuitive" information source: "You can actually put in, okay, what are 100% online degrees, so when I found that I was like, 'Oh, this is perfect!'" This page helped boost her confidence that Poppy would meet her needs.

By contrast, some students described that a lack of clarity in other colleges' websites dissuaded them from attending those institutions. Student 3 related, "there are places where I would click onto [a college's] website. I would start looking at it and that information wasn't freely available or it wasn't easily understood. For me, if it's not easily understood from the beginning, it's not a program that I necessarily want to invest my time in." Student 5 ruled out one particularly convenient college because of the website: "I had originally looked at [neighboring college] because my mother-in-law and father-in-law live close so I could drop [my children] off if I needed to go in or whatnot. But... it just seemed like [the website] wasn't as user-friendly and I just wasn't impressed." Student 5 went on to muse: "If your website's not amazing, how good is your online program?"

"She Really Explained to Me the Process": Campus Counselors Providing Information

While many students relied primarily on websites to do initial scouting for information, students who spoke with counselors often reported that they were an excellent resource. For instance, Student 18 related that a Sage counselor provided a tremendous amount of support at

the enrollment phase. The counselor at Sage “created an educational plan for me, so I know exactly what classes I need to take for the next year and how she really explained to me the process of what it would be to transfer over as well.” Student 18 went on to name several other colleges she had talked to during the enrollment phase, which did not offer the same comprehensive support. As we discuss below, supportive admissions processes were named as a specific factor that promoted attendance for some students.

Overall, students found college sources valuable in helping them to finalize their enrollment decisions, particularly in Sage where the counseling and application services received especially high marks from students.

Motivations for Institution Choice

While some of the students in our sample only ever seriously considered the institution they ultimately ended up attending, many considered other institutions. Of those students who did consider other colleges, a wide variety of options were considered, including other community colleges locally; other regional community colleges; or online options offered by four-year institutions like University of Phoenix, Western Grand Canyon University, extension schools at University of California campuses, and Arizona State University. Respondents named several considerations that pushed them to attend Poppy and Sage specifically. Cost, class choice and convenience, reputation, and student supports during admissions were key factors students considered when deciding between institutions.

“The Most Cost-Effective Thing”: Financial Considerations

While many students had considered four-year universities or other private two-year colleges, including non-profits, the relative affordability of the community college system made it an attractive option for many students. For Student 8, who considered an extension program at a University of California institution, the decision “came down to price...I just didn't want to have that kind of debt.” Similarly, Student 19 considered attending a private non-profit college that explicitly offered fully-online degrees, drawn by the convenience of the online program that culminated in a four-year degree. However, although the program “seemed very accommodating to your schedule,” she ultimately decided against that route due to price: “They're just extremely expensive.” Many more students ruled for-profit colleges out out-of-hand due to their expense. Student 12's thought process was typical of these students: “I also looked at the ‘commercial colleges’, I guess you could say, that you see on TV that are fully online, like University of Phoenix and the price point was just absolutely ridiculous. So I didn't even consider those.”

In addition to having a lower list-price than many other four-year and private options, students noted that the financial aid offered by the community colleges made them an attractive option. While Student 23 considered a for-profit college, she was swayed by the offer of a tuition waiver “that was only accepted at community colleges. So a university was not in the option at the moment.” For many students, cost was the primary consideration in college choice.

“I Needed Convenience”: Class Choice, Campus Proximity and Access to Multiple Colleges

While many students opted for a community college due to the favorable price point, they also valued the convenience of course offerings given other constraints in their lives. In

particular, the breadth of availability of online courses was a major point pushing students towards Sage and Poppy specifically. Student 19 articulated this point: “for me, online works better, [since I’m] working full time. Then I noticed that there’s a lot of colleges that don’t offer online programs. Like the majority of the classes are Tuesday, Thursday from 8:00 to 10:00, and most people work during that time... [Sage] offers a lot of online classes, which is great.” Student 16 weighed this point heavily as well. Her primary motivation in attending Sage was “the amount of online [options] they offer per class. There’s more than just one, they have a lot of room and availability.”

Knowing that entire degree or credential programs could be completed solely online was important for many students. Student 15 ruled out institutions that did not offer complete credential programs online: “Often times what I saw was that there was a particular class that was really interesting...but the entirety of the program was not offered online, which is a common situation.” Student 12 similarly wanted to avoid a situation where a required course “could be available online every single semester, and then randomly it will change it on-campus only. So I didn’t really feel comfortable pursuing a degree from where that was a possibility.” This made her prize schools that explicitly advertised fully-online degrees.

Interestingly, even among students who preferred online classes, the proximity of the campus was an important consideration for many students. They reasoned that even if most of their classes were online, they may need to talk to professors or visit student services, and they wanted to make sure they were able to do those things on campus if necessary. Student 19 related that for her,

...proximity was a consideration in case I had to go to the college and maybe get an education plan, or if I had to make an appointment with a counselor or just something that came up, maybe there was an event I wanted to go to...I’ve had friends that would register online to colleges far away, like up north. It just seems if something came up, what if I needed to go on campus?

Student 2 reported similar motivations in limiting his search to Poppy’s district: “If I did have to ever go back to campus [for coursework], I didn’t want to have to drive to [an area 1.5 hours away] to finish my classes. If I needed to go to campus [it was important] that I would be able to do that.” For these respondents, it made sense to look for colleges with physical campuses that they could easily access if need be for face-to-face coursework or appointments.

Similarly, some students anticipated having to take a handful of courses face-to-face—despite intending to attend almost-fully online—and so they prized proximity to campus. Student 24, who juggled her coursework with her children’s demanding schedules, articulated that because she anticipated possibly needing to do some face-to-face components of classes—such as hybrid options—being close to campus was important to her to make sure she could continue to balance her schedule: “I needed flexibility, I needed convenience, and I needed something that, [geographically] was located around my children and their schedule.” Sage’s blend of offering online courses but also proximity made her feel confident in managing her schedule.

In addition to considering the convenience of options at their home college, Poppy students in particular pointed to the benefits of attending a school nested in a district that

provided access to online courses at sister institutions. As Student 9 said, “If [a Poppy] online class is full, at least you can try and see if they have it at another [college in the district].” For Student 5—who was recruited into the sample because she attended classes at Poppy but counted another college in Poppy’s district as her “home” campus—the expanded availability of online classes through the district model was a major factor driving her to choose her college: “I’m able to utilize all these campuses that have different online courses and areas and I can take them at each college [in the district]... That really sold me because the availability of classes.”

“I was...Leery of Other Online Programs:” Familiarity, Reputation, and Trust

Particularly for those who grew up in the vicinity of Sage and Poppy, many students cited familiarity with the colleges based on either friends’ experiences or from knowing the colleges in the region. For instance, Student 10’s friends who had attended Poppy spoke positively about the experience: “They all told me that they liked Poppy and that the teachers are really there for you.” As we note above, for some students, the recommendations of friends and family were so persuasive that they really did not consider other options.

Some students considered other options but explicitly viewed community colleges as more reputable compared to schools that they viewed as predatory. Several respondents reported being turned off by aggressive marketing from for-profit institutions. One student went so far as to block the calls of a for-profit college that she had investigated because of the “predatory” recruitment tactics: “... [I recall] the predatory phone calls I got after. Like, day after day after day. I was like, ‘Mmm-hmm, you’re for-profit.’ ...It was bad enough I had to block it.” (Student 14). Other respondents who considered for-profit options similarly were put off by the promised ease of degree receipt at those institutions. Speaking of for-profits, Student 25 worried that “if it’s that easy to get a degree from some place, it may not be accredited. So I was a little too leery on other online programs to be quite honest with you.” By contrast, she had heard of Sage’s programs and understood from others who had attended that Sage had a strong reputation and maintained academic rigor, both in its online programs and more generally.

While some respondents were leery of for-profit colleges, others viewed them more positively. Student 17 recalls that “...people did recommend me Phoenix...I wanted to do the Phoenix because you finish faster, but it was too expensive.” In these cases, often financial motivations pushed students to enroll at community colleges instead.

“They Obviously Want Me There”: Application Process and Student Supports

At Sage in particular, several students specifically mentioned the college’s outreach and welcoming approach to online students as a factor in their enrollment. Student 20 applied to three community and technical colleges, but ultimately enrolled at Sage because they offered immediate and enthusiastic outreach to her as a new student:

Sage and [another nearby community college] were definitely [on my list] and I’m not sure it happened with [the other] one, but Sage was like, “Oh, welcome. Congratulations on enrolling.” So I definitely felt more drawn to that because it’s like, okay, they obviously want me there enough that they’re responding to me sooner.

This, combined with greater clarity over the availability of online offerings at Sage, swayed Student 20's matriculation decision.

Other students echoed that the ease of matriculation factored into their choice to attend Poppy. Student 24 was deciding between Sage and the same nearby community college. After she was admitted to Sage, they followed up with a helpful program for matriculating students where students watched "a few different videos" and met "with a counselor who just really explained everything". The outreach "solidified" Student 24's intention to choose Sage over the other school: "Sage, I feel like, offered way more." Student 18 was also taken by the program's online-friendly approach to student services. She relates that as she was weighing college options, the availability of online counseling was a major selling point:

I reached out to a counselor on Sage and they said, "You don't even have to come in. We even do the counseling appointments via, like a Zoom as well. I think it was Zoom or Skype. When she actually told me that, I was sold right away with that because I was like, if I need to reach out to a counselor or whatever, I can just email them, and they respond.

The value of this approach was especially apparent to Student 18 because it compared favorably to another college she had attended: "coming from another community college, I noticed a difference right away."

While most Poppy students also rated the application process as "easy", several commented they would have preferred more guidance and support in matriculating. As one first-time student put it, Poppy staff "never helped me out. I became really frustrated when I was there because they didn't understand that it's my first time going to college and I have to take off time to go there, you know, of course you can't do anything over the phone" (Student 7). The student was especially frustrated at needing to physically go onto the campus to get help. Others recounted "time-consuming" sessions on the phone with the registrar's office (Student 12) or going in for "multiple visits to the counselor's office on the weekends" (Student 8) to address transcript issues. Overall, more students recounted difficulties in the application process at Poppy than at Sage.

Discussion

This study explored students' use of information and motivations for institution choices when selecting fully-online two-year academic programs among a sample of students who ultimately chose community college programs. We find that students relied on a mix of information provided by the college (e.g., college websites and college personnel) and external information sources (e.g., family, friends and external websites) to make decisions. As our participants gathered information, students often started with information external to the college—e.g., information from web searches or recommendations from friends, family, or colleagues—and then relied more on on-campus sources of information such as websites and counselors as they narrowed their choice. College websites served as a marker of program quality for some students, as students felt that high-quality online programs should also communicate clearly in their college websites. Students, particularly from Sage, lauded admissions procedures that provided significant outreach and support; consistent with research

showing that administrators consider personal outreach crucial in recruiting online students (Ortagus & Tanner, 2019).

Students in our sample identified several factors that loomed large in their decisions to pursue their fully-online degrees at our two sample community colleges. Cost was a major driving factor. Students also wanted to be confident they would be able to access the coursework needed to graduate. They considered the robustness of online course offerings and whether multiple campuses were available to broaden the range of online courses they had access to, and whether campuses were sufficiently proximate to allow them to be on campus if needed for either meetings or coursework. Students valued the reputation of the colleges they attended, and some decided against for-profit options due to perceptions of lower quality or predatory approaches. Finally, students appreciated demonstrations that colleges would provide welcoming environments.

In some ways, our findings echo past work. For instance, the centrality of cost as a consideration echoes findings from past research around why students opt for community colleges (Iloh & Tierney, 2013, 2014). The importance of cost may also reflect the pressures often associated with nontraditional students, who may be maintaining financial independence or caring for dependents (Horn & Carrol, 1996; Bers & Smith, 1987; United States Department of Education, n.d.a.). Similarly, convenience has been identified as a primary concern of students enrolling in individual online classes in prior work (Benbunan-Fich & Hiltz, 2003; California Community Colleges Chancellor's Office, 2017b; Clinefelter & Aslanian, 2017; Farris et al., 2003; Jaggars, 2014; Ruffalo Noel Levitz, 2016; Lansing, 2017), and our students' accounts of needing consistent online courses to mesh with their schedules and academic needs echoes this work. Students in our interviews relied heavily on family and friends in forming opinions about schools' reputations; echoing prior work around undergraduate choice (Somers et al., 2006, but differing from work focused on fully-online enrollment at the graduate level which found more minimal influence of personal recommendations from friends and family (see Capranos & Dyer, 2020). Our findings suggest that the decisions of fully-online undergraduate applicants more closely resemble face-to-face undergraduate applicants than fully-online graduate applicants.

On the other hand, prior research around community college leaders' expectations post-COVID (Hart et al., 2025) found that some leaders expected students open to online courses to "shop around" for possible courses across entire state systems given the lack of geographic constraints. While our study was conducted pre-COVID, our findings suggest that many students may still prefer local colleges as their primary institutions, as they value being able to go into campus if needed.

The pattern of information use reported by students also appears to be similar to findings reported by Bers and Smith (1987), namely that nontraditional students do not tend to engage in a sequential search process, but rather that search and choice happen simultaneously with students deciding on a particular college as soon as it appears to meet most of their needs. We find that for some students who relied primarily on familiarity and word of mouth, those students trusted this information enough to expect a satisfactory outcome without a broader consideration of options.

On the other hand, students who engaged in more comprehensive search processes related that availability and clarity of information was an important factor in their final decision. With this in mind, institutional websites should be both comprehensive and easy to navigate with up-to-date information about the college, course and program offerings, and enrollment processes. If availability of information contributes to college choice (Iloh & Tierney, 2014), and online students make rapid choices simultaneously with their search process as suggested by Bers and Smith (1987), then it is particularly important that institutions make sure that needed information is readily available. Our findings suggest that students are disinclined to search extensively for needed information before moving on to the next school or program option, especially if they view disorganized websites as a marker of program quality.

Our study has some important limitations. The interviews presented in this study capture only a small range of the experiences of students enrolling in fully online degree programs. Participants were predominantly female and older than traditional college age (25+), and their processes, influences, and access to information may be different from that of other groups. We drew from just two colleges, and it may be that the choices made by these students would differ in other settings. Additionally, we do not capture the processes and experiences of students who made different final decisions; this is an important delimitation to our work caused by our decision to sample students in community colleges. Future research is needed to explore the processes of those students who considered fully online degree and certificate programs and ultimately rejected the online route in favor of a traditional face-to-face pathway. Moreover, recent research suggests that college students are becoming more open to online courses in the post-COVID era (Bright & Vogel, 2024; Tang et al., 2025); it is possible that student preferences for fully-online programs may also have shifted post-pandemic. Future research should explore this possibility.

Nonetheless, our findings have important implications for policymakers as colleges face expanded use of online courses post-COVID. Community college stakeholders have voiced concerns that students would be drawn away from local colleges' programs by broader online choices—including options to enroll in non-proximate colleges or in the system's first fully-online college, Calbright (Hart et al., 2025; Watanabe, 2018)—yet if students make decisions based on familiarity with an existing brick-and-mortar campus, and if students prefer to have a local “home college” to preserve the option for in-person interactions if needed, that fear may be unfounded. This set of findings echoes those of other studies showing that graduate students sought information on local options even when intending fully-online attendance that theoretically eliminated geographic constraints (Capranos & Dyers, 2020), and that fully-online students have become increasingly likely to prefer local campuses over time (Clinefelter et al., 2019). Existing colleges may want to present prospective students with enrollment options on-campus and online, promote the availability of student support, and affirm community ties through a carefully developed website providing clear, timely information. Colleges should also find ways to adapt student support services, at admissions but also for processes such as counseling and financial aid, to support fully online students without requiring them to come to campus. Similarly, it is important that colleges continue to recognize that it is the convenience of online courses that draws students to fully online degree programs. Attention to these processes should help colleges recruit and serve fully-online students going forward.

Declarations

Acknowledgements

This study is an extension of a dissertation study that investigated students' decision processes when choosing to enroll in an online degree program (see Hill, 2019). For purposes of this paper, we have expanded the sample to include an additional college and focused only on the sources of information and the choice of institution, not the overarching choice of pursuing a fully online degree. For a more detailed discussion of the choice to pursue a fully online degree in the single-college sample, see Hill, 2019. We thank the participants in this study who shared their time and insight with us. We are also grateful to distance education leaders at Poppy College and Sage College for their help in this study. We thank dissertation committee members Kevin Gee and Michal Kurlaender for their feedback during the development of this project, and Lauren Lindstrom for her input on manuscript drafts. We gratefully acknowledge support for this work to the second author from the University of California, Davis School of Education Dean's Research Excellence Award grants. All errors are solely ours.

Ethics Board Approval

This study was conducted with approval by the University of California, Davis IRB (#1297729).

Conflicts of Interest

We have no conflicts of interest to declare.

References

- Allen, I. E., & Seaman, J. (2013). *Changing course: Ten years of tracking online education in the United States*. Sloan Consortium. <https://eric.ed.gov/?id=ED541571>
- Barnes-Teamer, T. (2003). *Confirming college choice: How career aspirations and social capital influence decision-making of technical college students* (3102776). [Doctoral dissertation, University of New Orleans]. ProQuest Dissertation & Theses.
- Benbunan-Fich, R., & Hiltz, S. R. (2003). Mediators of the effectiveness of online courses. *IEEE Transactions on Professional Communication*, 46(4), 298–312. <https://doi.org/10.1109/TPC.2003.819639>
- Bers, T. H., & Smith, K. (1987). College choice and the nontraditional student. *Community College Review*, 15(1), 39–45. <https://doi.org/10.1177/009155218701500106>
- Bright, K., & Vogler, J. S. (2024). Learning online vs. learning in person: A mixed-methods approach to understanding how student preferences and perceptions have evolved since the pandemic. *Online Learning*, 28(4), 56–78. <https://doi.org/10.24059/olj.v28i4.4565>
- Cabrera, A. F., & La Nasa, S. M. (2000). Understanding the college-choice process. *New Directions for Institutional Research*, 200(107), 5–22. <https://doi.org/10.1002/ir.10701>
- California Community Colleges Chancellor's Office. (2017). *2017 distance education report*. Sacramento. <https://www.cccco.edu/About-Us/Reports>
- California Community Colleges Chancellor's Office DataMart. (n.d.). *Annual/term student count report*. <http://datamart.cccco.edu>
- Capranos, D., & Dyers, L. (2020). *Online student behaviors and attitudes: A survey of prospective students, current learners, and recent graduates of Wiley Education Services' partners*. Wiley. https://web.archive.org/web/20220222102126/https://universityservices.wiley.com/wp-content/uploads/2020/04/202404-Online-Student-Behaviors-and-Attitudes-Report-WES-Final-for-Web_x.pdf
- Chapman, D. W. (1981). A model of student college choice. *The Journal of Higher Education*, 52(5), 490. <https://doi.org/10.2307/1981837>
- Clinefelter, D. L., Aslanian, C. B., & Magda, A. J. (2019). *Online college students 2019: Comprehensive data on demands and preferences*. Wiley. <https://oscqr.suny.edu/wp-content/uploads/2024/07/OCS-2019-FINAL-WEB-Report.pdf>
- Deming, D. J., Goldin, C., & Katz, L. F. (2012). The for-profit postsecondary school sector: Nimble critters or agile predators? *Journal of Economic Perspectives*, 26(1), 139–164. <https://doi.org/10.1257/jep.26.1.139>

- Farris, P. W., Haskins, M. E., & Yemen, G. (2003). Executive education programs go back to school. *Journal of Management Development*, 22(9–10), 784–795.
<https://doi.org/10.1108/02621710310495775>
- Flowers, J., & Cotton, S. (2003). Master of arts in career and technical education—now 100% online. *Tech Directions*, 63(2).
<https://www.proquest.com/openview/5255d6eba27b87f86eb7bd85e7b33cda/1.pdf?pq-origsite=gscholar&cbl=182>
- Hardin, R. (1993). The street-level epistemology of trust. *Politics & Society*, 21(4), 505–529.
<https://doi.org/10.1177/0032329293021004006>
- Hart, C. M. D., Hill, M., Alonso, E., & Xu, D. (2025). “I don’t think the system will ever be the same”: Distance education leaders’ predictions and recommendations for the use of online learning in community colleges post-COVID. *The Journal of Higher Education*, 93(3), 436–460. <https://doi.org/10.1080/00221546.2024.2347810>
- Hearn, S. L., & Long, M. S. (2023). Adult learners’ college access and choice process: A literature review. *Student Affairs on Campus*, 6(1), 37–47.
<https://hdl.handle.net/1969.1/200244>
- Hill, M.S. (2019). *Nontraditional and the new normal: Three studies on nontraditional student pathways in higher education* (22622181). [Doctoral dissertation, University of California, Davis]. ProQuest Dissertation and Theses. <https://www.proquest.com/dissertations-theses/nontraditional-new-normal-three-studies-on/docview/2309856041/se-2>
- Hill, P. (2021, February 28). Fall 2019 IPEDS data: Final pre-pandemic profile of US higher ed online education. *On EdTech Newsletter*. <https://onedtech.philhillaa.com/p/fall-2019-ipeds-data-final-pre-pandemic-profile-of-us-higher-ed-online-education>
- Hill, P. (2024, January 21). Fall 2022 IPEDS data: Profile of US higher ed online education. *On EdTech Newsletter*. <https://onedtech.philhillaa.com/p/fall-2022-profile-us-higher-ed-online-education>
- Horn, L. J., & Carroll, C. D. (1996). *Nontraditional undergraduates: Trends in enrollment from 1986 to 1992 and persistence and attainment among 1989 beginning postsecondary students*. National Center for Education Statistics, U.S. Department of Education.
<https://files.eric.ed.gov/fulltext/ED402857.pdf>
- Hossler, D., & Gallagher, K. S. (1987). Studying student college choice: A three-phase model and the implications for policymakers. *College & University*, 62(3), 207–221.
https://www.researchgate.net/publication/234741450_Studying_Student_College_Choice_A_Three-Phase_Model_and_the_Implications_for_Policymakers
- Iloh, C., & Tierney, W. G. (2013). A comparison of for-profit and community colleges’ admissions practices. *College & University*, 88(4), 2–12.
<https://www.proquest.com/openview/d3c423c30a960d064ff07ec89c8d7708/1?pq-origsite=gscholar&cbl=1059>

- Iloh, C., & Tierney, W. G. (2014). Understanding for-profit college and community college choice through rational choice. *Teachers College Record*, 116(August), 1–34. <https://doi.org/10.1177/016146811411600808>
- Jaggars, S. S. (2011). Online learning: Does it help low-income and underprepared students? *Community College Research Center Working Paper*, 26. <https://academiccommons.columbia.edu/doi/10.7916/D82R40WD>
- Jaggars, S. S. (2014). Choosing between online and face-to-face courses: Community college student voices. *American Journal of Distance Education*, 28(1), 27–38. <https://doi.org/10.1080/08923647.2014.867697>
- Lansing, J. (2017). A new model of college choice for distance learners. *Journal of Educational Technology Systems*, 45(3), 365–389. <https://doi.org/10.1177/0047239516673183>
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2020). *Qualitative data analysis: A methods sourcebook* (4th ed.). Sage.
- Ortagus, J. C. (2017). From the periphery to prominence: An examination of the changing profile of online students in American higher education. *Internet and Higher Education*, 32, 47–57. <https://doi.org/10.1016/j.iheduc.2016.09.002>
- Ortagus, J. C., & Tanner, M. J. (2019). Going to college without going to campus: A case study of online student recruitment. *Innovative Higher Education*, 44, 53–67. <https://doi.org/10.1007/s10755-018-9448-9>
- Parsad, B., Lewis, L., & Tice, P. (2008). *Distance education at degree-granting postsecondary institutions: 2006-07*. Institute of Education Statistics, National Center for Education Statistics. <https://nces.ed.gov/pubs2009/2009044.pdf>
- Perna, L. W. (2006). Studying college access and choice: A proposed conceptual model. In J. C. Smart (Ed.), *Higher education: Handbook of theory and research* (Vol. XXI, pp. 99–157). https://doi.org/10.1007/1-4020-4512-3_3
- Public Agenda. (2013). *Not yet sold: What employers and community college students think about online education*. <https://kresge.org/wp-content/uploads/2020/07/Online-learning-college-degrees-2013.pdf>
- Ruffalo Noel Levitz. (2016). *2015–16 national online learners’ satisfaction and priorities report*. <https://files.eric.ed.gov/fulltext/ED602841.pdf>
- Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Sage.
- Seidman, I. (2013). *Interviewing as qualitative research* (4th ed.). Teachers College Press.
- Somers, P., Haines, K., Keene, B., Bauer, J., Pfeiffer, M., McCluskey, J., ... Sparks, B. (2006). Towards a theory of choice for community college students. *Community College Journal of Research and Practice*, 30(1), 53–67. <https://doi.org/10.1080/10668920500248886>

- Tang, Y., Tseng, H., Kuo, Y., Yeh, H., & Liu, J. (2025) Setting the stage for success: Readiness and connectedness as antecedents of learning continuance intention in online earning. *Online Learning*, 29(1), 214–239. <https://doi.org/10.24059/olj.v29i1.4402>
- Tierney, W. G., & Venegas, K. M. (2009). Finding money on the table: Information, financial aid, and access to college. *Journal of Higher Education*, 80(4), 363–388. <https://doi.org/10.1353/jhe.0.0059>
- United States Department of Education. (2009). *Choosing a postsecondary institution: Considerations reported by students*. NCES. <http://nces.ed.gov/pubs2009/2009186.pdf>
- United States Department of Education. (n.d.a.). *National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), 2019, fall enrollment*. <https://nces.ed.gov/ipeds/use-the-data>
- United States Department of Education (n.d.b.). *National Center for Education Statistics, 2003–04, 2007–08, 2011–12, 2015–16, and 2019–20 National Postsecondary Student Aid Study (NPSAS:04, NPSAS:08, NPSAS:12, NPSAS:16, and NPSAS:20)*. https://nces.ed.gov/programs/digest/d22/tables/dt22_311.22.asp
- Watanabe, T. (2018, January 10). Gov. Brown proposes California’s first fully online public community college. *Los Angeles Times*. <https://www.latimes.com/local/education/la-me-online-community-college-20170110-story.html>

Appendix A

Table 1

Participant Characteristics for Each Site, Compared to Full College

Characteristic	Poppy College		Sage College	
	Sample	Full College	Sample	Full College
	%	%	%	%
Gender				
Male	20	55	10	40
Female	80	45	90	60
Age Range				
24 and under	26	45	10	65
25 – 29	27	20	40	15
30 – 39	20	20	30	10
40 and over	27	15	20	10
Race/Ethnicity				
Latino	40	30	30	40
White	27	40	60	40
Asian/Pacific Islander	13	15	20	5
Black/African American	7	5	0	5
Other	0	15	0	15
Declined to Answer	13	0	0	0

Note. Source: authors' tabulations from participant survey data (Columns 1 and 3), and fall 2019 enrollment figures from the Integrated Postsecondary Education Data System (Columns 2 and 4). College-data rounded to nearest 5% to preserve anonymity of colleges. Numbers for race/ethnicity categories in Sage sum to more than 100 due to respondents reporting multiple ethnicities. For consistency with Poppy's race reporting, race and ethnicity were combined into a single category. For example, if ethnicity was identified as Hispanic/Latino and race was left blank or identified as White, students were coded as Latino.

Table 2
Code Hierarchy for Codes Used in This Paper

Code Group, Theme, Subcode	Description	Example
Choice of College	Discussion of factors that impacted their choice of the current college students attend. Includes discussion that a factor is a plus or a minus, is important or is not.	See below
<i>Financial</i>	Discussion of financial considerations in choosing current college. May include raw cost, financial supports available, etc.	"Most of it was online and then when they do call me, when you sign up for information they call you and I would ask them all these questions and then it really truly came down to financial aid and being able to afford \$4000 a month was just too much right now."
<i>Reputation</i>	Discussion of reputation as a factor in college choice. Includes having heard from others about a college, or being generally aware of it as having good programs or good supports. May include factors that erode trust (e.g., thinking colleges use predatory recruitment). May also include familiarity (e.g., based on prior attendance)--school as a "known quantity".	"So, just those little things of like, it was such a high-quality school, their [Sage's] rates on how many people were getting degrees and stuff, it just was phenomenal."
<i>Logistics</i>		See below
Proximity	Mentions of proximity as a reason for attending college--e.g., because students expect they may have to go into campus either for an odd in-person course or two, or because they may have to use student services, have tests proctored, etc.	"Well it's [Poppy is] close for me if I did need to go in to take a test or something or other. It's the closest college for me."
Choice of Classes	Discussion of availability of classes that are of interest. Includes availability of online classes or breadth of online offerings if those weighed into students chose a particular college.	"At some colleges, there would be, let's say that you needed two colleges, or two courses to complete a degree. Which is unrealistic, but for sake, we'll pretend. One of those courses could be available online every single semester, and then randomly it will change it on campus only. So I didn't really feel comfortable pursuing a degree from where that was a possibility."
Multiple Colleges	Discussion of benefits of having multiple colleges as options, in the context of a district. Coded if the fact that multiple colleges are available plays into the choice of whether to attend.	"So, I like that, that they gave you the option where you can kind of take the class, regardless if it's on their campus or offered through their school that [Poppy's district] offers through their core colleges, if you can't get into a class. If their online class is full, at

Application Process

Discussion of the application process--considerations on whether the application process makes it easy or difficult to complete and apply

least you can try and see if they have it at another one [campus].”

Like I said, from the minute that I started doing my registration and the financial aid and everything, for me it has been a really good experience. Everybody's been very flexible and very welcoming. It's just worked out very well, especially I think coming from another community college I noticed a difference right away.

Sources of Information*External Sources: Human*

Mention of people NOT affiliated with college who helped provide information--family, friends, colleagues, people affiliated with other government agencies, etc.

“I had two or three of my clients who were, probably a good ten years younger than me, who walked me through every single thing, and really gave me a good idea of what to expect, or not what to expect”

External Sources: Web

Mentions of websites outside of those from home college. This can include home sites of other colleges they did not ultimately go to as well.

“I use Google. I go through the ones that look like they have meaning, but I guess one site that I do like to look at is called Quora, Q-U-O-R-A dot com, and those are basically forums where a person can ask a question about anything and a lot of people will give their insight on it, or they'll give you the information, or they'll even give you links towards information too. I kind of like that website, because there's a lot of people who tend to use it, and they definitely will reach out to you and answer your question if you have one.”

College Sources: Web

Mentions of using home college website to get information--e.g., on degree options, course availability, to learn more about supports, or the college generally

“If I hadn't found that [Poppy] website there, it would be very difficult for me to find out what was 100% online.”

College Sources: Human

Mentions of talking to humans at the home college (or other college sites) to decide whether to apply/in help with application process. Includes counselors (academic, financial aid, admissions, etc.), Vet Center personnel, etc.

And I did have to spend a lot of time on phone with the registrar's office, just to figure out which category I was under. So that was kind of time consuming, and they don't want to speak to you, unless you have already applied and have a student ID. So it was a little bit time consuming, versus just click, click, click, apply, you're done.

Note. We exclude codes and sub-codes that we did not draw on for this paper, e.g., codes in the “motivation for college enrollment” family, which related to students’ goals in returning to college generally, “motivation for online degree or certificate,” which coded why students preferred online course-taking. These codes were out of the scope for this paper.

Appendix B

Interview Protocol

Introduction

Good [morning/afternoon], and welcome. My name is [interviewer name], and I'm from [Institution (Blinded for Review)]. I'll be recording this interview so that I don't miss any important details. I'm going to start the recording now [START RECORDING].

Okay, let's get started. We are talking with students who are taking fully online classes to earn degrees (and certificates?) at [Institution name] as well as other schools to get a better understanding of the factors that were important to you when you decided to pursue your education fully online at [Institution Name]. We are also interested about the sources of information that you used to learn more about different program options.

Before we get to the questions, I want to make sure you are informed about what the study entails and that you consent to participate. I'm going to read a short form to you, and at the end, I will ask you whether you agree to participate.

[Read Consent Form, ask respondent to indicate consent.]

[If participant agrees to participate, express appreciation; if not, thank the participant for considering participation and let them know that their participation will be halted at this time.]

[Interviewer Background]

Because my focus is truly on *your* experience, I want you to take charge of the interview. I have some guiding questions, but I really want to know about your experience, your thought process, and your challenges. Please feel free to take me in the right direction. If my questions don't make sense, please let me know and don't hesitate to ask for clarification.

Guiding Questions

- 1) I'd like to get started by asking you to introduce yourself and tell me what program you are attending and which degree or certificate you are working toward.
 - a) Probe: Specific discipline
- 2) What were you doing when you decided to go back to school? What made you decide to return to school and pursue your degree/certificate?
Additional probes, if needed:
 - a) What do you want to do with your degree/certificate?
 - b) Were you working full-time or part-time when you decided to enroll, and are you working now?
 - c) Do you have a family you are taking care of? How did that factor into your decision?
 - d) Did you go to college right out of high school?
 - e) How long do you anticipate that it will take you to complete our goal?
- 3) Tell me about when you first started thinking about starting a fully-online degree.
 - a) Did you attend any other colleges before this?
 - b) Did you ever take college classes face-to-face before you decided to pursue your fully-online degree?
 - i) How did you do in those classes?
 - ii) How was your experience of taking face-to-face classes?
 - c) What factors contributed to you decide that you wanted to pursue an online degree/credential program at this time?
- 4) Tell me a bit about how you looked for a program—how did you first hear about **{Institution Name's}** program? (Probes: Did you hear about the program through friends/family/colleagues/teachers/advertisement, etc.)
- 5) After you learned about **{Institution Name's}**, where else did you look for information to learn more about it?
 - a) Did you talk to friends or family members?
 - b) Did you talk to professional colleagues?
- 6) Additional probes for a and b: Why did you talk to those specific people? Had they taken classes or a full degree online?
 - a) Did you read online reviews? From what websites?
 - i) Can we do a screen share and you can you walk me through some of the places you looked?
 - b) Did you use an online search engine (Google)? Do you remember any of the key search terms you used?
 - c) Did you get advice from a counselor? High school or college
 - d) Did you talk to someone from the college/university?
 - e) What other sources of information did you use?

- 7) What sources of information did you find most helpful as you decided which program to enroll in? What made that source of information especially helpful?
- 8) Which sources of information did you feel were the most reliable/accurate? Why?
- 9) Which other schools and programs did you consider, including this one, and why did you ultimately choose **{Institution Name}**?
 - a) What made you consider those schools?
 - b) What did you rule out?
 - i) Why did you specifically rule out those schools?
 - c) Did you consider attending at a physical campus? What factored into your decision to consider attending a physical campus, and ultimately to attend virtually instead?
- 10) What are the biggest factors that ultimately made you decide on this program?
- 11) When you made the decision was it easy to enroll? Were there any parts of the enrollment process that seemed difficult or burdensome?
 - a) What did you do next?
 - b) What steps, if any, did the college or university take to support you as you were enrolling?
- 12) If someone were to come to you now for advice about enrolling in an online program, what advice would you give them?
- 13) Is there anything else that you think I should know about your decision-making process in enrolling in an online program?

Learner Support Practices in Open and Distance Learning Institutions in Gaborone, Botswana

Linda Sameta

Faculty of Education, Blessings University of Excellence, Lusaka, Zambia
lindasmphande@gmail.com

Sourav Mukhopadhyay

Graduate School of Education, Nazarbayev University, Astana, Kazakhstan
sourav.mukhopadhyay@nu.edu.kz

Fazlur Moorad

Primary Principal, Westwood International School, Gaborone, Botswana
fazlurmoorad@gmail.com

Abstract

The Government of Botswana has embraced open and distance learning (ODL) as a strategic approach to achieve universal access to quality education. However, a notable discrepancy between enrollment and completion rates in ODL institutions threatens the fulfillment of Sustainable Development Goal 4 and the establishment of a skilled workforce. This study investigates the importance of robust learner support systems in bridging this gap. Employing a qualitative multiple-case study design, data were collected from 42 ODL practitioners using open-ended questionnaires and individual interviews. Although this design provided in-depth insights into learner support, findings are limited in generalizability and reflect the perspectives of ODL practitioners in a specific context only. The findings reveal that effective learner support—comprising online technical assistance, improved Internet accessibility, virtual learning evaluation, and fostering learner communities—is essential for enhancing completion rates. This study emphasizes the need for ODL institutions to invest in technological infrastructure and implement comprehensive learning management systems to effectively support learners. Although these findings are similar to those of studies conducted in developing countries, they provide valuable guidance for improving learner support practices in ODL programs, particularly in the context of Botswana's educational landscape.

Keywords: Learner support, open and distance learning, technological infrastructure, Sustainable Development Goal 4 (SDG 4), Botswana, qualitative research

Sameta, L., Mukhopadhyay, S., & Moorad, F. (2025). Learner support practices in open and distance learning institutions in Gaborone, Botswana, *Online Learning* 30(1), pp. 399-422. <https://doi.org/10.24059/olj.v30i1.4765>.

The Government of Botswana (GoB) has adopted Open and Distance Learning (ODL) to achieve universal access, inclusion, and equity in quality education (Seeletso & Morolong, 2025). Globally, ODL institutions face a mismatch between enrollment and completion rates (Maritim & Getuno, 2018). In Botswana, researchers are concerned about low ODL learner completion rates, particularly in teacher-training colleges that offer primary or secondary education diplomas (Kamau, 2012; Sikwibele & Mungo, 2009). Students enrolled at these colleges struggle to complete their studies (Magetse et al., 2024). Failure to resolve this problem could negatively impact the government's efforts to increase access to education and improve the skill base of the population. This is a global challenge that remains under-researched (Bawa, 2016).

Decades of ODL research from the developed world, primarily from the United States of America, Canada, and Europe, inform current understanding of learner support services, operational frameworks and pedagogical strategies often viewed as international best practices. However, the applicability and integration of these established online learning strategies are still in the nascent stages in the developing world, including Botswana. This research aims to transpose these methodologies to Botswana and critically examine their effectiveness, adaptability, and sustainability given distinct educational, technological, and socio-economic landscapes. By focusing on Botswana, this study contributes to understanding how established ODL practices can be adapted and potentially transformed to meet the specific needs of learners in developing nations, thereby extending the global dialogue on educational equity and access to ODL.

ODL is becoming a crucial way to deliver higher education, with the potential to broaden access to various education levels cost-effectively in Botswana and other African countries. It promotes student engagement, access to information, and content sharing (Mathew & Iloanya, 2016). To maximize ODL's impact in Botswana, institutions must invest more resources, enhance parity with face-to-face provision, and integrate e-learning strategies (Nage-Sibande & Morolong, 2018; Tladi & Nleya, 2019). However, ODL programs, particularly in Africa, often have low success rates, due to inadequate institutional and national regulatory policy frameworks (Kihwelo, 2014). The Government of Botswana (GoB) has, among other policies, the Education and Training Sector Strategic Plan (ETSSP) 2015-2020, which aligns with Sustainable Developmental Goal 4 and Vision 2036 (Musekiwa & Mandiyanike, 2017). The ETSSP was created to improve access, inclusion, equity, accountability, and governance in the education system (Republic of Botswana, 2015). Under the guidance of the ETSSP, initiatives such as the Back-to-School Program, which offers young people (below 35 years) a second chance to obtain the skills necessary for the workforce, have been implemented through the ODL (Republic of Botswana, 2015). Additionally, National Literacy Programme (NLP) was introduced in 1981; as a result the adult literacy rate has improved significantly (Gumbo & Oats, 2025). According to UNESCO (2014), the quality and relevance of education still need special attention if sustainable development is to be achieved. Despite these advancements, Botswana's ODL institutions face ongoing challenges, including limited resources, planning issues, e-learning integration challenges and negative perceptions of dual-mode universities (Sibande, 2011; Tladi & Nleya, 2019;). Despite these hurdles, ODL remains vital for expanding access to higher education in Botswana (Giannini-Gachago & Seleka, 2005). Nevertheless, ODL's success depends on clear policies, a strong vision, leadership support, and an understanding of its systemic nature (Uys, 2003).

Theoretical Framework

Transactional Distance Theory (TDT) served as the theoretical framework for this study, investigating the unique dynamics of teaching and learning in distance education (Moore, 2018). TDT provides a theoretical lens that helps assess learner-instructor interactions, ODL program structure and learner empowerment encompassing synchronous and asynchronous communication methods such as live discussions, emails, discussion forums, and personalized assignment feedback. A TDT-based pedagogy promotes dialogue and individualized learning experiences by accommodating individual learner needs. In Botswana's higher education ODL context, this approach provides insights into instructional material creation, technological support, and learning community development. Flexible content, open schedules, and feedback mechanisms are crucial structures for effective ODL course delivery. TDT can also assess how institutions design flexible curricula, support learners through various communication channels, and encourage self-directed learning.

Furthermore, TDT can facilitate ODL programs' effectiveness. This theory aids in understanding and addressing unique distance education challenges, such as maintaining engagement and supporting learners without regular face-to-face interactions. Applying TDT principles, ODL can improve learner outcomes, increase satisfaction, and create a more inclusive and accessible educational environment. Bolliger and Halupa (2018) and Blayone (2019) demonstrated that reducing transactional distance through structured interactions and meaningful dialogue significantly enhanced student satisfaction and learning outcomes. This emphasizes the importance of active participation and instructor presence, particularly relevant for ODL in Botswana, where engagement and support are crucial. Zozie and Chawinga (2018) highlighted ODL's potential to increase access to higher education in remote areas, a key goal for Botswana; however, they highlighted the need for adequate infrastructure to support these initiatives. Similarly, Şenocak et al. (2021), emphasized robust technological support and responsive instructional design to mitigate isolation and enhance student engagement. Collectively, these findings show TDT could provide a comprehensive framework for designing and implementing ODL programs that balance the structure, interaction, and learner autonomy, making it a well-suited theoretical foundation for research within Botswana's educational landscape.

Literature Review

Learner Support and Completion Rate in ODL Institutions

Learner support is critical for ODL institutions, promoting educational access (Rakoma, 2018) and improving student success, retention, and satisfaction (Ouma, 2019; Wani et al., 2023). Key factors for student success depends on continuous professional development for staff (Modise, 2020), effective strategies for delivering support (Shikulo & Lekhetho, 2020), and inclusive provisions support for students with disabilities (Ntombela, 2021). Undoubtedly, institutions encourage information and communication technologies (ICTs) to enhance support services (Tseng & Inman, 2024). Open universities in developing countries, such as Sri Lanka and Indonesia, have demonstrated the importance of tailored support strategies, encompassing instructional design, learning engagement, and quality assurance (Zuhairi, et al., 2019). Therefore, comprehensive, accessible, and adaptable learner support systems are vital for successful outcomes in distance learning environments (Angelino et al., 2007). Ramdass and Nemavhola (2018) suggest that an ODL learner support framework should include motivation, building learner confidence, support for under-

prepared learners, preparing learners to study independently, and developing a sense of belonging to the institution.

Establishing a robust social learning community is crucial for effective learner support (Shea et al., 2005). These communities promote trust, shared identities, and collaborative relationships, which are essential for effective learning and problem-solving in the ODL. Furthermore, social learning communities have the potential to facilitate collective action and knowledge sharing (Shea & Bidjerano, 2019) and scaffold students to overcome socio-ecological vulnerabilities through participatory approaches (de Souza et al., 2020). Overall, these studies emphasize the importance of social learning communities (Angelino, et al., 2007), in promoting networking and collaboration to provide learners with a sense of belonging, which motivate and engage students in information flow (Maritim & Getuno, 2018).

Learner support through orientation also plays a critical role in retaining learners (Martin, et al., 2023). Similarly, Maritim and Getumo (2018), suggest that early contact with learners through pre-entry counselling sessions and the provision of prerequisite information can increase learners' success and completion rates. Additionally, mentoring is important for students' continued learning (Paniagua & Simpson, 2018; Youp, 2018). Support services, such as career guidance and identifying at-risk students, should be mandatory and continuous for a more effective impact on completion rates (Bawa, 2016; Paniagua & Simpson, 2018). The application of tracking mechanisms is critical for identifying at-risk learners (Kamau 2012; Paniagua & Simpson 2018). These authors also indicate that students with a clear understanding of their enrolled program reduce chances of withdrawing. Gordon (2019) advises that mentoring can help learners clarify their goals.

Online Learner Support

The need to employ online support as a strategy to improve learners' accessibility to learning resources and services in ODL cannot be overemphasized. Online learning delivery is supported by learning management systems (LMS), online technical support, open educational resources (OER), Internet services, and technological devices. Studies (Angelino et al., 2007; Mathew & Iloanya, 2016) highlight the potential of modern technology to improve accessibility and enhance ODL programs delivery, thereby increasing completion rates. Technologies such as LMS, chats, and visual and audio files are essential for online delivery (Maritim & Getuno, 2018).

Information, including academic advising, consultations, program requirements and policies and feedback, can be made available online for learners (Meyer et al., 2022). In addition, online technical support systems should be readily available to troubleshoot challenges and provide prompt responses (Eunice & Cosmas, 2019). In the USA, most institutions support learners by facilitating access OER or loaning out devices such as laptops and offering wi-fi hotspots to those in need (U.S. Department of Education, 2017). For ODL learners to succeed, computer literacy is essential (Maritim & Getuno, 2018).

Motivation and Engagement of Learners in Open and Distance Learning

Motivation is an indispensable aspect of learner support and plays a crucial role in ensuring learner engagement in ODL programmes (Zuhairi, 2019). ODL learner motivation must be at the forefront of the delivery process (Lucey, 2018). Botton and Gregory (2015) identified successful motivating strategies to help institutions improve online learning processes and improve learner completion rates. Their study revealed that lecturers or tutors

can support learners by actively participating in discussion forums and sending reminder emails. Lucey (2018) suggests that instructors need to constantly interact with their learners online and provide regular constructive feedback. Another motivating approach is integrating relevant and employment-applicable content into the curriculum (Botton & Gregory, 2021; Lucey, 2018). Additionally, flexible course design allows learners to complete studies and assignments at their own time, pace, and place also increases motivation (Lyyra et al., 2024).

Purpose of the Study

This study aimed to gain insight into the implementation process of ODL programs and establish effective support practices that could improve learner completion rates. The overarching research question is: How can learner support be improved to help increase learner completion rates in ODL institutions in Botswana?

Methods

Research Design

This study is part of a master's dissertation by the first author, investigating the management of course delivery quality in Open and Distance Learning (ODL) institutions in Gaborone. A qualitative multiple-case study design was employed, which enabled the researchers to compare and contrast the cases to gain deeper insights. Three universities, each forming a unique case, were selected to collect data, offering diverse perspectives on the research problem (Cresswell, 2014). Although a qualitative multiple-case study provided in-depth contextual insights into learner support mechanisms from the perspectives of practitioners, it has inherent limitations, particularly regarding generalizability and potential biases. Nonetheless, the findings offer valuable information about the challenges experienced by ODL practitioners in Botswana and may serve as a useful reference for practitioners in other countries with limited resources.

Research Site

This research was conducted at three universities in Gaborone, Botswana, one private institution, and two government-funded institutions. The research sites were purposively sampled based on their distinct and varied approaches to ODL service delivery and support structures, providing a comprehensive landscape of ODL practices. These sites were chosen for their unique characteristics, including modes of delivery and technological infrastructure, as detailed in Table 2. These factors are critical in providing a comprehensive understanding of management practices in diverse ODL settings.

Participants

The study involved key informants, including teaching staff and managers of ODL programs, who provided relevant data. Participants were purposively selected based on the following criteria: a) employment at the institution for more than one year, either part-time or full-time; b) willingness to voluntarily participate in the study; and c) training in teaching distance learners either formally or in-house. Purposive sampling has inherent limitations; however, this strategy was deemed most suitable because our objective was to gain rich, detailed insights from "key informants" within the specific rather than to generalize findings. This approach allowed us to recruit participants with sufficient experience and knowledge to understand this complex phenomenon deeply. The study included participants from both blended residential and fully online modes of distance learning (see Table 1). A total of 42 participants participated in the study, comprising 29 males and 13 females aged between 25 and 60 years. The participants were from diverse backgrounds and held different academic

positions, which contributed to a comprehensive understanding of the various perspectives within the ODL programs.

Table 1

Personal Professional Background of the Participants Who Responded to Survey

		Research Sites			Total
		Univ.1	Univ.2	Univ.3	
Gender	Male	19	4	6	29
	Female	7	2	4	13
Highest Qualification	Masters	18	6	6	30
	Doctorate	7	3	2	9
Experience	0-1 Years	4	1	1	6
	2-5 Years	13	4	5	22
	6-9 Years	3	1	1	5
	10+ Years	5	3	1	9
	Computing	4	0	1	5
Subjects	Graduate studies	2	0	0	2
	Business and Accounting	12	3	4	19
	Tourism and Hospitality	1	0	0	1
	Education	7	2	3	12
	Science	0	0	2	2
	Economics	0	0	1	1
	Diploma	2	0	0	2
Programmes Taught	Bachelor	16	7	8	29
	Master	7	0	1	8
	Doctorate	1	0	0	1
Positions	Tutor	3	2	2	7
	Lecturer	20	4	5	29
	Associate Professor	1	0	0	1
	Supervisor/ Manager	2	0	3	5
Full time /	Full time	16	4	7	27
Parttime	Part time	8	2	3	13

Research Instruments

Two data-collection instruments were specifically designed for this research: a) a web-based open-ended questionnaire and b) a semi-structured interview guide. The instruments were developed based on comprehensive literature review on ODL and learner support (Bawa, 2016; Kamau, 2012; Maritim & Getuno 2018; Ouma, 2019; Shea et al., 2005; Sikwibele & Mungo, 2009). To ensure its appropriateness and clarity, instruments were reviewed by three experienced ODL facilitators from higher education institutions and research experts. This review focused on instructional strategies, learner communities, management skills, and learner motivation to help establish content validity. Additionally, a semi-structured interview guide aimed at gathering detailed information about effective instructional delivery methods, learner support, and motivation. This guide was then systematically applied during interviews with the ODL facilitators to explore these themes in depth. Sample questions from the interview included: “What strategies do you use to

motivate distance learners?” and “How do you manage learner communities in an ODL setting?” The complete web-based questionnaire and interview guide are provided in Appendix A and Appendix B, respectively.

Data Collection Procedure

The study was approved by the Institutional Review Board of University of Botswana and a research permit from the Ministry of Tertiary and Skills Development, Botswana. Informed consent was obtained from both institutions and individual participants. Data were collected via web-based questionnaires sent through Google Forms and accompanied by an informed consent form. Sixty-four participants were invited to participate, and 42 of them responded to the questionnaire. All 42 participants were then requested to participate in a follow-up telephonic interview, but only ten agreed. Subsequently, ten semi-structured telephonic interviews were conducted; all the interviews were conducted in English and recorded using a voice recorder to ensure accuracy. To overcome the inherent limitations of a qualitative multiple-case study research design, the first author employed reflexivity through a detailed journal and engaged in discussions with the other researchers. This approach helped maintain focus on the research and capture the authentic voices of participants. Trustworthiness was significantly enhanced by triangulating data from multiple collection methods (web-based questionnaire and telephonic individual interviews) and diverse participants. After transcribing the interviews, a member check exercise was carried out. We provided participants with the transcribed information to comment on whether they felt these transcribed data accurately represented their own opinions and experiences. Participants were also asked to add any additional information. All participants subsequently agreed with their respective transcription and confirmed that the information accurately reflected their contributions to the investigation, thereby enhancing the accuracy and trustworthiness of our data, as well as the credibility and depth of the findings.

Data Analysis

Data were coded and analyzed using a thematic analysis procedure following Braun and Clarke’s (2006) framework. This involved coding the data, identifying themes, and aligning them with the research objectives. Data were independently coded by each researcher and subsequently jointly reviewed and discussed to achieve consensus on the codes and emerging themes. This collaborative approach significantly enhanced the credibility of the findings and mitigated potential researcher bias in the coding process. Data from multiple sources were triangulated and compared across cases to gain a comprehensive understanding of the ODL management practices. For example, responses regarding instructional strategies were grouped under themes such as “learner engagement” and “technological challenges” to provide a nuanced understanding of the issues faced by ODL practitioners.

Findings

Description of the Cases

Case 1: University 1: Private University

It offers business, accounting and finance, computing, education, health information management, and tourism and hospitality courses. The main mode of service is technology-enhanced blended and distance learning (BDL).

Case 2: University 2: Government-Funded

The Education faculty consists of 13 staff members. It offers courses in primary education, integrated early childhood development, special and inclusive education, educational leadership, distance education practitioners, and quality assurance. The institution uses technology-enhanced open- and distance-learning approaches.

Case 3: University 3: Government-Funded

This institution offers accounting, finance, management, marketing, and adult education and management courses. The predominant mode of delivery is face-to-face in a residential distance learning system.

Learner Support in Botswana's ODL Context

This multiple-case study illustrates ODL practices. Table 2 provides the mode of delivery, technology use and infrastructure, mode of assessment, level of courses offered, support services, clientele and quality standards. The analysis of Sites 1 and 2 clearly indicates that private universities have better technology and infrastructural support than government institutions. Private institutions provide multiple modes of teaching and learning that are fully online and blended, whereas government institutions use only technology-enhanced face-to-face delivery. This study, along with previous studies such as Mathew & Iloanya (2016), and Kamau (2012), reported that there remains a significant gap in ODL service delivery. The quality of learner support and the level of use of technology in the delivery process seem inadequate in the government compared with private institutions.

Table 2

Characteristics of the Research Sites

Institution	Types of Univ.	Mode of Delivery	Mode of Assessment	Main Technology infrastructure	Faculty Support	Learner Support Services	Courses/ Clientele	Quality Standards
Univ.1	Private	Both-fully online and blended Blackboard & LMS used for online delivery, recorded videos & PowerPoint slides used, Discussion forums, WhatsApp groups, learner centered methods, micro-content delivery method, Virtual labs available	Online assessment- Graded discussion forum participation, peer-reviews, internet tests, use of safe assign and Turnitin Anti-plagiarism software, Online grading system, adaptive relief mechanism to fix submission dates.	Blackboard learning management system, adaptive relief mechanism, Virtual laboratories, Zero-rated Blackboard LMS, Offline mobile application, GLPI technology	E-teacher training, Workshops in partnership with blackboard LMS facilitators/capacity building through short courses in area of specialization and customer care, technical support for staff (provision of home internet connectivity, laptops), physical and e-library	Offline mobile application, Collaboration with internet service providers to provide free /cheaper internet, Online tracking mechanism, career counselling services, Alumni association, student manuals for technological tools, help line, GLPI ticketing system, virtual learner orientation, orientation packs, e- library facility, virtual student-staff consultative meetings, OER / free modules	Certificate, Diploma, Bachelor and Post graduate courses (Masters). International and local students, mostly working mature students.	ISO certified (BOS ISO 90001:201, Program accredited by BQA, GLPI ticketing system report, visual learning evaluation checklist / reports, internal service level agreement, continuous program reviews, Industrial reference forums, Academic integrity policy

Univ.2	Govt. Funded	Blended learning (Face-face and online activities) with plan to go fully online, Moodle portal to deliver tutorials, assignments, discussion forums, WhatsApp groups, PowerPoints	Face-to-face / Timed online tests. Anti- plagiarism software	Moodle Portal, Center for instructional technology, google meet. Smart classrooms, audio files, video recordings special boards, Both physical and e-library	Tutor induction and training, Commonwealth training program partnership, involvement of academic staff in decision-making.	Institutional collaboration with local internet providers to provide learners with free bundles. Learner support with tablets/ help desk, online/ face-face. Learner induction, e-library facility, trained counselors, online boot camp	Certificate, diploma, bachelor's and master's degree. Back -to-school both young and working adult learners, Local students.	Research ethics policy, Academic integrity policy
Univ.3	Govt. Funded	Residential mode of distance education. Residential tutorials and assessment sessions, Video conferencing tutorials, WhatsApp groups, learner-centered, Independent study, face-face and video conferencing tutorials.	Face-to-face, tests & examinations. Couriered/mailed assignments.	Video Conferencing, Print media and audio-visual modes of learning.		Face-to-face, orientation	Diploma and degree programs Mature working adults	Process of Developing

ODL is not just about technology infrastructure; it is argued that addressing learners' support practices, promoting learner motivation, using technology in instructional delivery, quality standards, and capacity building of faculty (staff) members has the potential to provide quality services and improve completion rates in ODL institutions.

The following sections present a detailed thematic analysis of participants' perceptions regarding instructional strategies in Open and Distance Learning (ODL). Participants' perceptions across the three research sites were analyzed thematically, and three predominant themes emerged. They are (a) instructional support, (b) technological support, and (c) creating learning communities.

Instructional Support

Effective instructional support in open and distance learning (ODL) is paramount for promoting effective learning experiences in such unique environments. It involves designing courses and materials that can be easily adapted to accommodate students' learning needs and styles without sacrificing the quality or effectiveness of instructional delivery. Furthermore, faculty perspectives on pedagogical considerations helped us understand instructional strategies that met the specific needs of both instructors and learners. A multifaceted approach to instructional design is crucial, and combining diverse strategies that are engaging, accessible, and impactful provides rich learning experiences for students. The findings were categorized into three sub-themes: a) flexibility in the course structure, b) relevance of content, and c) providing feedback.

Flexibility in the Course Structure

It also emerged from the findings that—to successfully support learners t—there is a need to ensure flexibility in the course structure. It is important to highlight that most ODL students are adult learners with multiple commitments. Therefore, learners must be given room to maneuver in the event that they are unable to meet set deadlines. For instance, if a learner is unable to submit an assignment on the due date, an extension is provided to complete the task. However, learners should be informed and oriented regarding their flexibility. In addition, it is important for course instructors to continue their professional development to address program delivery. A participant in a managerial position from a private university [Univ.1] was of the view that:

Because most distance learning students are adults who are mostly working and have many obligations, we need to be flexible enough to accommodate their diverse schedules and responsibilities so that they can complete their program. We orient students about the program, course content, mode of delivery and availability of support services. We regularly organize professional development program for course instructors.

Flexibility is crucial for accommodating diverse student needs and for improving learning outcomes. It extends beyond e-learning to include elective courses, reduced teaching hours, and exam distributions. Additionally, the content of the program should be relevant.

Relevance of Course Content

The findings of this research suggest the need for distance learners to find the content of the course relevant to their occupation, addressing unemployment, skill development, and socio-economic challenges. ODL is seen as a flexible alternative to traditional education that is capable of reaching a wider audience and providing relevant skills for the job market. One of the course instructors from a private institution [Univ.1] believed the following:

Students will be retained if they are motivated to learn... they will only be retained if they see the value of what they are learning. When students find material relevant and meaningful, they are more likely to continue their education. Therefore, it is important to create a curriculum that is both engaging and applicable to their lives.

The opinions of the participants from government institutions were not very different, as one of them said:

Motivation is necessary...they need to like what they are doing and aim to complete whatever they study.

ODL can play a significant role in transforming and empowering the vibrant adult population into productive human resources by providing need-based training and equipping it with need-based skills.

Providing Feedback

Providing learners with valuable feedback and adequately addressing their questions can motivate them. Effective feedback is important; such feedback must be

clear, personalized, detailed, and balanced. It serves to highlight learners' strengths and areas for improvement, driving change, and enhancing their learning experience. The findings of this study indicate that faculty members use feedback strategies, including written, audio, video, and automated methods. Participants of this research were of the opinion that the way lecturers give feedback to learners affects the retention of ODL students. One of the participants from a government university [Univ.3] suggested:

Student retention issues are quality related because students must see that they are getting value for their money. If learners receive feedback and do not see it as feedback, they lose interest in the system. How one handles students' voices matters a lot and goes a long way to improve student retention.

Feedback is important. It promotes positive interaction between instructors and students and makes ODL a better learning option for mature learners. Participants further described how student-centered strategies—such as flipped classrooms, microcontent delivery, and the use of recorded videos enabled learners to take ownership of their learning and revisit content as needed. For example, one respondent noted:

Posting recorded videos on the learning platform could be said to be an effective approach of delivering instructions in ODL as it allows for asynchronous delivery of content where learners can access the work in their own time and from anywhere. Students can also revisit the videos for further understanding and getting clarity of the content.

Faculty also emphasized the importance of tailoring instruction to individuals who need extra support by promoting self-directed learning, which they believed could help motivate students to persist in their studies.

Technological Support

Technological support is crucial for ODL students; therefore, institutions that offer courses in ODL mode must provide comprehensive technological support. Such support plays a central role in addressing student queries and improving response quality. ODL students value flexibility and require information for enrollment, reliable teacher support, and prompt responses. Analysis of the participants' perceptions emerged into four sub-themes, and they are a) online technical support, b) virtual learning monitoring, c) internet accessibilities and d) online visibility of faculty

Online Technical Support

Participants believed that learners could be supported by technology when delivering their instructions. Almost 90% of the participants themselves suggested that academic staff in ODL need to acquire technological expertise to improve their delivery methods. Participants reported using video conferencing such as Teams and Zoom, as well as learning management systems (LMS) such as Moodle and Blackboard; they found such tools effective and kept the learners connected. Regarding issues related to LMS, participants believed that students could access learning resources as well as interact with their lecturers, tutors, and peers. The following responses emerged.

Our learning materials are placed on the LMS via Blackboard, which is also available to the students as a mobile application. Students had access to the

materials they used in their classes. We have a portal for them, which includes PowerPoint slides, audio files, and video recordings.

The findings also indicate that distance learners can be supported through the use of a helpdesk that provides technology support to students. Open-source I.T. asset management systems, such as GLPI have the potential to provide efficient support to students by connecting them to the relevant departments and getting immediate assistance. One respondent explained:

We have our e-learning department, which we call the center of the instructional technology. They had a help desk and email. Students are told that whatever problems they have, they will be assisted by sending the helpdesk an email.

Virtual Learning Monitoring

The participants of the study indicated that although LMS is integrated with a tracking system to identify inactive students and monitor their learning activities, it should be started early to prevent dropouts. To explain the process of monitoring learners, one participant from a government institution [Univ.2] explained,

There is something called learning analytics that shows what is going on with respect to student and tutor activities on the platform. Therefore, you can see the profiles of the students.

It was also found that the learners in ODL were encouraged to access open online educational resources (OER) and libraries, where they could access e-journals, e-books, modules, and other resources. During the interview, one of the respondents raised this issue at a government university [Univ.2] and suggested:

There are many modules provided by international platforms, such as open educational resources, that are fully free for both staff and students.

Internet Accessibility

Participants emphasized the need for uninterrupted internet connectivity to access their education. The study revealed that ODL learners were provided with free internet connectivity by signing agreements with institutions and internet service providers. The study also revealed an offline mobile application on the Blackboard LMS. Elaborating on this issue, one participant said,

The school also collaborates with telephone internet service providers (ISPs) for students at a very low cost. Therefore, the internet should not be a barrier to technology use.

One of the participants from the university said,

We have made arrangements with different service providers to help zero-rate our board. In addition, within Blackboard, there is a mobile app with an offline feature where the student can download all the content and use it without the need for the Internet.

However, there was general contention over the cost of internet data, inadequate internet accessibility by learners, and one participant further expressed concern over existing inequalities among students. He said:

In rural and even urban areas, some students particularly those from lower socioeconomically backgrounds are unable to access internet connectivity and do not have equipment such as laptops or smartphones. Others have all of these facilities.

In addition, participants reported that learners were given tablets to access resource materials. One participant said,

One thing we do as an institution is to give our online program tablets so that they have a gadget to complete their assignments.

Online Visibility of Faculty

Participants suggested that learner support through lecturers or tutors was visible online, so that learners could feel their presence. About 81% of the participants agreed that tutors' online presence was key to engaging and retaining learners in the course. Different ways of showing visibility online emerged from the interviews, including communicating with students through class WhatsApp groups and emails, monitoring learner participation through tracking mechanisms, making follow-ups for inactive students, and posting recorded videos. One of the participants claimed that:

Currently, it is easy to monitor class activities on an online platform. Tutors should check so that they can see the history of who is using the system. Once you locate those who are not, you need to communicate with them and follow up by writing an email.

These findings demonstrate that, while technological tools are widely adopted for ODL, technical challenges related to internet access and device availability remain significant obstacles for many learners, particularly those from the lower socioeconomic background directly impacting their participation and engagement in distance education.

Building Learning Community

The study found that building communities among distance learners is another essential component that could improve learner support and increase the completion rate. Building a successful learning community depends on a) learner orientation and b) mentor-learner relationships.

Learner Orientation

Learner orientation introduces the learner to the expectations of the institution and the systems or practices in place. During orientation, learners are induced on technology infrastructure, the Learning Management System, and the use of the latest technologies to access online learning. One of the participants highlighted this:

We also took them through Blackboard LMS, which is the platform where learning takes place. They have to know how to navigate the system, where to find the learning resource, which is the teaching content, the assessment, discussions, and grades, and how to communicate with each other within

Blackboard and with the lecturer, where they share ideas and conduct peer reviews, and how to go through the e-library to find journals, e-books, and to download or borrow online.

Echoing this sentiment, another participant reported

A prerequisite communicated to learners at registration is that they must be I.T. literate and need to have either a laptop, desktop, or any mobile device. They need to have minimum internet infrastructure to be able to undertake online learning.

Mentors-Student and Student-Student Relationship

The ODL students are supported by program mentors who continuously provide the necessary information about the program and monitor their progress. Participants included the use of discussion forums on the LMS and WhatsApp groups; such activities could cultivate trust, collaboration, and knowledge-sharing. Eighty percent of respondents indicated that establishing a relationship with students could have a positive impact on the learner completion rate. During the interviews, it emerged that establishing discussion forums on Blackboard LMS or Moodle and WhatsApp groups plays an important role in facilitating interactions among learners and supports collaborative learning. The participants shared the following sentiments:

On Blackboard, there is a feature for discussion forums where the lecturer can post a topic for the students to discuss, and then there will be a thread of discussions on that topic. The discussion forum builds trust and knowledge-sharing.

The other participants said:

Students interacted with each other through WhatsApp and other modes or tools. Students are expected to comment on other students' work posted in discussion forums, assess and grade their work, and learn together.

The mentor also suggested intervention measures to assist the learner with any challenges and support the learners by providing both academic and social guidance from the start to the end of the program. One of the respondents stated the following:

We also have program mentors. Their mandate is to engage learners from day one, when the learner is enrolled in the program. The mentor welcomes the student and introduces the program and module, telling the students of the expected modalities, how the program is studied, checking the performance of the learners, and their participation in the discussion forum. When they are not participating, the mentor checks the students about what is happening. 

The participants of this study also indicated the importance of learner motivation and linked it with learner completion rates. The participants agreed that learner motivation is essential for ODL delivery. Eighty percent of respondents highlighted the importance of learners' motivation as an essential element in ODL success. This finding suggests the need for motivation as a learner-support practice in ODL programs. Against this backdrop, the interview participants elaborated in-depth and suggested ways of motivating learners to complete their ODL courses, including assisting in setting goals and providing constructive feedback.

The findings of the study established that ODL learners could be motivated by ensuring that they set goals from the beginning of the course and need to be self-driven and disciplined to complete their programs. One participant lamented,

People believe that learning online is easy. In reality, learning in class is easier because you learn from what you have been told by somebody else. However, in DL, it is the responsibility to learn.

Discussion

This study aimed to explore strategies and good practices in the ODL to improve learning outcomes and learner completion rates in selected institutions in Gaborone, Botswana. Through qualitative research involving 42 ODL practitioners, the study identified critical elements impacting learner success. The findings suggest that implementing an effective learner support system is a critical strategy for enhancing and increasing completion rates. This aligns with previous research emphasizing comprehensive orientation, continuous professional development for staff, and diligent addressing of support delivery challenges (Maritim & Getumo 2018; Ouma 2019; Wani et al., 2023). Specifically, a robust support system contributes significantly to improve student success, retention and satisfaction of ODL settings (Ouma 2019; Wani et al., 2023).

This study highlights the potential of technology integration to strengthen support services and enhance instruction. Information and communication technologies are increasingly encouraged for this purpose. Findings indicate the effectiveness of helpdesk facilities and the GLPI ticketing system for addressing technical difficulties promptly, which decentralizes learner support services and promotes access and participation in ODL (Eunice & Cosmas, 2019; Kamau, 2012). Moreover, the use of virtual learning analytics emerged as a crucial practice to track and monitor student activities on the LMS. This enables early identification and intervention for at-risk learners, a strategy supported by Paniagua and Simpson (2018) for improving student retention. The literature consistently values technologies like the LMS for enhancing delivery and fostering social and academic interactions, thereby reducing isolation and improving completion rates (Boston & Gregory, 2015; Eunice & Cosmas, 2019; Maritim & Getumo, 2018). Instructors' active online presence and engagement are also vital for building rapport and facilitating learning, directly impacting learner success (Baton & Gregory, 2015). The integration of technology, such as the LMS, helpdesk facilities, and virtual learning analytics, provides opportunity to promote student engagement thus supporting the Transactional Distance Theory.

The findings of this research also highlight the importance of social learning communities for promoting trust, collaboration, and knowledge sharing, thereby enriching the ODL experiences and student success. Establishing a strong social learning community through discussion forums and WhatsApp groups could promote a sense of belonging and counteract feelings of isolation which are crucial for motivating distance learners to persist. These communities facilitate collective action and help students overcome socio-ecological vulnerabilities through participatory approaches (de Souza et al., 2020).

This study affirms the crucial role of early orientation and ongoing mentoring in ensuring learner retention and achievement within ODL programmes (Paniagua & Simpson, 2021). Specific orientation on learning resources, technology infrastructure interactions, and lecturer access is vital for ODL success (Maritim & Getuno, 2018). Program mentors play a critical role in providing continuous guidance and suggesting intervention measures to help learners clarify their goals. According to Gordon (2019), this support functions as a key element of the Dialogue component within Transactional Distance Theory.

Facilitating access to Open Education Resources (OER) and the library services support learners and widens participation in distance learning ((U.S. Department of Education, 2017; Zuhairi, 2018). Furthermore, providing free internet connectivity and loaning out devices like laptops are fundamental, as effective online learning depends on access to necessary digital devices (Eunice & Cosmas, 2019; U.S. Department of Education, 2017). This is consistent with the literature indicating that the practice of integrating OER into teaching and learning plays a critical role in Botswana and other developing countries. Studies have also emphasized the importance of tailored support strategies, such as instructional design, learning engagement, and quality assurance in ODL (Zuhairi et al., 2019).

Besides resources, learners' motivation emerged as a critical support component (Lucey, 2018). Findings suggest learners are motivated by setting goals and owning their learning process, highlighting the need for students to understand their enrollment to reduce withdrawals (Paniagua & Simpson, 2018). Content relevance, aligning with students' future aspiration, is also vital for persistence (Baton & Gregory, 2015; Lucey, 2018). Learners must be self-driven and take ownership of their learning process. This study suggests that the learning content should be in line with what students plan to do in the future so that they will be motivated to continue learning. This is consistent with many scholars who consider the relevance of content to be a necessity in helping learners persist. Literature also supports the need to provide learners with valuable and satisfactory feedback (Lucey, 2018). Flexible course design, content relevance, and fostering self-driven learning directly supports independent learning, and thus the reduction of transactional distance is emphasized in TDT.

Despite the extensive body of literature on learner support in ODL from developed countries, significant gaps remain in understanding the specific challenges and strategies that are most effective in different contexts, particularly in developing countries such as Botswana. This study sought to understand ODL practitioners' perspectives; participants identified critical elements such as online technical support, virtual learning evaluation, and the creation of learner communities as they significantly impact learner completion rates. This study contributes to the existing literature by offering new insights into the implementation process of ODL programs in Botswana. This highlights the necessity of investing in technology infrastructure and adopting the International Organization for Standardization (ISO) quality standards to effectively support learners. Furthermore, participants highlighted the importance of continuous professional development for ODL practitioners, and the need for flexible course structures to accommodate adult learners with multiple commitments. By focusing on the specific context of Botswana, this study provides valuable recommendations for ODL institutions in similar settings to bridge the gap between enrolment and completion rates. The findings of this research indicated that the helpdesk facility in place was an effective learner support practice that could help learners counter

technical difficulties by easily getting assistance. Participants reported that facilitating learners' access provided by established internet providers in the country was another way to offer quality learner support. Thus, it was believed that every learner is given a chance to participate effectively in the learning process and complete it. Furthermore, interestingly, the practice of providing technology devices to students as a support intervention has emerged, such as giving learners gadgets to help them access online learning. Participants of this study were of the opinion that to support distance learners, technology must be utilized to deliver instructions. Learning resources, including lecture videos, assessments, discussion questions, grades, and announcements can be uploaded online for easy access. To this effect, Eunice and Cosmas, (2019) suggested that effective online learning is only possible when students possess the required technological devices.

This qualitative multiple-case study, while offering in-depth insights into learner support, has several inherent limitations due to its methodological approach. Firstly, the qualitative nature of the study inherently limits its generalizability, as findings emerge from a purposively selected sample and reflect practitioner perspectives. We acknowledge this and have focused on enhancing trustworthiness through careful thematic analysis and researcher reflexivity. Secondly, the study's scope was confined to a very specific context: three institutions within Gaborone, Botswana. While this allowed for an in-depth exploration of local dynamics, it reduced the transferability of results to wider geographical or institutional settings. In addition, the use of telephone interviews for some participants, though practical, may also have limited the depth of interaction and the observation of non-verbal cues. Furthermore, this research did not explore the specific technical challenges learners face concerning digital infrastructure and devices. We also did not examine the long-term effects of technology use and support systems on student achievement and retention. The role of learners' socio-economic factors influencing access to and success in ODL were not explored in detail. While faculty anticipated that active, learner-centered approaches and technology integration would likely promote sustained engagement and reduce attrition, these expectations were not empirically tested within the study period. As such, the analysis of technology use and support systems was limited to faculty's immediate observations and perceptions, rather than documented long-term outcomes.

Future researchers may focus on these areas employing different methodologies or expanding the geographical scope for broader representativeness and generalizability. However, the insights we gained through this research offer valuable information about the challenges ODL practitioners face and could certainly be a useful reference for practitioners in other resource-limited countries. As ODL becomes an increasingly popular mode of accessing higher education, more research is needed in this area. Future research should expand the scope to include learner support, strategies for setting up online teams, and the processes of working together in a longitudinal timeframe. Such studies could broaden practitioners' understanding of effective strategies for implementing and facilitating online teamwork in tertiary education.

Conclusions and Recommendations

This study sought to establish effective learner-support practices to improve the learner completion rates in ODL institutions. Overall, the findings suggest that learner orientation, online technical support, virtual learning monitoring and evaluation, provision of e-learning resources, internet accessibility, mentoring, use of LMS

platforms, tutor online visibility, course flexibility, learner motivation, and building learning communities are effective distance learner support elements, among others. The findings of this study are in line with the findings of studies conducted in developed countries, which can significantly contribute to providing an ODL mode of delivery to promote universal access to education in Botswana and other developing countries. However, the study revealed the challenges of inequality among learners in accessing Internet connectivity and gadgets. To achieve universal access and equity in education, it is necessary for the government to close the gap in the digital divide by subsidizing the Internet to make it affordable for all learners.

The study also found that a difference in the level of technology use between government and private institutions negatively affects the ODL teaching and learning processes. To bridge this gap, participants felt that government institutions need to invest in technology infrastructure, such as LMS, in ODL institutions. Government-aided institutions should emulate private institutions in adopting quality standards such as BOS ISO 9001:2015 to support learner success.

Declarations: The authors declare no conflicts of interest.

Acknowledgement: The authors would like to thank the participants of this research as well as the reviewers. We sincerely thank Dr. Anita Jayachandran at Graduate School of Education at Nazarbayev University for reviewing the manuscript and providing valuable feedback.

Ethics Approval: This study was approved by the University of Botswana Institutional Review Board.

References

- Angelino, L.M., Williams, F.K., & Nativig, D. (2007). Strategies to engage online students and reduce attrition rates. *The Journal of Educators Online*, 4(2), 1-14.
<http://doi.org/10.9743/JEO.2007.2.1>
- Bawa, P. (2016). Retention in online courses: Exploring issues and solutions-A Literature Review. *SAGE Open*, 6(1), 1-11. <http://doi.org/10.1177/2158244015621777>
- Blayone, T. J. B. (2019). Theorizing effective uses of digital technology with activity theory. *Technology, Pedagogy and Education*, 28(4), 447–462.
<https://doi.org/10.1080/1475939X.2019.1645728>
- Bolliger, D.U., & Halupa, C. (2018). Online student perceptions of engagement, transactional distance, and outcomes. *Distance Education*, 39(3), 299–316.
<https://doi.org/10.1080/01587919.2018.1476845>
- Boton, E.C., & Gregory, S. (2015). Minimizing attrition in online degree courses. *The Journal of Educators Online*, 12(1), 62-90.
<https://files.eric.ed.gov/fulltext/EJ1051044.pdf>
- Braun, V., & Clark, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <http://doi.org/10.1191/1478088706qp063oa>
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.
- de Souza, G. H. S., Jardim, W. S., Junior, G. L., Marques, Y. B., Lima, N. C., & Ramos, R. S. (2020). Brazilian students' expectations regarding distance learning and remote classes during the COVID-19 pandemic. *Kuram ve Uygulamada Egitim Bilimleri*, 20(4), 65-80.
- Eunice, M-K. K., & Cosmas, M. . (2019). An analysis of factors affecting utilisation of Moodle learning management system by open and distance learning students at the University of Eswatini. *American Journal of Social Sciences and Humanities*, 5(1), 17–32. <https://doi.org/10.20448/801.51.17.32>
- Giannini-Gachago, D., & Seleka, G. (2005). Experiences with international online discussions: Participation patterns of Botswana and American students in an Adult Education and Development course at the University of Botswana. *International Journal of Education and Development using ICT*, 1(2), 163-184.
<http://ijedict.dec.uwi.edu/viewarticle.php?id=42>
- Gordon, K. (2019). *The influence of mentoring relationships on the professional development of in-service distance education students*. Unpublished master's dissertation submitted to the University of Pretoria for Master of Education.
<http://hdl.handle.net/2263/71690>

- Gumbo, M. T., & Oats, R. (2025). Triumphs, challenges, and prospects of the adult basic education programme in Botswana. *Adult Learning*, 37(1), 45-55. <https://doi.org/10.1177/10451595251345279>
- Kamau, J. W. (2012). The effectiveness of learner support services to distance learners in a primary education diploma. A case study in Botswana. [Doctoral dissertation, University of Pretoria]. <https://repository.up.ac.za/bitstream/handle/2263/24076/00front.pdf>
- Kihwelo, P. F. (2014). Quality assurance systems in open and distance learning: A search for normative judgement. *Huria: Journal of the Open University of Tanzania*, 14(1), 1-21. <https://www.ajol.info/index.php/huria/article/view/110764>
- Lucey, K. (2018). *The effect of motivation on student persistence in online higher education: A phenomenological study of how adult learners experience motivation in a web-based distance learning environment*. Duquesne University. <https://www.proquest.com/openview/75669bf6363835b0384a9d3c13ac2fec/1?pq-origsite=gscholar&cbl=18750>
- Lyyra, P., Anttonen, S., & Waselius, T. (2024). Exploring and counteracting stage specific course completion risk factors in open higher education distance learning. *European Journal of Open, Distance and E-Learning*, 26, 60-71. <https://doi.org/10.2478/eurodl-2024-0004>.
- Magetse, T., Khoza, S., & Naiker, V. (2024). Exploring the use of information and communication technology in open and distance learning: The case study of Botswana Open University. *Journal of Research and Education Studies: e-Saintika*, 8(2), 219–240. <https://doi.org/10.36312/esaintika.v8i2.1748>
- Maritim, E.K., & Getuno, D.M. (2018). Scalability of learners' success rates in e-learning: A survey study of the learners' perspectives. *European Journal of Open, Distance and E-Learning*, 21(1):1-15. <http://doi.org/10.2478/eurodl-2018-0001>
- Martin, F., Oyarzun, B., & Sadaf, A. (2023). Higher education instructor perception of helpfulness of inclusive and equitable online teaching strategies. *Online Learning*, 27(4), 144-170. <https://doi.org/10.24059/olj.v27i4.4019>
- Mathew, I. R., & Iloanya, J. E. (2016, November). Open and distance learning: Benefits and challenges of technology usage for online teaching and learning in Africa. In *Pan-Commonwealth Forum* 8, 22, (pp. 1-8). <https://oasis.col.org/server/api/core/bitstreams/641a15d2-ce53-47d3-8306-6c568ff2fae2/content>
- Meyer, H. S., Preisman, K. A., & Samuel, A. (2022). Get Connected: A Scoping Review of Advising Online Graduate Students. *Online Learning*, 26(3), 274-292. <https://doi.org/10.24059/olj.v26i3.2819>
- Moore, M. G. (2018). The theory of transactional distance. In M. G. Moore & W. C. Diehl (Eds.), *Handbook of distance education* (4th ed., pp. 66–80). Routledge.

- Modise, M. P. (2020). Continuous professional development and student support in an open and distance e-learning institution: A case study. *International Journal of African Higher Education*, 7(1), 49-68. <https://doi.org/10.6017/ijahe.v7i1.10902>
- Musekiwa, N., & Mandiyanike, D. (2017). Botswana development vision and localisation of UN Sustainable Development Goals. *Commonwealth Journal of Local Governance*, 20, 135-145. <https://doi.org/10.5130/cjlg.v0i20.6469>
- Nage-Sibande, B., & Morolong, B. L. (2018). A trend analysis of opportunities and challenges of open and distance learning provision in dual-mode institutions. *Distance Education*, 39(4), 495-510. <https://doi.org/10.1080/01587919.2018.1457951>
- Ntombela, S. C. (2020). Teaching and learning support for students with disabilities: issues and perspectives in open distance e-learning. *Turkish Online Journal of Distance Education*, 21(3), 18-26. <https://doi.org/10.17718/tojde.761919>
- Ouma, R. (2019) Transforming university learner support in open and distance education: Staff and students perceived challenges and prospects, *Cogent Education*, 6,1-15, <https://doi.org/10.1080/2331186X.2019.1658934>
- Paniagua, A. S. E., & Simpson, O. (2018). Developing student support for open and distance learning: The EMPOWER project. *Journal of Interactive Media in Education*, 9, 1-10, <https://doi.org/10.5334/jime.470>
- Rakoma (2018). *Rural students' experiences of online learning support in an open distance learning environment*. [Master of Philosophy dissertation, Stellenbosch University]. <https://scholar.sun.ac.za/handle/10019.1/103278>
- Ramdass, K., & Nemavhola, F. (2018). Quality practices: An open distance learning perspective. *Turkish Online Journal of Distance Education*, 19(1), 234-235. <https://files.eric.ed.gov/fulltext/EJ1165896.pdf>
- Republic of Botswana (2015). *Education and training sector strategic plan (ETSSP 2015-2020)*: Government Printer, Gaborone, Botswana. https://www.gov.bw/sites/default/files/2020-03/ETSSP%20Final%20Document_3.pdf
- Seeletso, M., & Morolong, B. L. (2025). Botswana Open University. In S. Mishra & S. Panda (Eds.), *Handbook of Open Universities Around the World* (pp. 55-65). Routledge.
- Shea, P., Li, C. S., Swan, K., & Pickett, A. (2005). Developing learning community in online asynchronous college courses: The role of teaching presence. *Online Learning*, 9(4), 59-82. <https://doi.org/10.24059/olj.v9i4.1779>
- Shea, P., & Bidjerano, T. (2019). Effects of online course load on degree completion, transfer, and dropout among community college students. *Online Learning*, 23(4), 6-22. <https://doi.org/10.24059/olj.v23i4.1364>

- Sikwibele, A. L., & Mungoo, J. K. (2009). Distance learning and teacher education in Botswana: Opportunities and challenges. *International Review of Research in Open and Distance Learning*, 10(4), 1-16, <https://www.irrodl.org/index.php/irrodl/article/view/706/1337>
- Şenocak, D., Büyük, K., & Bozkurt, A. (2021). Examination of the Hexad user types and their relationships with gender, game mode, and gamification experience in the context of open and distance learning. *Online Learning*, 25(4). 250- 266. <https://doi.org/10.24059/olj.v25i4.2276>
- Shikulo, L., & Lekhetho, M. (2020). Exploring student support services of a distance learning centre at a Namibian university. *Cogent Social Sciences*, 6(1). <https://doi.org/10.1080/23311886.2020.1737401>
- Sibande, B.N (2011). Open and distance learning and access to higher education in Southern Africa: The Botswana experience. [Doctoral dissertation University of Pretoria] University of Pretoria Repository. <https://repository.up.ac.za/server/api/core/bitstreams/92ea7f7a-f3d3-4dd0-8ed5-e56042e1b580/content>
- Tladi, L. L., & Nleya, P. (2019). Integrating e-learning in open and distance learning: The case of Botswana Open University. *Progressio*, 41(1), 1-22. <https://doi.org/10.25159/2663-5895/4935>
- Tseng, H., & Inman, C. (2024). New normal in higher education for the post-COVID-19 world: Reimagining and re-examining factors for student success in online learning. *Online Learning*, 29(2), 213–240. <https://doi.org/10.24059/olj.v29i2.4629>
- UNESCO (2014). UNESCO Roadmap for Implementing the Global Action Programme on Education for Sustainable Development. Paris: UNESCO. <http://unesdoc.unesco.org/images/0023/002305/230514e.pdf>
- U.S. Department of Education (2017). *Building technology infrastructure for learning guide* Washington, D.C. <https://files.eric.ed.gov/fulltext/ED589999.pdf>
- Uys, P. M. (2003). Critical success factors in the infusion of instructional technologies for open learning in development settings: The case of the university of Botswana. *International Review of Research in Open and Distributed Learning*, 4(2), 1-12. <https://doi.org/10.19173/irrodl.v4i2.150>
- Wani, S. A., Asgar, A., & Srivastava, M. (2023). Learner support services at distance higher education institutions in the union territory of Jammu and Kashmir. *Asian Association of Open Universities Journal*, 18(3), 246-261. <https://doi.org/10.1108/AAOUJ-02-2023-0026>
- Youp, N. (2018, October). *Exploring factors contributing to student retention in open University Malaysia*. Asian Association of Open Universities, Hanoi Vietnam. <https://doi.org/10.13140/RG.2.2.30216.67849>

- Zozie, P., & Chawinga, W. D. (2018). Mapping an open digital university in Malawi: Implications for Africa. *Research in Comparative and International Education*, 13(1), 211-226. <https://doi.org/10.1177/1745499918761952>
- Zuhairi, A., Karthikeyan, N. and Priyadarshana, S.T. (2019). Supporting students to succeed in open and distance learning in the Open University of Sri Lanka and Universitas Terbuka Indonesia, *Asian Association of Open Universities Journal*, 15 (1), 13-35. <https://doi.org/10.1108/AAOUJ-09-2019-0038>

Appendix A

Web-based Interview Questions

1. Describe your most effective online teaching methods. What makes them successful for distance learners?
2. How do you adapt practical or hands-on activities for online delivery?
3. How do you manage and encourage interaction within learner communities in online courses? What strategies work best to build connection?
4. What key skills do you find most important for effectively managing an online course or program?
5. Describe a time you faced a significant challenge in online course management. How did you address it?
6. What specific strategies do you use to motivate distance learners?
7. In your opinion, what factors most influence a distance learner's motivation to complete a course?

Appendix B

Interview Guide: Online Learning Experiences

Thanks for your time. We're discussing online teaching and learning to understand what works well. Your answers are confidential.

1. What are the most effective ways you deliver learning materials in online courses?
Probe: What tools do you use? And why?
2. How do you teach hands-on or practical subjects effectively online?
3. Do you think online and in-person teaching methods should be the same?
Probe: Why or why not?
4. How do you manage learner communities and encourage interaction among students in an Open and Distance Learning (ODL) setting?
5. What kind of support (like tech help or advising) is available for online students from our institution?
Probe: How well does it help them, especially with new technology or learning independently?
6. What strategies do you use to motivate distance learners to engage and complete their courses?
7. Does a student's motivation affect whether they finish their online course?
Probe: What helps students stick with it?
8. How do you make sure your online materials are accessible for all students, including those with different needs?
9. What's one main thing our institution could do to better support online learners or teachers?
10. Do you have any other thoughts on online teaching and learning to share

Blended New Student Orientations are Making a Difference: A Case-Study on Students' Experience with the Online Learning Activities

Pamela P. Smalley
Brigham Young University

Richard E. West
Brigham Young University

Abstract

Transitioning from high school to college is challenging for many students. The inability to make successful transitions can affect students' abilities to integrate into and graduate from college, especially for marginalized students. New student orientations were created to help students navigate their new academic environments. However, with the advent of the COVID-19 pandemic, all in-person orientation activities defaulted to online formats. As institutions emerged from the pandemic, various blended new student orientation modalities were implemented. This case study focuses on how a university's new student orientation blended modality (consisting of both online and in-person activities) affected social connectedness as perceived by first-year students. Twenty students were interviewed, leading to three main findings regarding the impact of blended modalities: (a) they motivated these students to transition to college, (b) they helped these students develop a sense of connection to the institution before even stepping foot on campus, and (c) they showed that the combination of online and in-person orientation activities provided a holistic experience for these students. We discuss how blended modalities help build and strengthen connections and a sense of belonging between students and institutions. We conclude with suggestions on how current technology trends in education might be used to adapt blended modalities from their current state to one that could result in more engaging and personalized orientation experiences for first-year students.

Keywords: Blended learning; new student orientation; sense of belonging; transitioning

Smalley, P., & West, R. (2026). Blended new student orientations are making a difference: A case-study on students' experience with the online learning activities. *Online Learning*, 30(1), pp. 423-455. <https://doi.org/10.24059/olj.v30i1.4848>

Introduction

The transition from high school to college can be a challenge academically, socially, and emotionally for many first-year students (Schuster, 2019). Students coming from diverse backgrounds (due to socioeconomic status, educational training, and learning abilities) may find this transition even more challenging (Astin, 1984). To help students make this transition successfully, institutions coordinate in-person orientation activities designed to orient students to their new environment through socially focused tasks (Pascarella et al., 1986). Additionally, these activities serve the purpose of helping students make social and institutional connections, which Astin (1984), Tinto (2003), and others (Cutrona, 1982; Rovai, 2002; Sidelinger & Booth-Butterfield, 2010) have claimed are crucial to transition, integration, and graduation. A student's inability to make social and institutional connections may lead to learning difficulties, challenge a growth mindset, and increase attrition rates (Bruffaerts et al., 2018; Credé & Niehorster, 2012; Lee & Robbins, 1995). College orientations play an important role in overcoming these barriers.

However, the COVID-19 pandemic caused the suspension of all in-person orientation activities, and colleges and universities rushed to produce orientation activities for an online student audience. After the pandemic, many institutions recognized the benefits of online orientation activities. They began investing more time, effort, and resources into integrating online orientation activities with previous in-person activities, creating blended orientation modalities. However, it's been unclear how students perceived the blended orientation activities and their influence on the social connectedness between students and the institution. While scholars have conducted studies on either online or in-person new student orientations separately, more can be learned by examining blended modalities. Since blended orientation activities have become common only recently, only a few studies have been conducted on the topic. Moreover, the rapid implementation of these hybrid models has outpaced current research, leaving a gap in understanding their impact on new student orientations, especially from the students' perspective. Without this understanding, institutions may risk missing opportunities to support student transition and wellbeing in meaningful ways.

This paper aims to answer those inquiries by interviewing students about their experiences with the blended orientation activities and how those experiences may or may not have influenced their social connectedness or sense of belonging to the institution.

Literature Review

In this literature review, we analyzed the existing literature on college orientations and their effects on student psychology, mainly from the ERIC database, drawing from topics such as social connectedness, traditional and online college orientations, and blended orientation practices. Most existing studies have focused on the impacts of traditional and online orientations on new students' academic, affective, and social connectedness. However, blended orientation for first-year college students is a fairly new topic, and there has been little published on it in terms of social connectedness.

Social Connectedness

Many theoretical frameworks uphold the concept of successful student transition through social and institutional connections. In 1981, Transition Theory emerged from Schlossberg's extensive studies and interviews in adult development, counseling psychology, and career development. In her findings, she saw patterns for the impact of transition on a person's sense of identity and the role of social support in facilitating the transition process. Building upon Astin's Student Involvement Theory (1984) where student success is based on student college involvement, Tinto incorporated the framework of social connectedness and transitioning in his Model of Institutional Departure (1993), which elaborated on how students will persist in their education if they are integrated into both the academic and social aspects of the institution. Rovai (2002) expanded the reach of these theories by incorporating them into online learning. He concluded that building a sense of community within an online environment will decrease feelings of isolation and increase integration and overall retention. These theories build upon each other and strengthen the argument that students who participate in college orientation at the beginning of their first year are more likely to have a successful transition (Can & Kalkan, 2021; Jorgenson et al., 2018; Starke et al., 2001). These frameworks laid the foundation for our research and questions.

More recently, many studies on social connectedness have framed the concept in terms of belonging or sense of belonging. In their mixed-methods study, Xu and Brown (2024) explored how to build a sense of belonging and ways to "foster connections" (p. 336) for online post-traditional students at a higher educational institution. Although their research did not focus on new student orientations, their findings showed that one of the most impactful factors promoting a sense of belonging among this group of students is university support and acceptance. They suggested that institutions provide support and acceptance through social presence aimed at "normaliz[ing] challenges, provid[ing] support, and promot[ing] interactions and inclusion (p. 336). Lastly, the study conducted by Mohzana (2024) concluded that first-year orientations "assist new students in adapting to a new campus environment by increasing their sense of belonging to the institution" (p. 176).

Confidence and Motivation in Making Transitions

Schlossberg's Transition Theory highlights the importance of connection and a sense of belonging as essential elements in navigating life transitions. Supporting this framework, Sax and Weintraub (2014) and Mohzana (2024) found that the first year of college is critical in shaping a student's ability to successfully transition from high school. Students who struggle with this adjustment are less likely to return for their second year (Nalbone et al., 2015; Mayhew et al., 2016; Schuster, 2019). Schuster (2019), Attaraya (2021), and Mohzana (2024) further emphasized that institutions must take a more active role in supporting students through this transition by fostering confidence, reducing anxiety, and helping students become familiar with the institution's culture and expectations. In addition to confidence, new student orientations may motivate students to become more involved in the institution's culture, which will also aid in a more positive transition experience (Li et al., 2022; Mohzana, 2024).

College Orientations

As involvement, integration, and sense of belonging fall under social connectedness, institutions looked to college orientations as a resource for helping students navigate successful transitions. Most college orientations are often described as either traditional or online modalities.

Traditional In-Person Orientations

The focus of traditional orientations has been for first-year students to be on campus, bond with peers through social gatherings, and learn about different institutional resources and cultures (Can & Kalkan, 2021; Mohzana, 2024). Although many traditional colleges are shifting towards more academic and institutional orientation goals—such as helping students navigate online course systems, register for classes, and increase awareness of available institutional resources—social factors remain prevalent in orientation experiences (Brooman & Darwent, 2013; Can & Kalkan, 2021). Traditional college institutions have often used higher grade point averages (Owusu et al., 2014), and an increase in self-efficacy (Can & Kalkan, 2021), resilience (Can & Kalkan, 2021), and social connectedness (Brooman & Darwent, 2013; Can & Kalkan, 2021; Thongsawat et al., 2019) as evidence of students' transitional successes. However, these positive results were not consistently seen in every study except for social connectedness. For this reason of maximizing social connectedness and belonging (Leonard et al., 2024; Ning et al., 2021), the majority of in-person new student orientations are beginning to rely more on online components to support students in learning about academic and institutional goals and services (Clark et al., 2024; Garivaldis et al., 2022).

Online Orientations

Similar to traditional orientations, online institutions implemented online orientations focused on setting up, navigating, and using online courses (Scagnoli, 2001). Initially, their primary concern was aiding students' academic success. However, they later recognized the importance of social connectedness and institutional engagement as factors in student retention and success (Abdous, 2019; Castro & Tumibay, 2021; Colucci & Grebing, 2020). Despite this, earlier online studies showed that recreating authentic social connections between peers, students to faculty, and students to institutions proved challenging (Gao & Lehman, 2003; Marjanovic, 1999; Wang & Hsu, 2008). Still, online orientation designs are evolving to overcome this challenge as more recent studies have shown some positive results in terms of academic achievement (Colucci & Grebing, 2020), self-efficacy (Abdous, 2019; Marshall, 2017; Stoebe & Grebing, 2020), retention rates (Marshall, 2017; Stoebe & Grebing, 2020), and social connectedness (Jaggars & Xu, 2016), especially for community college students (Robichaud, 2016).

These evolving designs are incorporating different elements to increase engagement and connectedness. Some of these elements are virtual reality tools, interactive campus tours with pop-up information, and discussion or social media groups. In a qualitative study conducted by Sadanala et al. (2023), the metaverse and virtual reality (VR) tools are used to semi-immersify online university students in their new academic environment. The results of their study showed “the VR online orientation could effectively disseminate the necessary information, and students could retrieve the corresponding information that the orientation can offer, both in an interactive, immersive, engaging, and resource-saving way” (p. 727). Even though there were some challenges with using the VR tool, several students claimed that “the design of the university

campus appeared to be quite realistic” (p. 727). Additionally, their study found that those students who were dissatisfied with using VR were still “positive about learning through the VR technology for orientation and about other opportunities available for them as new online students in the program, rather than visiting the campus in person” (p. 727).

In a design research study carried out by Leslie (2024), using several technological tools (such as Blackboard, Articulate Storyline, discussion boards, and blogs for journaling) successfully increased student engagement. In addition to these innovative tools, other studies of online orientations have included videos (Hanna-Benson, 2019; Liu, 2019; Watts, 2019), interactive activities (Hanna-Benson, 2019; Jones, 2013; Lui, 2019), tutorials (Taylor, 2015), quizzes/assessments (Liu, 2019; Taylor, 2015), and embedded information (Chou, 2012; Hanna-Benson, 2019; Liu, 2019). As technological advancements come forth, it is clear that they will play a role in the orientation experience.

During and Post COVID-19 Pandemic College Orientations

Faced with challenges in both traditional and online college orientations, institutions continued to seek models best adapted to their students’ needs. However, with the worldwide COVID-19 pandemic, higher education institutions could not hold in-person orientations and instead defaulted to online formats (Crozier, 2021; Gravett & Ajjawi, 2022). As institutions adapted, they began to see the advantages (accessibility, flexibility, and reduced stress and financial costs) and challenges (differences in online navigation skills, access to technological devices and the internet, intrinsic motivation, and lack of opportunities for connections with peers, faculty, or the institution) of an online modality. In 2021, many institutions combined online and traditional models into a blended modality (Crozier, 2021). A blended orientation modality provides students with resources and opportunities to learn about the university’s culture and expectations through both online and in-person mediums.

Studies on Blended Orientations

Before delving into studies on blended orientations, it is important to understand the concept of blended learning, particularly in higher education. At its basic, broad definition, blended learning is an approach that delivers content through traditional in-person (F2F) and online (OL) activities or interactions (Graham, 2006). However, within the context of blended learning, there are various types (i.e., flipped classroom, flex, station rotation) that differ based on degrees of online interactions, online integration, flexibility, and personalization, making it more complex than its basic definition (Castro, 2019; Castro & Tumibay, 2021). Fernandes et al. (2016) refined the definition of blended learning with the addition of “materialized in a flexible, multimodal, and multi-linear redesign” (p. 12). By interpreting Fernandes et al., we agree that there is more than one right way of conducting blended learning, and these nuances allow instructional, course, or program designers to facilitate blended learning to best meet their needs. Akin to blended learning, blended orientation models will vary based on the needs of their institutions.

Traditional in-person orientations and blended orientations both prioritize key themes essential to student success: social connectedness/sense of belonging and meaningful engagement with the campus culture and support systems. In-person formats achieve this through immersive, full-day(s) experiences that include live interactions with other incoming

students, peer-mentors, and institutional administrators that build emotional ties to the institution (Can & Kalkan, 2021; Leonard et al., 2024; Mohzana, 2024; Ning et al., 2021). Blended orientations, however, do not dilute these themes; rather, they expand on them. By combining online flexibility with in-person engagement, blended models warrant that more students, especially non-traditional students, can access the same sense of connection in ways that meet them where they are (McGee et al., 2016; Rovai & Jordan, 2004). They create new pathways to belonging through videos, discussion boards, interactive activities, and personalized onboarding, while still incorporating live events to deepen relationships. Additionally, the online component of blended orientation allows institutions to share easily accessible support resources and gives students the ability to review those resources throughout the school year, thereby reducing cognitive overload (Hodgson et al., 2008), which can happen during in-person orientation. Rather than being a compromise, blended orientations represent an evolution, building on the strengths of tradition while broadening impact and inclusivity.

Little has been published on blended orientations and their effects on social connectedness and belonging. While articles are being published on blended learning, only a couple (McGee et al., 2016; Ware & Strickland, 2019) have touched on blended college orientations. The multi-university, blended online learning orientation study conducted by McGee et al. (2016) found that most colleges had their preferred method of delivering orientation materials. These ranged from no “distinction between the two delivery modes” to including a diagnostic section that could “benefit the university by both filtering enrollment as well as providing a necessary introduction to BOL (blended online learning) by giving the student a stronger idea of what is expected of their performance” (McGee et al., 2016, p. 225).

Other online orientation modalities have included text-based websites, video tutorials, and live webinars with university personnel. McGee et al. concluded that although these institutions varied in their approaches to blended online learning orientations, these modalities help students to be more successful as they become aware of services, tools, and expectations (2016). Although their study focused on blended online learning orientations, we found no evidence of “blendedness,” as the mentioned orientation modalities only included online activities and not in-person activities.

The case study conducted by Ware and Strickland (2019) was more aligned with the expectations of a blended orientation model. Their study concluded that blended orientations offered the following benefits to students: (a) reduced anxiety due to awareness of course expectations, (b) minimized orientation time in class, and (c) provided opportunities for students to prepare before coming to class. Although both studies conducted by McGee et al. and Ware and Strickland focused on blended orientations or aspects of it, they did not engage in how this modality can affect students’ sense of belonging.

Research Questions

Based on the theoretical frameworks and studies presented in the literature review, we believe that modality can play an important role in a blended orientation setting (Colucci & Grebing, 2020; Crozier, 2021; Graham, 2021) and help students develop social and institutional connectedness (Brooman & Darwent, 2013; Foster et al., 2012; Jorgenson et al., 2018; Rovai,

2002). As students rely on more information to guide their academic and social involvement decisions, institutions are discovering a need to disseminate this information more effectively (Giblin et al., 2021; Makara & Karabenick, 2013). As a result, many institutions are redesigning their orientation programs and supplementing in-person activities with online activities, aiming to provide students with more valuable information and the advantages of both worlds (Crozier, 2021; Graham, 2021). Besides the concerns of costs, time, and effort required to create an effective online component, institutions are weary of the social disconnect students may feel when participating in online orientation activities due to a lack of human interactions (Hehir et al., 2021; Tinto, 1993), which may influence their motivation to be socially involved once on campus. To validate or resolve this concern, we must understand how students perceive online orientation activities.

There are currently no articles about the connection between blended college orientations and social connectedness from students' perspectives. As blended orientations become integrated into higher education, more research needs to be done. This literature review helps identify a gap in the current research on the topic of social connectedness in blended college orientations, particularly with a focus on the online component of the blended modality. In this context, we posed the main research question: What are students' perceptions of their blended college orientation experiences? In addition to the students' experiences, our secondary research questions focused on the online component of the blended new student orientation asked: (a) How does it motivate students to engage with their new community? (b) How does it assist students in developing connections to the institution? (c) How does it help students gain a sense of belonging after participating in blended orientation activities? Although Tinto (1993) mentions both social and academic integration as predictors of academic persistence, this paper will mainly focus on social integration as the online and in-person orientation activities were developed mainly with that intentionality, and not primarily for academic integration.

Methods

As this study's focus was on a sense of connection and belonging among students and the institution, we used qualitative methods to allow us to obtain answers directly from students about their experiences through semistructured interviews. This study's parameters were defined by the participants (first-year college students) who engaged in both face-to-face and online orientation activities at a specific institution. With these boundaries, a case study qualitative approach (Merriam, 1998) was the best research design.

Research Design

The study took place at a private research university located in the Western part of the United States. First-year students enrolling in the fall of 2023 chose to receive orientation information through online orientation activities before coming to campus, in-person and on-campus activities, or both—allowing them to experience a blended modality. Students could also choose not to participate in any of the orientation modalities.

These different orientation modalities can be studied as units of analysis (Merriam & Tisdell, 2016). See Table 1 for a list of elements in each of the online and in-person new student orientations. As this case study was focused on the online orientation component, a description

of the online approach was emphasized. Students were sent monthly orientation emails by the institution's Office of First-Year Experience with links to where they could access the online learning modules. An online modality using computers and mobile devices was used to access a digital learning system through the institution's website. In these online orientation activities, students viewed video presentations and selected to learn more about specific interests through digitally interactive activities. The online orientation activities consisted of seven learning components. The first and last components served as an introduction and closing, while the remaining five modules (academics, learning, services & support, student life & culture, and wellness & safety) created most of the learning content.

Students moved linearly through the modules and were not able to skip to different sections. If students needed technical support, the online learning module consisted of contact information students could use to get assistance. Students were encouraged to complete the online orientation activities before arriving on campus. With the ability to leverage technology through the online orientation activities, our conjecture was that students would benefit from additional information that would not be included in the in-person orientation activities.

Other benefits of these online orientation activities might include reduced cognitive overload and more allotted time for interactions during the in-person activities. Additionally, online orientation activities increased flexibility, allowing students to access online information when, where, how often, and as quickly as they would like.

Table 1

Elements in Each of the Online and In-person New Student Orientations

Modalities	Online Activities	In-person Activities
Location	In any place with internet access	On the institution's campus
Duration	Flexible: Ranging from 2 days to 2 weeks	3 days
Access	Individually through a website (sent via the Office of First-year Experience), on an electronic device (computer, laptop, mobile, tablet, etc.) with internet access	Face-to-face in-person interactions in groups of 50–60 students
Content	1. Introduction (Welcome) 2. Academics (LMS, time management, majors/minors, how to register for classes)	1. Welcome assembly 2. Crash courses (a fast-paced in-person review of the 5 online

	3. Learning (academic integrity, library, testing center)	content topics) with peer mentors in groups across campus
	4. Services & Support (academic advising, career services, IT, accessibility, financial center)	3. Social activities (Friday Fun Night, soccer or volleyball games, ice-cream & food trucks, group photos)
	5. Student Life & Culture (list of clubs, sports events, mascot, housing)	4. Club fair (over 100 tables represented by different clubs on campus)
	6. Wellness & Safety (CAPS for mental health, student health center, fitness centers, Title IX, campus safety, SafeWalk)	5. Explore a major or department (optional)
	7. Conclusion	
Technical support	An email address & a telephone number were provided for students with technical issues	No technology was used

Participants

The participants were drawn from a pool of incoming first-year students at a private university. Since this study was conducted in collaboration with the institution's Office of First-Year Experience (OFYE), they sent a survey email to all incoming first-year students with a direct link to participate in the study. The institution's survey identified students who (a) completed all of the online orientation activities, (b) completed part of the online orientation activities, and (c) never completed any part of the online orientation activities. The interviewed participants consisted of both females and males. Our criteria for selecting participants for the study were that the participants (a) come directly from high school, (b) be 18 to 19 years old, (c) enroll full-time at the university for the coming year, and (d) complete both online and in-person orientation activities. The first 20 participants who met the inclusion criteria were interviewed for this study.

Although there were an estimated 7,000 incoming first-year students, only a little more than 1,300 students (19%) responded to the survey email. Of those 1,300 survey responses, 55.74% completed the online orientation activities, 16.10% started but did not complete the entire online orientation activities, and 28.16% did not complete any portion of the online orientation activities. Among the survey respondents, about 100 students replied to our study request to participate in a 30-minute interview. From these 100 students who met our inclusion criteria (come directly from high school, be 18 to 19 years old, enrolled full-time at the university for the coming year, and completed both online and in-person orientation activities), we selected the first 20 students (20%) who replied to our email and scheduled an interview date and time. The 20 selected students (12 females and 8 males) were from 12 states and comprised of 15 different majors, with three as undeclared. Although more students could have been

interviewed for this study, the researchers believed that after 20 interviews, a level of saturation in the findings had sufficiently been reached.

Instrument and Data Collection Process

Data collection came from semistructured interviews. Interviewed participants received compensation for their time with a gift card to the institution's bookstore, funded by the institution's Office of First-Year Experience. The questions used in the semistructured interviews were created and revised by a group of researchers consisting of the authors and two external researchers. We first asked the main question about students' experiences with the online orientation activities, allowing students to respond freely about their perceptions, and then, if needed, followed up with questions for more details and further clarification (see Table 2).

The semistructured interviews were conducted over Zoom during the first two weeks of the fall semester (September 2023) since the in-person orientation activities took place three days before classes started. Video recordings of the interviews were transcribed into text for coding purposes. All transcribed text and human-entered codes were kept on an Excel spreadsheet in a separate file from the original transcripts for simplification and privacy protection of the participants. All survey participants were given pseudonyms to protect their identities, and data was aggregated.

Table 2

Samples of Semistructured Interview Questions

Type of Questions	Samples of Questions
Main/First Question	Please tell me about your online orientation experience.
Potential Follow-up Question	Did the online orientation experience motivate you to become more involved at [institution]? Why or why not? How?
Potential Follow-up Question	Did the online orientation experience affect how connected you feel to [institution]? Why or why not?
Potential Follow-up Question	After completing the online orientation activities, how do you feel about being a part of the [institution] community?
Potential Follow-up Question	Did the online orientation experience impact how you feel about contributing to the [institution] community? Why or why not?

Data Analysis Process

The researchers decided to use Saldana's (2013) coding methods and Braun and Clarke's (2006) thematic analysis method to analyze the data for two main reasons: (a) it allows for the interviews to be organized in a meaningful way through themes that may not be obvious and (b) by focusing on themes, we can offer a more in-depth understanding of the participants' perceptions. One main drawback of using thematic analysis is bias in interpretation. Two researchers reviewed the transcripts, created codes, and discussed any discrepancies. Two external researchers and an administrator from the Office of First Year Experience resolved any disagreements. The researchers tried to minimize biases as shown in the Trustworthiness section by implementing a transparent coding process, justification for code choices, member checking, peer debriefing, and thick descriptions.

The following are steps we took to analyze the interviews based on Saldaña's coding methods (2013). First, we became familiar with the data by reviewing the 20 video transcripts twice and the researchers' memos written after each interview to gauge the "feel" of the information. Second, we determined initial codes throughout interview transcripts by going through each interview line by line. Initial codes that ranged from a few grouped words (i.e., "useful information," "very helpful," "too long") to complete sentences (i.e., "And now, I'm even more excited, because I'm actually experiencing all the things that I was oriented about.") were saved in an Excel spreadsheet with columns for each of the familiarization and coding steps. Inductive coding was used as there was no predetermined set of codes. Third, the initial codes were then combined into groups with similar patterns. Fourth, these combined codes were discussed among the researchers to determine the emergent themes (see Table 3).

Table 3
Samples of Thematic Analysis

Transcript Quote	Initial Code	Combined Code	Possible Theme
<i>I'm a first-generation college student, so I had no idea what I was doing. I thought [the online orientation activities] would help me.</i>	• First-generation college student • No idea what I was doing • Thought it would help	• New experience/ environment • Confusion, anxiety • Helpful resource	• Resource about a new environment • Resource to alleviate nervousness, anxiety, and fear of failure in a new experience

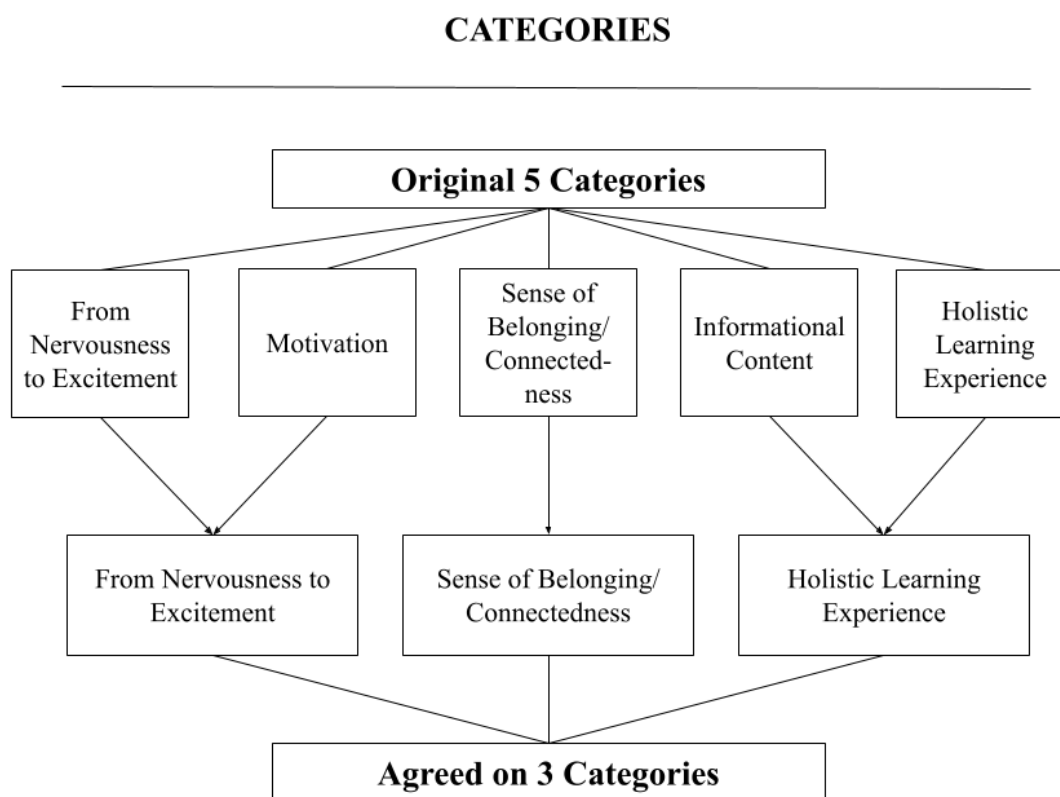
<i>To a small degree it both helped me understand how to get help when I have questions, it also opened my eyes to the complexities of [institution]. So, in a sense, it made me feel anxious about all the things, all the changes, and the big things that we're going to have to do, but it also offered solutions to them.</i>	• Helped me understand how to get help when I have questions • It also opened my eyes to the complexities of [institution] • Made me feel anxious about all the things...all the changes...and the big things that we're going to have to do • Offered solutions	• Helpful resource • Confusion, anxiety • Complexities of a new (academic and living) environment	• Resource about a new environment (complexities) • Resource to alleviate nervousness and anxiety • Resource that fueled anxiety
<i>The orientation modules helped with all the other information you wouldn't have time to talk about during in-person orientation. I think they both came together quite nicely.</i>	• In-person and online orientation activities focused different things • Both came together nicely	• Each type of orientation had their own focus • Each orientation component complemented each other • Helpful resource	• Resource for "what" but not "how" but complemented in-person orientation activities
<i>I did it in a few days, and it was just an overload of information...It really taught me what things are, but not how to do them necessarily. For example, there</i>	• Did it in a few days • Overload of information • Taught me what things are but not how to do them • I'm not following you guys	• Personalized learning • Too much information • "What" but not "how" • Confusion, overwhelmed • Need to know more about "how"	• Resource for "what" but not "how" • Resource for a new environment

<i>was a video where they're in the library and speed walking around to show you where stuff is. And I'm like, I'm not following you guys. This thing is huge. It showed me what's in there and what I can do here, but I don't actually know where to find it yet.</i>	• This thing is huge • I don't actually know where to find it yet		
<i>I think it helped knowing something before, I felt I knew a little bit more about what was going on before coming on campus, which helped me see what resources are here. I felt more connected.</i>	• Knew a little bit more before coming on campus • Helped me see what resources are here • I felt more connected	• Helpful resource • Available institutional resources • Sense of belonging/connected	• Resource about a new environment • Learned more about institutional culture and expectations • Felt connected to the institution
<i>Not really. Not really, but it didn't make me feel less connected. I don't know. It gave me good information. I guess that was the main thing I was looking for.</i>	• "Not really" in response to the question: Do you feel that your online orientation experience helped you feel more connected to the [institution]?	• Sense of belonging/connected • Helpful resource	• Resource about a new environment • Did not feel connected to the institution

-
- It didn't make me feel less connected
 - It gave me good information...the main thing I was looking for
-

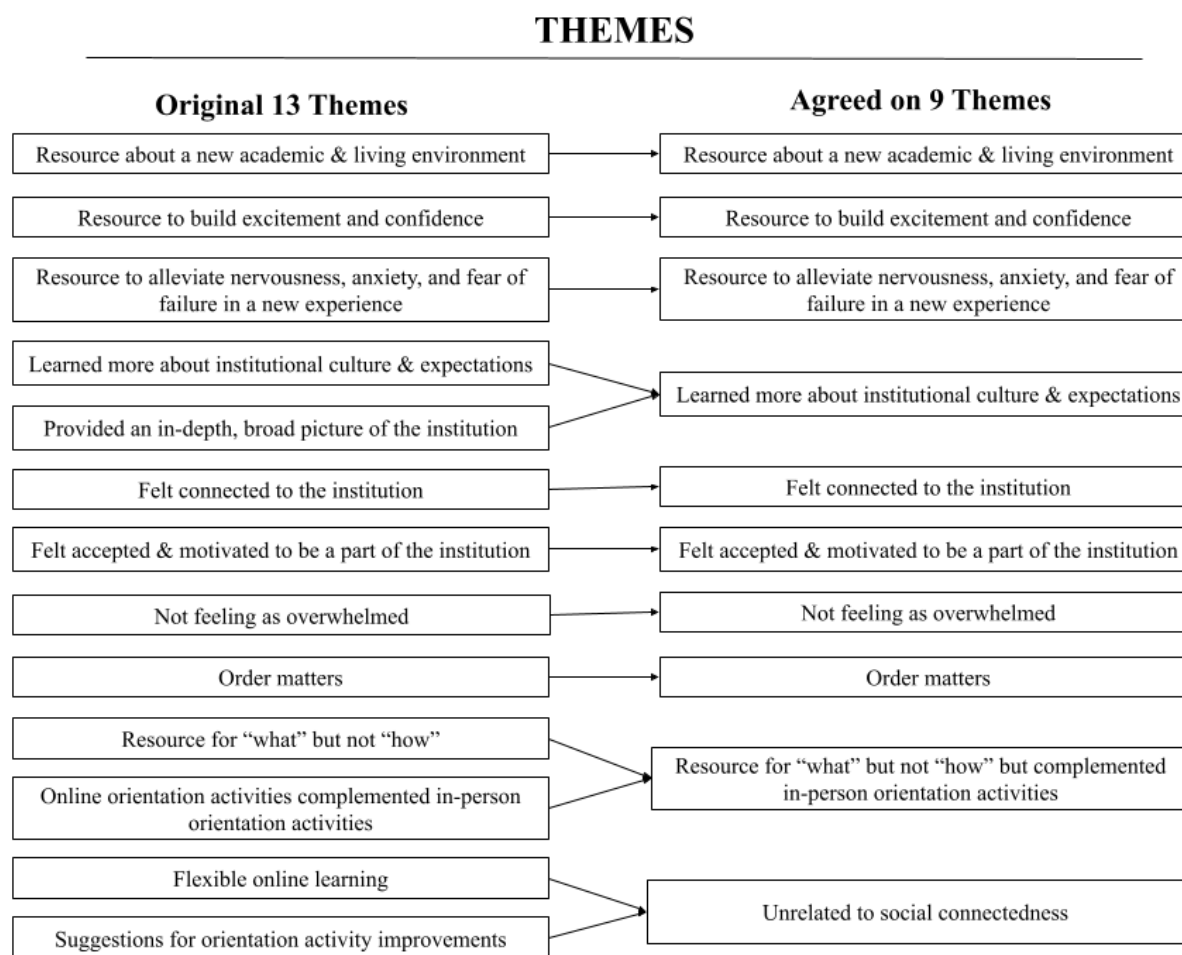
Originally, there were five categories and 13 themes. Two of the categories, *from nervousness to excitement* and *motivation* were combined since students in their excitement became more motivated, one being the cause of the other. We also decided that *informational content* was a part of the *holistic learning experience* and combined the two categories (see Figure 1).

Figure 1
Emerging Categories Flow Chart



Although we kept nine of the original 13 themes, two themes were combined (*resource for “what” but not “how”* and *online orientation activities complemented in-person orientation activities*). The themes *learned more about institutional culture and expectations* and *provided an in-depth, broad picture of the institution* were combined due to similarities on the subject. Two themes—*flexible online learning* and *suggestions for orientation activity improvements*—were viewed as unrelated to social connectedness and were removed (see Figure 2). In the end, only three categories and nine themes remained (see Table 4). After this process, peer debriefing was conducted with members of the Office of First-Year Experience to determine the credibility of these themes.

Figure 2
Emerging Themes Flow Chart



Trustworthiness

For purposes of trustworthiness, memos, peer debriefing, and member checking were used. Memos were kept on how interview participants were selected and why, and the researcher’s initial thoughts and takeaways after the interviews. Peer debriefing of the findings

consisted of the researcher, the committee chair, and an administrator from the Office of First-Year Experience. Member checking was used to confirm with interview participants that the overall findings accurately reflect their views, feelings, and experiences. The completed analysis was emailed individually to each participant, along with an explanation that if any quote or a perspective was misrepresented, they could contact the researcher directly. Member checking allowed students to confirm or clarify any direct quotes in the narrative. Additionally, to ensure correct representation, all participants were required to have their cameras on during the Zoom interviews. With the use of these trustworthiness strategies, we were able to provide a more correct and valid case study.

Findings

Our study produced three main findings about online orientation activities and blended modalities: (a) they supported students' motivation to transition to college, (b) they helped to develop a sense of belonging, and (c) they contributed to an overall holistic experience in addition to the in-person orientation activities—which students still believed to be important. Within each category of findings, we identified many themes (see Table 4). Although transition played a major role in how the blended orientation activities were perceived within all the findings, we have chosen to place it within its own category as there were themes that we felt were specifically geared towards alleviating anxiety and nervousness and preparing students before coming to and living on campus.

Table 4
Categories and Main Themes

CATEGORIES	THEMES
From nervousness to excitement	• Resource about a new (academic and living) environment • Resource to build excitement and confidence • Resource to alleviate nervousness, anxiety, and fear of failure in a new experience
Sense of belonging /Connectedness	• Learned more about institutional culture and expectations • Felt connected to the institution • Felt accepted and motivated to be a part of the institution
Holistic learning experience	• Resource for “what” but not “how” but complemented in-person orientation activities • Order matters • Not as overwhelmed

From Nervousness to Excitement

More than half of the students found online orientation activities to be relevant sources of information for transitioning. For many of these first-year students, this was their first time living alone and away from families and friends. Cassandra shared, “I’m a first-generation college student, so I had no idea what I was doing at all. I thought [the online orientation activities] would help me a bit.” Many of these students looked to the online orientation activities to help

them with this transition. Danielle commented, “It made me excited after going through all the online orientation activities and seeing what’s going to be there for me and how different college was going to be from my high school. It made me excited about college.” Even though there was a sense of excitement about change, there was also trepidation. Laura said, “I wanted to make sure I had all the necessary information to be successful on campus. I just wanted the information I needed to succeed so I could feel less scared about coming to [the institution].” Nancy shared an interesting perspective about the role of online orientation before an in-person orientation, stating:

I’m new and nervous. I want as much information as I can get because there are a lot of things like logistics that I don’t know, and I want to understand. If you’re in person and you don’t understand something, it’s different from being at home at your computer and not understanding something. If you’re in person, you’re worried about where you’re going and if everything is going to be okay. It’s good to have a baseline knowledge before you get thrown into that.

Penelope shared that the online orientation activities “reassured me as a new freshman. I didn’t know anything, and I was really scared, but I would come back to review things just so I could get that reassurance again.”

Additionally, students reported that the online activities reduced anxiety, nervousness, and any fear of failure by creating a level of familiarity with the institution and culture that helped students feel prepared before even stepping foot on campus. Barbara said, “I don’t think everyone did the online things, so I’m a little step above. And now, I’m even more excited, because I’m experiencing all the things that I was oriented about.” They also claimed that the information in the online orientation activities increased their excitement to participate within the institution. One student shared, “It took away some of the nervousness of it and replaced that nervousness with even more excitement.”

Students also stated that online orientation activities supported in-person orientation activities by motivating them to engage more with peers and become more involved with extracurricular activities, organizations, and clubs, once on campus by informing them of possible options. Evelyn shared, “I don’t think [the online orientation activities] would help anyone make friends unless it was telling them about opportunities to make friends once they came to campus.” Grant, another first-year student, remembered, “It got me more excited about doing stuff because there’s just a lot of stuff I didn’t know existed.” Based on his experience with the online orientation activities, Grant said, “It showed me that there are a lot of different ways that I could connect with people and get help if I needed it.” Even though the online orientation activities did not directly connect students to their peers, they may have had an indirect and supportive effect once students arrived on campus.

Sense of Belonging/Connectedness

Most participants perceived an increased attachment to their institutions and a sense of belonging after participating in the online orientation activities of the blended modality. Students are trying to find where they belong as they transition from high school to college. Katherine stated, “I’m trying to do my research online and go on different social media pages [about the

institution] and just find what fits me because I'm eager to find where I belong." As students first interacted with the online orientation activities, they became more familiar with the institution. This familiarity led to an increase in connectedness with the institution and being able to see themselves as a part of that community. Evelyn claimed, "I think it helped knowing something before, I felt I knew a little bit more about what was going on before coming on campus, which helped me see what resources are here. I felt more connected." Another participant, Nancy, explained how her perception of the institution changed:

I'm from Oregon. It's pretty far, and so I'd always considered [the institution] like my stepping stone to getting employment and moving on with my life. I did feel more connected after watching [the online orientation activities]. I felt more connected, because this isn't just a stepping stone, it's going to be a great experience.

For her, the institution morphed into something she could take part in.

In addition to connectedness, students felt a sense of belonging. Danielle shared, "It helped me understand the expectations at [the institution] and made going there in a few months more real to me. Before, it was a completely abstract concept. I want to contribute and be a part of this." John, like several other participants, observed that the online orientation activities helped him feel more "accepted" into his new academic community:

In the beginning, I felt a little lonely, if we're being honest, but I think I felt [the online orientation activities] helped alleviate some of that loneliness, knowing where you could go, meet people, or find things to do. It made me feel more connected and realize that there's something for everyone. If you're an introvert, extrovert, or whatever type of personality you have, whatever your interests are, you can always find something that fits you, and I found stuff that fits me.

Another student, Matilda, said, "When you spend so much time on something, you feel connected to it more. The time I spent in the modules helped me bond with the fact that I'm going to [institution] and I felt more connected." Beyond connectedness, some participants expressed "a deeper understanding of wanting to get into stuff" and to "join and be a part of the culture" of the institution. Even one participant who struggled to feel connected noted, "As an outsider, I felt less like an outsider because I had more inside information," when talking about their perception of the online orientation activities. This idea of wanting to be a part of the institution contributes greatly to a sense of belonging.

Another factor that enhanced a sense of belonging was the perception that the institution had positive feelings toward the students. Some students asserted that the blended orientation activities gave the impression that the institution was organized, cared about them, and wanted them to succeed. Cassandra said, "I do think that [blended orientation] would help [new students] be a little less nervous just because you can tell that the people who put the time and effort into it care about you." Harry added, "It was nice to learn that [institution] wants us freshmen to succeed as much as possible, and so they provided links to resources to help me." It is this perception of the institution wanting students to succeed that also factors into participants feeling an increase in acceptance and being a part of the community.

Even though the online orientation activities provided connectedness and a sense of belonging for most students, there were a few participants who did not feel this way. For them, it was the in-person orientation activities that cemented that connection. Barbara commented:

I don't think the online orientation modules made me feel like I belonged. I think I only felt that way after going to the in-person orientation. I felt like I had a network of people that the online orientation modules didn't give me.

Interestingly, those same students who did not identify an increased sense of belonging or connectedness to the institution after the online orientation activities indicated they felt neutral about the concept of attachment to the university.

Holistic Learning Experience

The majority of students who participated in the blended orientation modality thought online orientation activities complemented the in-person activities by allowing for refreshers through some overlapping of information. Grant shared, "Because of online orientation activities, I knew where buildings are physically and what they did in those specific buildings, so when I got on campus for the in-person orientation, I knew where to find everything." He also added that by completing the online orientation activities first, he "was able to get a job before coming to campus and beat the rush of new applicants."

Most students believed completing the online orientation activities first before attending the in-person orientation gave them a more holistic overall blended orientation experience. Ingrid said, "In-person orientation showed more of the things you need to be on campus to see. The orientation modules helped with all the other information you wouldn't have time to talk about during in-person orientation. I think they both came together quite nicely."

A few participants could see the benefits of doing the blended orientation in either order. One participant, Victor, commented:

I don't know if it's better to introduce online first and then more fully develop an idea of how things work in person, or go to in-person first, and then finish it off by filling in any gaps with the online.

However, after some deliberation, Victor concluded by saying, "Maybe online first [because] then you get a broad look at these different things that are available." Many participants agreed that the online and in-person orientation activities complemented each other, especially after completing the online orientation activities first.

Another component of the blended modality that several participants mentioned was how overwhelming the in-person orientation was. John observed, "There's a ton of new stuff, a ton of new information, and [blended orientation] sort of help[s] break up that information. So, it's not just all dumped on you at once." Learning in smaller increments online and then coming on campus in person helped students to better process the new information and not be overwhelmed, which were important factors in how students perceived the blended orientation.

Although students perceived a blended modality to be a more holistic experience, there were differing opinions on the other advantages of the online and the in-person orientation activities. Some participants preferred the online orientation activities, while others preferred the in-person orientation activities for various reasons. For those who preferred the online orientation, their reasoning was based on convenience, flexibility, and accessibility. Penelope offered:

I could complete the [online orientation activities] on my own time, which was very convenient. I felt that the online orientation modules gave me information that I was not able to get in the physical orientation. I'm a student with accessibility concerns, so I was in a wheelchair, and we had to go through routes that were away from the group for extended periods, and I did not get that information in person. However, with the online orientation, I was able to get what I missed.

Still, some participants preferred in-person orientation and commented on the advantages of learning with other people, knowing the why and not just the what of the institution, and hearing stories shared by mentors. Thomas remarked, "[In-person orientation helped] first and foremost for learning my way around campus. My mentor told us stories about the campus that I would never have gotten online or if I had had a map." While Danielle shared, "Seeing and hearing people be passionate about their interests at the in-person orientation motivated me and made me want to join in." Katherine acknowledged that for her, "I feel like I learned better by talking to people and asking questions. I learn by talking to friends and family, not doing a lot of online research. That's probably why I leaned more towards in-person." For some students, the need for personal interaction is crucial to learning, again supporting the need for a blended modality over only online or in-person orientation activities.

Discussion

Although research on blended learning, in general, has shown it to be beneficial with some challenges, this qualitative case study's specific focus was on the impact of the online orientation activities in a new student blended orientation modality by asking: What are students' perceptions of their blended college orientation experiences? We also wanted to understand students' motivation to engage with their new community and how connections to the institution and a sense of belonging develop after participating in blended orientation activities. In asking these questions, our findings confirmed transition and involvement theories. Second, our findings supported the ability of online orientation activities to help build connections to the institution before students arrive on campus. Lastly, they illuminated how a blended orientation modality was perceived by students.

Building Confidence to Motivate Involvement

This study found that online orientation activities in a blended modality motivated more than half of the participants to become involved in their university community. These activities included learning about their new environment, growing excitement and confidence about their transition, and alleviating concerns they may have had about becoming new college students.

Additionally, these activities can contribute to greater first-year student involvement in their university community and thereby increase retention rates.

As institutions adapt their orientation modalities to increase student confidence, engagement, and retention rates, researchers are exploring students' narratives of their experiences. In Thomas' multi-project report (2012), three research studies looked at college retention through involvement. The first study was conducted by researchers at Nottingham Trent University, Bournemouth University, and the University of Bradford. Two key findings in their longitudinal study are of particular interest: a lack of confidence and the ability to adapt to the university were categorized as demotivation or motivation for retention (Foster et al., 2012). In particular, other studies have shown low learning motivation within the online-only learning environments (Buchan & Precey, 2023; Pregowska et al., 2021), a perceived weakness of blended learning. The focus then became how to increase confidence and the ability to adapt (Mohzana, 2024).

A second study, conducted by researchers at the University of Reading and Oxford Brookes University, concluded that institutions can help increase confidence and the ability to adapt, which would lead to an increase in retention by providing first-year students with support in terms of managing expectations and promoting a sense of belonging (Mohzana, 2024; Morey et al., 2012).

In the third study by Cashmore et al. in 2012, researchers at the University of Leicester "found that 43% [of first-year students who dropped out] felt that [they were] not being given helpful academic support from their department [or institution]" while "25% of respondents regarded the fact that they did not know where to go to seek academic help or advice" as reasons for drop out (Thomas, 2012, p. 42). The need for institutional support is aligned with our findings that students gain excitement and confidence through a blended orientation modality. Students perceived that the blended orientation modality managed expectations and created a sense of belonging, thereby increasing students' motivation to become more involved in their university community.

Connections to Institutions Through Online Orientation Activities

In Rovai's definition (2002), connectedness is a sense of belonging, being a part of something greater, building relationships, and "may play a role in student commitment toward the institution" (Jorgenson et al., 2018, p. 76). Tinto (2003) added that as institutional commitment increases, students become more aware of their responsibility to participate within the institution. Many studies have shown the need for students to make connections as a condition for retention (Bruffaerts et al., 2018; Credé & Niehorster, 2012; Cutrona, 1982; Lee & Robbins, 1995; Rovai, 2002; Sidelinger & Booth-Butterfield, 2010). In both their qualitative and empirical studies on the perception of students on connectedness, Jorgenson et al. observed that many students "did not distinguish between social and institutional connectedness, even though previous research identifies the two as independent concepts" (2018, p. 79). In the online orientation activities of a blended orientation modality, students could not directly interact with their peers to build those relationships, and many recognized this lack of student-to-student interaction. However, our study showed that online orientation activities helped students build connections with institutions. This challenges the observations made by Jorgenson et al., as our participants viewed social and institutional connectedness as two distinct concepts.

Even though many see social connectedness as the most important of the two concepts from Jorgenson et al. (Brooman & Darwent, 2013; Foster et al., 2012), institutional connectedness is still relevant and impactful on students (Jorgenson et al., 2018; Tinto, 2003). As students orient themselves through the online orientation activities of a blended modality, our study showed that students with disabilities and first-generation students preferred a blended learning modality and found it helpful, as it offered greater access and flexibility.

This institutional attachment may be the result of students perceiving online orientation activities in a blended modality either as a neutral entity or one that leans in support of them and wants to see them succeed. It is this feeling of support that develops and strengthens institutional connectedness as students move from a “me” mentality to a “we” mentality (Tinto, 2003). Online orientation activities are crafted to inform students of institutional culture, expectations, and resources (McGee et al., 2016; Ware & Strickland, 2019); they are unlikely to produce misinterpretations that may lead to feelings of insecurity or marginalization.

By growing institutional connectedness before social connectedness through online orientation activities, institutions can reinforce a sense of belonging and support in a controlled learning environment. During in-person orientation activities, there are many moving parts and people that first-year students may negatively process certain speech, actions, or facial and body expressions of peer mentors, faculty, staff, and other students. Online orientation activities avoid these pitfalls. The focus of orientations now surpasses that of transition and delves deeper into one of integration.

Blended Modality as a Holistic Experience

The term “holistic” is more commonly used in medicine and psychology, viewing something as holistic is to see individual components as parts of a whole (Merriam-Webster, n.d.). Each component holds value independently and may contribute different or additional values when seen as part of a whole. As previously mentioned in the literature review, both online (Colucci & Grebing, 2020; Marshall, 2017; Stoebe & Grebing, 2020; Jaggars & Xu, 2016) and traditional (Brooman & Darwent, 2013; Can & Kalkan, 2021; Owusu et al., 2014) orientation activities, as individual components, hold strengths and challenges.

Graham (2021) predicted that after the COVID-19 pandemic, many institutions would “return to in-person education but will want to augment that experience with what they consider the best of the online learning opportunities for their students,” (p. 23) opening the door to more blended learning and orientation experiences. The best of these online orientation opportunities in terms of a blended modality came in the form of accessibility, flexibility, reduced stress, cognitive load, and financial costs (Crozier, 2021; Hill & Smith, 2023; Ware & Strickland, 2019). Students could progress through the online versions at their own pace and review information that was pertinent or of interest to them. Even with these benefits, there were still challenges.

These remaining challenges of a blended modality were differences in online navigation skills and access to technological devices and the internet (Crozier, 2021; Hill & Smith, 2023). The challenges of intrinsic motivation and lack of opportunities for connections with peers or the

institution (Harper et al., 2024) were no longer barriers as students learned online about, and were motivated by, the institution's culture and expectations and came in person to experience what was learned online and build connections with their peers (McGee et al., 2016).

It is the experience of being able to connect to the institution through online activities and then connect with peers through in-person activities that captures the best of a blended modality. Many students in our study perceived the blended modality as a more holistic orientation experience in comparison to an online or in-person only model. In their meta-analysis on the effects of blended learning, Yu et al. (2023) concluded that blended learning had a significant positive effect on students' attitudes and motivations.

Several students in our study commented that the online and in-person orientation activities complemented each other, further increasing their motivation to be a part of the institution. They also perceived a greater advantage to completing the online orientation activities first. Yu et al. inferred similar conclusions in their study, showing that online first and then in-person later produced a slightly higher effect ($g = 0.722$) than other sequence variations; although most of their sequence variations had "upper-medium effects" (2023, p. 10). While many of our participants perceived an online first and then in-person later sequence to be holistic, they did not agree with Yu et al. that most variation sequences had similar positive effects. Some students believed that a reversed sequence of in-person first and then online later orientation modality would come off as a redundant or unnecessary process, concluding that sequence does matter in creating a holistic experience.

Other studies further support the claim of blended learning as a holistic experience. In their research, Beukes et al. (2019) explored students' perceptions of blended learning from a holistic perspective. Their study of 461 third-year undergraduate accounting students concluded that students perceived the online components (tutorials and lecture videos) as greatly contributing to their learning experience. Studies conducted by Zhou and Chu (2016) and Suson (2024) also found that blended learning environments provided better student experiences through tutorials and ease of use for motivation and satisfaction. Studies on blended learning environments have resulted in more student engagement (Buchan & Precey, 2023; Johler, 2022) and increased learning effectiveness (Beukes et al., 2019; Mikulecky, 2019; Salcedo, 2022) to create a more cohesive and holistic learning environment (Suson, 2024).

Implications for Practice

As traditional and online institutions turn to blended orientation modalities, the future designs of orientation programs must be considered. Although we are no longer limited by time or resources due to a pandemic, many institutions rely on traditional and somewhat conservative approaches as they form their blended orientation activities. This section identifies implications for practice affecting future designs of orientation programs at traditional and online institutions, prompting consideration of how to effectively implement blended approaches and ensure the most impactful experiences are achieved.

Online Integration

As more traditional institutions move towards adopting blended orientation modalities, students will benefit from greater levels of preparation and transitioning (Wilson & Minhas-

Taneja, 2015). However, the challenge is in implementation. As the meta-analysis on blended learning of Yu et al. (2023) emphasized, there are many elements and combinations of elements that make blended modalities more effective. As mentioned previously in our study, the sequence of online and then in-person instruction is important to effectiveness. Additionally, the proportion of online and in-person instruction is another factor to consider when creating a blended orientation modality. In their study, Yu et al. (2023) concluded that 50% online was the most successful ratio, while other combinations of online and in-person produced lower results. Lastly, deciding how to disperse the content among the online and in-person activities plays a key role in the effectiveness of a blended modality. These blended learning factors contribute to the overall reception and effectiveness of blended orientation modalities.

Online Interactions

Our study showed that more could be done to foster increased interaction with peers and engagement with content through online orientation activities. In addition to poll checks, discussion boards, and Padlet-like introduction videos, gamification presents a dynamic approach to enhancing peer interactions during orientation online activities. By creating online teams of first-year students with commonalities, such as majors, interests, or geographical locations, and incorporating ideas like virtual scavenger hunts, interactive challenges, and leaderboards geared towards helping students make successful transitions, institutions can create platforms where students collaborate, connect, and compete with their peers virtually.

Flexibility and Personalization

Many online orientation activities provide a general overview of the institution and resources and often do not allow students to skip familiar topics or personalize for their interests. Several students in our study noted that this characteristic of the online orientation activities was frustrating. One potential approach is to allow students to select from a variety of academic and extracurricular topics they may want to delve deeper into. For example, if a student is interested in biology, the institution can provide specific online information about the biology department, including details on majors, minors, research opportunities, and faculty members. By implementing flexibility and personalization, institutions empower students to shape their own learning and orientation experiences.

Limitations

Due to the boundaries placed on this case study and despite our best efforts to minimize biases, there are inherent limitations due to its scope. The study's participants were from a specific institution's single orientation program and consisted of only the first 20 first-year college students (who met our criteria) to schedule an interview. Although the response rate was high to the request for interviews, the overall response to the general survey was low. As a result, institutional culture and response time may have influenced the findings and led to a skewed sample. To enhance the generalizability of future research, we recommend including more than 20 students from multiple institutions and expanding the scope by including students from other populations, such as non-traditional, community college, or transfer students.

Another possible limitation of this case study was the inclusion criteria and the selection of students who were motivated to respond to our email and interview schedule. By limiting which students participated in the interview process, this case study specifically looked at the

perceptions of students who may not represent many of their peers. This may have led to confirmation or selection bias. We suggest that future studies make efforts to intentionally include students from diverse backgrounds.

Additionally, the researchers used Excel spreadsheets and hand-coding for the data analysis. Even with peer-debriefing, it is possible that this type of analysis may have introduced research bias. To reduce research bias, future studies may choose to use coding software.

There was a limitation of time. Although this study focused on blended orientations and their impact on students' social connectedness, it did not encompass the extent of time that the impact would last. Future studies could also discuss the challenges faced as students' self-paced and personalization may lead to missed information and complete rates. Lastly, by exploring the impact of blended online orientation activities from both a social connectedness and an academic persistence view, as identified by Tinto (1993), institutions would have a more comprehensive understanding of the benefits and challenges. To better answer these last points, we suggest conducting future research involving longevity and the impact of blended orientations on social connectedness and academic persistence after the first year of college.

Conclusion

This study highlights blended modalities, consisting of online and in-person activities, transforming traditional new-student college orientations into more flexible, personalized, and empowering instruments. As students engage with the online orientation activities, these interactions may result in greater confidence, connection to the institution, and a holistic experience. With more focus placed on the design and implementation of online orientation activities, institutions can better meet the diverse needs of their student body and create an overall learning environment that encourages successful student transition, retention, and a sense of belonging.

Disclosure Statement

The authors declare no known conflict of interest related to this research. Although both authors are affiliated with the university used in this study, we disclose that the research was conducted independently and not influenced by any member of the institution. Participants in this study had no previous association or contact with the researchers or peer-debriefing committee.

References

- Abdous, M. H. (2019). Well begun is half done: Using online orientation to foster online students' academic self-efficacy. *Online Learning Journal*, 23(3).
<https://doi.org/10.24059/olj.v23i3.1437>
- Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Student Development*, 25(4), 297–308.
<https://www.middlesex.mass.edu/ace/downloads/astininv.pdf>
- Atteraya, M. S. (2021). Acculturation stressors and academic adjustment among Nepalese students in South Korean higher education institutions. *International Journal of Environmental Research and Public Health*, 18(12), 6529.
<https://doi.org/10.3390/ijerph18126529>
- Beukes, B., Barac, K., & Nagel, L. (2019, June). Student preferences within a holistic blended learning environment. In *EDEN Conference Proceedings* (No. 1, pp. 276–290).
https://www.researchgate.net/publication/349102626_Student_Preferences_within_a_Holistic_Blended_Learning_Environment
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Brooman, S., & Darwent, S. (2013). Measuring the beginning: A quantitative study of the transition to higher education. *Studies in Higher Education*, 39(9), 1523–1541.
<https://doi.org/10.1080/03075079.2013.801428>
- Bruffaerts, R., Mortier, P., Kiekens, G., Auerbach, R. P., Cuijpers, P., Demyttenaere, K., Green, J.G., Nock, M. K., and Kessler, R. C. (2018). Mental health problems in college freshmen: Prevalence and academic functioning. *Journal of Affective Disorders*, 225(1), 97–103. <https://doi.org/10.1016/j.jad.2017.07.044>
- Buchan, A., & Precey, R. (2023). Propelling student engagement in blended learning courses: A study of an English university. *Journal of Perspectives in Applied Academic Practice*, 11(3). <https://doi.org/10.56433/jpaap.v11i3.578>
- Can, N., & Kalkan, B. (2021). Adaptation of the Turkish language version of the Inventory of New College Student Adjustment: The roles of resilience and social self-efficacy in college adjustment. *International Journal of Contemporary Educational Research*, 8(2), 1–12. <https://doi.org/10.33200/ijcer.747467>
- Cashmore, A., Scott, J., & Cane, C. (2012). 'Belonging' and 'intimacy' factors in the retention of students—an investigation into the student perceptions of effective practice and how that practice can be replicated. *What Works: Student Retention and Success*, pp. 80–81. Paul Hamlyn Foundation.

- Castro, R. (2019). Blended learning in higher education: Trends and capabilities. *Education and Information Technologies*, 24(4), 2523–2546. <https://doi.org/10.1007/s10639-019-09886-3>
- Castro, M. D. B., & Tumibay, G. M. (2021). A literature review: Efficacy of online learning courses for higher education institution using meta-analysis. *Education and Information Technologies*, 26(2), 1367–1385. <https://doi.org/10.1007/s10639-019-10027-z>
- Cho, M.-H. (2012). Online student orientation in higher education: A developmental study. *Educational Technology Research and Development*, 60(6), 1051–1069. <https://doi.org/10.1007/s11423-012-9271-4>
- Clark, C. R., Muzacz, A. K., and LaGue, A. (2024). Assessing impacts of a hybrid orientation on counseling students' self-efficacy. *Journal of Technology in Counselor Education and Supervision*, 5(2), article 3. <https://doi.org/10.61888/2692-4129.1057>
- Colucci, R. L., & Grebing, R. E. (2020). The impact of an online orientation program on student success at a community college. *Journal of College Orientation, Transition, and Retention*, 27(1), 1–27. <https://doi.org/10.24926/jcotr.v27i1.2251>
- Credé, M., & Niehorster, S. (2012). Adjustment to college as measured by the student adaptation to college questionnaire: A quantitative review of its structure and relationships with correlates and consequences. *Educational Psychology Review*, 24(4), 133–165. <https://doi.org/10.1007/s10648-011-9184-5>
- Crozier, N. (2021). Designing effective online orientation programs for first-year university students. *Journal of College Orientation, Transition, and Retention*, 28(2), 1–16. <https://doi.org/10.24926/jcotr.v28i2.3739>
- Cutrona, C. E. (1982). Transition to college: Loneliness and the process of adjustment. In L. A. Peplau & D. Perlman (Eds.), *Loneliness: A source book of current theory, research, and therapy* (pp. 291–309). John Wiley.
- Fernandes, J., Costa, R., & Peres, P. (2016). Putting order into our universe: The concept of blended learning—A methodology within the concept-based terminology framework. *Education Sciences*, 6(2), 15. <https://doi.org/10.3390/educsci6020015>
- Foster, E., Lawther, S., Keenan, C., Bates, N., Colley, B., and Lefever, R. (2012). The HERE project toolkit: a resource for programme teams interested in improving student engagement and retention. *What Works? Student Retention and Success*. https://www.improvingthestudentexperience.com/library/UG_documents/Toolkit_HERE_Project.pdf
- Gao, T., & Lehman, J. D. (2003). The effects of different levels of interaction on the achievement and motivational perceptions of college students in a web-based learning environment. *Journal of Interactive Learning Research*, 14(4), 367–386. <https://psycnet.apa.org/record/2004-12029-001>

- Garivaldis, F. J., Chung, J., Braganza, L., Arulkadacham, L., Sharma, R., Reupert, A., McKenzie, S., Rose, G., Gupta, T., Aziz, Z., Mowbray, T., Ilic, D., and Mundy, M. (2022). Out of sight, but not out of mind: A case study of the collaborative development of a university-wide orientation resource for online students. *Educational Technology Research and Development*, 70, 531–558. <https://doi.org/10.1007/s11423-022-10090-3>
- Giblin, J., Stefaniak, J., Eckhoff, A., & Luo, T. (2021). An exploration of factors influencing the decision-making process and selection of academic help sources. *Journal of Computing in Higher Education*, 33, 1–18. <https://doi-org.byu.idm.oclc.org/10.1007/s12528-020-09252-0>
- Graham, C. R. (2006). Blended learning systems: Definition, current trends, and future directions. In C. J. Bonk & C. R. Graham (Eds.), *The handbook of blended learning: Global perspectives, local designs* (pp. 3–21). Pfeiffer Publishing.
- Graham, C. R. (2021). Exploring definitions, models, frameworks, and theory for blended learning research. In A. G. Picciano, C. D. Dziuban, C. R. Graham, & P. D. Moskal (Eds.), *Blended learning: Research perspectives* (vol. 3, pp. 10–30). Routledge.
- Gravett, K., & Ajjawi, R. (2022). Belonging as situated practice. *Studies in Higher Education*, 47(7), 1386–1396. <https://doi.org/10.1080/03075079.2021.1894118>
- Hanna-Benson, C. (2019). *Development and evaluation of an online university readiness course furthered by capturing the lived experience of students during this transition: A multi-perspective understanding of the transition to university* [Doctoral dissertation, Western University]. <https://ir.lib.uwo.ca/etd/6092>
- Harper, C. V., McCormick, L. M., & Marron, L. (2024). Face-to-face vs. blended learning in higher education: A quantitative analysis of biological science student outcomes. *International Journal of Educational Technology in Higher Education*, 21, 2. <https://doi.org/10.1186/s41239-023-00435-0>
- Hehir, E., Zeller, M., Luckhurst, J., & Chandler, T. (2021). Developing student connectedness under remote learning using digital resources: A systematic review. *Education and Information Technologies*, 26(5), 6531–6548. <https://doi.org/10.1007/s10639-021-10577-1>
- Hill, J., & Smith, K. (2023). Visions of blended learning: identifying the challenges and opportunities in shaping institutional approaches to blended learning in higher education. *Technology, Pedagogy and Education*, 32(3), 289–303. <https://doi.org/10.1080/1475939X.2023.2176916>
- Hodgson, P., Lam, P., & Chow, C. (2010). Assessment experience of first-year university students: Dealing with the unfamiliar. *CETL*. <https://doi.org/10.13140/2.1.2656.0648>

- Jaggars, S., & Xu, D. (2016). How do online course design features influence student performance? *Computers & Education*, 95(4), 270–284. <https://doi.org/10.1016/j.compedu.2016.01.014>
- Johler, M. (2022, October). Collaboration and communication in blended learning environments. *Frontiers in Education*, 7, Article 980445. <https://doi.org/10.3389/feduc.2022.980445>
- Jones, K. R. (2013). Developing and implementing a mandatory online student orientation. *Online Learning*, 17(1), Article 1. <https://doi.org/10.24059/olj.v17i1.312>
- Jorgenson, D. A., Farrell, L. C., Fudge, J. L., and Pritchard, A. (2018). College connectedness: The student perspective. *Journal of the Scholarship of Teaching and Learning*, 18(1), 75–95. <https://doi.org/10.14434/josotl.v18i1.22371>
- Lee, R. M., & Robbins, S. B. (1995). Measuring belongingness: The social connectedness and the social assurance scales. *Journal of Counseling Psychology*, 42(2), 232–241. <https://doi.org/10.1037/0022-0167.42.2.232>
- Leonard, J., Mylonas, A., Parker, P., and Wood, R. (2024). A caring approach to the first-year university student experience. *Journal of University Teaching and Learning Practice*, 21(1). <https://doi.org/10.53761/q1k5wx84>
- Leslie, H. (2024). Onboarding students at scale: A new student orientation course that prepares students to succeed in their online degree programs. *International Journal of Designs for Learning*, 15(2), 41–53. <https://doi.org/10.14434/ijdl.v15i2.35590>
- Li, X., Cai, T., Jimenez, V., & Tu, K. M. (2022). Youth coping and cardiac autonomic functioning: Implications for social and academic adjustment. *Developmental Psychobiology*, 64(8), e22338. <https://doi.org/10.1002/dev.22338>
- Liu, J. C. (2019). Evaluating online learning orientation design with a readiness scale. *Online Learning Journal*, 23(4), Article 4. <https://doi.org/10.24059/olj.v23i4.2078>
- Makara, K., & Karabenick, S. (2013). Characterizing sources of academic help in the age of expanding educational technology: A new conceptual framework. In S. Karabenick & M. Puustinen (Eds.), *Advances in help-seeking research and applications: The role of emerging technologies* (pp. 37–72). Information Age Publishing.
- Marjanovic, O. (1999). Learning and teaching in a synchronous collaborative environment. *Journal of Computer Assisted Learning*, 15(2), 129–138. <https://doi.org/10.1046/j.1365-2729.1999.152085.x>
- Marshall, L. (2017). *Impact of online orientation for first-time online students on retention, academic success, and persistence*. [Doctoral dissertation, Walden University] <https://scholarworks.waldenu.edu/dissertations/4388>

- Mayhew, M. J., Rockenbach, A. N., Bowman, N. A., Seifert, T. A., Wolniak, G. C., and Terenzini, P. T. (2016). *How college affects students: 21st century evidence that higher education works*. Jossey-Bass.
- McGee, P., Valdes, E., and Bullis, D. (2016). Blended/Online learner orientations: Recommendations for design. *EdMedia + Innovate Learning Online 2022*, 15(2), 215–241. <https://www.learntechlib.org/primary/p/48048/>
- Merriam, S. B. (1998). *Qualitative research and case study applications in education*. Jossey Bass Publishers.
- Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.
- Merriam-Webster. (n.d.). Holistic. In *Merriam-Webster.com dictionary*. Retrieved February 20, 2026, from <https://www.merriamwebster.com/dictionary/holistic>
- Mikulecký, P. (2019). Blended learning in smart learning environments. In P. M. Oliveira, P. Novais, & L. P. Reis (Eds.), *Progress in Artificial Intelligence: 19th EPIA Conference on Artificial Intelligence* (pp. 63–74). Springer International Publishing. https://doi.org/10.1007/978-3-030-30244-3_6
- Mohzana, M. (2024). The impact of the New Student Orientation Program on the adaptation process and academic performance. *International Journal of Educational Narrative*, 2(2), 169–178. <https://doi.org/10.70177/ijen.v2i2.763>
- Morey, S., Robbins, S., O'Regan, M., Hall, K., Fleming, S., and Mumford, C. (2012). *Comparing and evaluating the impacts on student retention of different approaches to supporting students through study advice and personal development at the Universities of Reading and Oxford Brookes*. Paul Hamlyn Foundation.
- Nalbone, D. P., Kovach, R. J., Fish, J. N., McCorry, K. M., Jones, K. E., & Rawlings Wright, H. (2015). Social networking websites as a tool for student transitions: Purposive use of social networking web sites for the first-year experience. *Journal of College Student Retention*, 17(4), 489–512. <https://doi.org/10.1177/1521025115579253>
- Ning, L., Kruchen, K., and Cyr, C. (2021). Belonging and mattering in the first-year welcome experience: A comparison study before and during COVID-19. *Journal of College Orientation, Transition, and Retention*, 28(2). <https://doi.org/10.24926/jcotr.v28i2.3768>
- Owusu, G. A., Tawiah, M. A., Sena-Kpeglo, C., and Onyame, J. T. (2014). Orientation impact on performance of undergraduate students in University of Cape Coast (Ghana). *International Journal of Educational Administration and Policy Studies*, 6(7), 131–140. <https://doi.org/10.5897/IJEAPS2014.0370>
- Pascarella, E., Terenzini, P., & Wolfle, L. (1986). Orientation to college and freshman year persistence or withdrawal decisions. *The Journal of Higher Education*, 57(2), 155–175. <https://doi.org/10.2307/1981479>

- Pregowska, A., Masztalerz, K., Garlińska, M., & Osial, M. (2021). A worldwide journey through distance education: From the post office to virtual, augmented, and mixed realities, and education during the COVID 19 pandemic. *Education Sciences*, 11(3), 118. <https://doi.org/10.3390/educsci11030118>
- Robichaud, W. (2016). *Student perceptions of a comprehensive orientation program for online courses*. [Doctoral dissertation, Nova Southeastern University]. https://nsuworks.nova.edu/fse_etd/26
- Rovai, A. (2002). Sense of community, perceived cognitive learning, and persistence in asynchronous learning networks. *Internet and Higher Education*, 5(4), 319–332. [https://doi.org/10.1016/S1096-7516\(02\)00130-6](https://doi.org/10.1016/S1096-7516(02)00130-6)
- Rovai, A. P., & Jordan, M. (2004) Blended learning and sense of community: A comparative analysis with traditional and fully online graduate courses. *The International Review of Research in Open and Distance Learning*, 5. <https://doi.org/10.19173/irrodl.v5i2.192>
- Sadanala, G., Xu, X., He, H., Bueno-Vesga, J. A., & Li, S. (2023). ‘Transition into relatable reality’: Experience analysis in a 3D desktop virtual-reality-based new student online orientation. *Journal of Research on Technology in Education*, 56(6), 711–732. <https://doi.org/10.1080/15391523.2023.2210321>
- Salcedo, M. D. C. N. (2022). Perception of blended learning in faculty and students of higher learning. *International Journal of Education and Practice*, 10(3), 227–236. <https://doi.org/10.18488/journal.61.2022.103.227.236>
- Saldaña, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). Sage.
- Sax, L. J., & Weintraub, D. S. (2014). Exploring the parental role in first-year students’ emotional well-being: Consideration by gender. *Journal of Student Affairs Research and Practice*, 51(2), 113–127. <http://dx.doi.org/10.1515/jsarp-2014-0013>
- Scagnoli, N. I. (2001). Student orientations for online programs. *Journal of Research on Technology in Education*, 34(1), 19–27. <https://doi.org/10.1080/15391523.2001.10782330>
- Schlossberg, N. K. (1981). A model for analyzing human adaptation to transition. *The Counseling Psychologist*, 9(2), 2–18. <https://doi.org/10.1177/001100008100900202>
- Schuster, M. T. (2019). Learning culture: First-year student transition, institutional culture, and the bubble of trial adulthood. *Journal of College Orientation, Transition, and Retention*, 26(2), 1–26. <https://doi.org/10.24926/jcotr.v26i2.2400>
- Sidelinger, R. J., & Booth-Butterfield, M. (2010). Co-constructing student involvement: An examination of teacher confirmation and student-to-student connectedness in the college classroom. *Communication Education*, 59(2), 165–184. <https://doi.org/10.1080/03634520903390867>

- Starke, M., Harth, M., and Sirianni, F. (2001). Retention, bonding, and academic achievement: Success of a first-year seminar. *Journal of the First-Year Experience & Students in Transition*, 13(2), 7–36. Retrieved from https://www.researchgate.net/publication/268823460_Retention_Bonding_and_Academic_Achievement_Success_of_a_First-Year_Seminar
- Stoebe, A., & Grebing, R. (2020). The effect of new student orientations on the retention of online students. *Online Journal of Distance Learning Administration*, 23(2), 1–8. <https://ojdla.com/assets/pdf/stoebe232.pdf>
- Suson, R. L. (2024). Factors influencing student satisfaction in blended learning: A structural equation modelling approach. *International Journal of Learning, Teaching and Educational Research*, 23(7), 207–227. <https://doi.org/10.26803/ijlter.23.7.11>
- Taylor, J. M. (2015). Innovative orientation leads to improved success in online courses. *Online Learning*, 19(4), Article 4. <https://doi.org/10.24059/olj.v19i4.570>
- Thomas, L. (2012). *Building student engagement and belonging in higher education at a time of change*. Paul Hamlyn Foundation Final Report. Retrieved from https://www.heacademy.ac.uk/system/files/what_works_final_report_0.pdf
- Thongsawat, S., Davidson-Shivers, G., & Chatphoomiphong, B. (2019). Designing an interactive student orientation to build social connectedness. *Journal of Educational Multimedia and Hypermedia*, 28(1), 99–112. <https://www.learntechlib.org/primary/p/178537/>
- Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition* (2nd ed.). University of Chicago Press. <https://doi.org/10.7208/chicago/9780226922461.001.0001>
- Tinto, V. (2003). Learning better together: The impact of learning communities on student success. *Higher Education Monograph Series 2003*, 1(8), 1–8. <https://www.yc.edu/v6/student-services/docs/successdocs/drtinto/LearningBetterTogether.pdf>
- Wang, S. K., & Hsu, H. Y. (2008). Use of the webinar tool (Elluminate) to support training: The effects of webinar-learning implementation from student-trainers' perspective. *Journal of Interactive Online Learning*, 7(3), 175–194. <http://www.sciepub.com/reference/129938>
- Ware, K., & Strickland, K. (2019). A blended approach to course orientation. *Nurse Educator*, 44(4), 221. <https://doi.org/10.1097/NNE.0000000000000628>
- Watts, J. (2019). Assessing an online student orientation: Impacts on retention, satisfaction, and student learning. *Technical Communication Quarterly*, 28(3), 254–270. <https://doi.org/10.1080/10572252.2019.1607905>

- Wilson, M. J., & Minhas-Taneja, V. (2016). Online orientation—a blended learning approach to student transition. *JANZSSA-Journal of the Australian and New Zealand Student Services Association*, 24(1), 61–68. <https://janzssa.scholasticahq.com/article/73096-online-orientation-a-blended-learning-approach-to-student-transition>
- Xu, L., & Brown, S. (2024). A sense of belonging in online post-traditional students: What matters? *Online Learning Journal*, 28(3), 326–352. <https://doi.org/10.24059/olj.v28i3.4>
- Yu, Q., Yu, K., Li, B., and Wang, Q. (2023). Effectiveness of blended learning on students' learning performance: A meta-analysis. *Journal of Research on Technology in Education*, 1–22. <https://doi.org/10.1080/15391523.2023.2264984>
- Zhou, M., & Chua, B. L. (2016). Using blended learning design to enhance learning experience in teacher education. *International Journal on E-Learning*, 15(1), 121–140. <https://www.learntechlib.org/primary/p/41984/>

Exploring Social Sciences and Humanities Student Perspectives on AI in Higher Education: A Comprehensive Study of Usage, Ethics, and Future Intentions

Ahmed Shehata

Sultan Qaboos University, Oman, Information Studies Department

Minia University, Egypt, Information Studies Department

Naifa Bint Eid Bait Bin Saleem

Sultan Qaboos University, Information Studies Department

Faten Hamad

Sultan Qaboos University, Oman, Information Studies Department

The University of Jordan, Jordan, Library and Information Science Department

Abstract

This study investigates social science students' perceptions, attitudes, and behavioral intentions toward artificial intelligence (AI) in higher education at Sultan Qaboos University. Drawing on the Theory of Reasoned Action, the research examines factors influencing AI adoption among students, including usage patterns, awareness levels, privacy concerns, and academic integrity considerations. Data were collected through a structured questionnaire from 255 students across various social science departments. The study employed regression analysis to test two models: factors influencing attitudes toward AI and determinants of behavioral intentions to use AI. Results reveal that AI tool usage ($\beta = .423, p < .001$) and awareness ($\beta = .198, p = .001$) significantly predict positive attitudes toward AI. Contrary to previous research, privacy concerns positively correlated with favorable AI attitudes ($\beta = .170, p = .011$). Students strongly support AI integration in education for improving efficiency (mean = 3.90) and work quality (mean = 3.67), while expressing the need for clear regulatory frameworks (mean = 3.78). The findings highlight a gap between AI usage and comprehensive understanding, suggesting the need for structured AI literacy programs. The study contributes to understanding AI adoption in higher education and provides recommendations for policy development that balances technological innovation with academic integrity and ethical considerations.

Keywords: Artificial intelligence; higher education; student perceptions; academic integrity; privacy concerns; technology adoption; social sciences education

Shehata, A., Saleem, N., & Hamad, F. (2026). Exploring social sciences and humanities student perspectives on AI in higher education: A comprehensive study of usage, ethics, and future intentions. *Online Learning*, 30(1), pp. 478-506.
<https://doi.org/10.24059/olj.v30i1.4989>

Introduction

The emergence of artificial intelligence (AI) as a disruptive technology in higher-education institutions is revolutionizing the teaching and learning landscape in global academic institutions. In the context of implementing AI in education, understanding how stakeholders perceive this transformative technology is critical for developing effective integration strategies that balance the wonders of technology with the value of holistic and community-based education.

Education has continued to be a cornerstone of the Sultanate of Oman's national development program, contributing to both individual progress and the wider development of the country's economy. The Sultanate has expressed considerable concern for excellence in education via holistic policy establishment that favors equitable access to quality education and, more importantly, incorporates technology as a vehicle of promoting critical thinking and entrepreneurial skills in the younger generation of students (Al-Maskri et al., 2012; Alzadjali, 2019). In this context, the rise of AI technologies presents both new possibilities and complex challenges that require analysis and evidence-based policy making.

Although the use of AI technologies in educational settings has been increasing, little is known about how students, as the main stakeholders of these tools, perceive, adopt, and integrate them into their academic interactions. The research conducted so far has tended to adopt an institutional perspective (university as an entity) and focus on technical implementation barriers. However, the students' comprehensive perspective—covering usage, attitude, privacy, and ethics in an integrated manner—or their models have not been widely explored based on integrated theories of technology acceptance (Dwivedi et al., 2023; Cardon et al., 2023).

In the existing research literature, there is a limited understanding of how AI is adopted in higher education. In contrast, studies tend to focus on specific aspects such as frequency of use (Chan and Hu, 2023), privacy concerns (Al-Zahrani and Alasmari, 2024) or academic integrity implications (Zhou et al., 2024), they have not identified how all these factors operate together to shape student attitudes and behavioral intentions toward the use of AI in teaching. In addition, studies in Middle Eastern and Gulf environments are significantly understudied and these geographical and cultural discrepancies underscore how AI is adopted in the diverse educational contexts around the world.

This gap is significant as student perceptions are central to successful technology integration. Holmes et al. (2022) highlight that successful AI integration needs inclusive frameworks from different stakeholders' perspectives, and Michel-Villarreal et al. (2023) state that sustainable AI implementation in education needs to be based on end-users' perceptions and attitudes. A significant limitation of existing educational technology literature is the lack of well-grounded, theoretically informed research on student perceptions of AI integration.

Social science students are an important group to consider when discussing the adoption of AI because their disciplines emphasize critical thinking, ethical reasoning, and human-centered approaches in tech-based solutions—skills and attitudes vital for understanding AI's broader significance in academic life. Moreover, the perspectives of social science students could

be especially valuable in developing comprehensive AI integration strategies, serving as a bridge between technical and humanistic views on technology adoption.

To fill this gap in the literature, this study examines social science students' perceptions of AI adoption at SQU in depth. Based on the Theory of Reasoned Action (TRA), the study also seeks to determine how various factors—AI tools usage, awareness and knowledge of AI, privacy concerns, perceived opportunities and challenges, and academic integrity considerations—cumulatively shape student attitudes and intentions to use AI in educational settings.

The study contributes to existing research in a number of specific ways. One, it stems from a theoretically robust and in-depth, multi-faceted understanding of various drivers and barriers to using AI that is unlike the linear analyses of individual factors. Second, it adds to the empirical evidence from the Gulf area, filling in the geographical void of AI ed research. Third, it provides policy-relevant reflections that support data-driven decision-making for the integration of AI into higher education institutions.

To be more specific, this study addresses three key research questions: (1) What influences students' attitudes towards use of AI in education? (2) What factors determine students' intention to use the AI tools for their academic work? (3) What are students' perceptions about opportunities and challenges and ethical considerations related to the use of AI in higher education? These objectives are implemented with an in-depth 6D survey tool, specifically created to measure the multi-faceted use of AI in educational environments.

The results of this paper are expected to provide valuable insights for educators, policymakers, and institutional leaders to develop best practices, ethical standards, and student-centered engagement methods for incorporating AI in higher education. As AI systems continue to advance and become more integrated into young people's education, it is essential to explore students' perspectives to guide sustainable and effective integration strategies that consider learning goals, the concept of the educated individual, and ethical technology use.

Literature Review

In recent years, the introduction of AI technologies in higher education has generated significant scholarly interest, particularly in relation to student attitudes toward AI implementation. This paper reviews the literature on key topics shaping students' experiences with AI in higher education, including how students perceive AI in academia, how they use AI as a study aid, their attitude to it, how their personal information is collected and used by AI, and ultimately, factors influencing students' adoption of AI tools. The following themes underpin students' engagement with AI-powered technology in educational settings.

Student Perceptions and Attitudes Toward AI in Education

Studies on student perspectives toward AI in education have progressed significantly. Early research found both positive attitudes and emerging skepticism. Chan and Hu (2023)

conducted a pioneering study with 399 students from various fields in Hong Kong, which generally showed a positive outlook toward generative AI, with similar average acceptance scores as those in the adapted technologies (ranging from 3.85 to 4.15 on a 5-point scale). This research established a baseline for student AI acceptance and identified factors associated with favorable attitudes, such as perceived usefulness in personalized learning and academic support.

The positive trends have been confirmed through further large institutional research, but subtle variations have emerged. Wells et al. (2024) examined 2,555 students from the University of Liverpool and identified that 93% of them had some knowledge of generative AI technologies. Specifically, 54% preferred tools like Grammarly, and 70% would not want to use ChatGPT to write an entire essay. This study highlights the need to differentiate between the strained relationship seen across AI applications when analyzing student perceptions.

The literature on student attitudes is grounded primarily in technology acceptance models. Cabero-Almenara et al. (2024) also showed that students with constructivist learning beliefs are more accepting of AI tools, and those who emphasize traditional pedagogical approaches are more resistant. This result indicates that fundamental educational philosophies play a role in the acceptance of AI.

A study showed that student acceptance drivers fall along several dimensions. Personalized learning support is highest in importance, with scores ranging from 4.12 to 4.35 on a five-point scale (Chan & Hu, 2023). Learners value most AI's availability 24/7, accurate and immediate feedback, and ability to adapt learning paths based on individual progress. Another valuable dimension is academic support, the mean word importance values of which range from 3.74 to 4.18, including writing support, research help, and citation support.

But alongside these positive attitudes, there are also major resistance factors. Concerns about academic integrity affect approximately half of students, stemming from uncertainty about plagiarism detection difficulties and unclear boundaries of use (Wells et al., 2024). Students are also worried that AI will take the place of human touch, with average concern ratings of 4.24 to 4.47 for existing connections in learning.

Demographic differences in attitudes also become significant. The acceptance levels increase especially among younger students aged 18–24 years. “Closer to AI” Generation Z students feel more comfortable with the inclusion of AI than older students (Cabero-Almenara et al., 2024). This variation is largely driven by field of study effects; STEM students have a 63.8% acceptance rate compared to their humanities peers, with only 0.2% expressing ethical concerns about AI taking over human creativity and critical thinking.

Cross-cultural research shows that different attitudes are found in different pedagogical situations. Western studies highlight concerns about privacy and academic integrity, while Asian studies report the acceptance of the authority of AI and a focus on efficiency gains (Chan & Hu, 2023). Such cultural differences have important implications for institutions with diverse student groups, raising questions around the way AI should be implemented in a culturally sensitive manner.

AI Usage Patterns and Applications in Academic Contexts

Recent studies on the use patterns of AI indicate its rapid acceptance among students and their sophisticated ways to integrate it. Recent large-scale analyses suggest 92% of students in the UK and 86% worldwide are currently using AI tools (Chronicle of Higher Education, 2024), up from only 66% in early 2024. Lifetime prevalence is 24–25%, and 54% report working with AI at least weekly on a variety of academic assignments.

Meta-analytic studies provide strong evidence for AI's usefulness in education. The current analysis includes a set of 51 studies (Wang and Fan, 2025). They found that ChatGPT had a large positive effect on learning effectiveness ($g = 0.867$), a significant positive effect on learners' perceptions ($g = 0.456$), and higher-order thinking skills ($g = 0.457$). These effect sizes show meaningful knowledge improvement when AI tools are effectively integrated into learning. The AI applications most frequently used in academic scenarios include explaining complex concepts, summarizing academic articles, guiding research ideas and methodologies, providing grammar checking and writing aid, assisting with early drafts and outlines, and offering help with assignments and problem-solving. ChatGPT leads the way as the favorite tool, followed by the most popular use-cases, which arise from Grammarly as a writing assistant, Microsoft Copilot for productivity-related jobs, and niche products like Paperpal and Jenni for academic-related help (Wang and Fan, 2025; Wells et al., 2024).

Disciplinary differences in usage patterns reveal important variations in AI adoption. Computer Science students comprise 46.5% of AI users despite representing only 5.4% of degree programs, indicating intensive adoption in technical fields (Von Garrel and Mayer, 2023). STEM fields collectively account for 70.5% of AI usage, with engineering students showing the highest usage rates at 11.3%. In contrast, humanities students use AI at a rate of 9.9%, with greater concerns about its appropriate use, while healthcare and medicine students show usage rates of 5.6% due to concerns about accuracy and liability.

Students develop nuanced strategies to incorporate AI support while upholding academic integrity. Effective approaches also include well-integrated methods (27% of students' responses), which involve embedding AI tools into learning processes and critically analyzing their outputs. Moderate or controlled use (14% of responses) involves AI serving as a support in learning without replacing human interaction and critical thinking. Information refinement (14% of responses) is the process of comparing AI outputs with authoritative academic sources (Li et al., 2024).

AI usage patterns reveal academic integrity challenges, a significant concern. Studies show that 18% of students include AI-generated text in their papers, and 51% are likely to continue doing so even if it violates their institution's policy (White, 2023). However, 88% rely on AI for revision preparation and study aids, which raises difficult policy questions for universities trying to balance the benefits of technology with maintaining academic integrity.

Privacy Concerns and Digital Literacy

Student privacy and digital literacy are essential in shaping AI adoption in education. Chan (2023) conducted pioneering work on AI policy requirements in higher education from students' and teachers' perspectives by surveying 457 students and 180 teachers in Hong Kong universities. We identified ten key focus areas for AI policy development (e.g., privacy and transparency of algorithms, institutional responsibility) and recommended an AI Ecological Education Policy Framework across pedagogical, governance, and operational dimensions accordingly.

New studies suggest a limited willingness for privacy among students. Brown et al. (2021) indicate that students actually care about privacy when they understand how their data is collected and used. They found that “optimistic bias” influences student attitudes, where students are concerned about privacy issues for society but do not believe they are personally at risk, leading to conflicting protective behaviors.

Results from digital literacy assessments indicate that students have misguided perceptions of what AI can and cannot do. Laupichler et al. (2023) identified significant differences in AI literacy among German university students, with most showing very low levels of knowledge about AI. Using their validated evaluative tool, they discovered that students had knowledge gaps related to algorithmic decision-making, data privacy consequences, and the limitations of AI systems, which hindered their ability to use AI tools effectively and safely.

Studies on dependence effects have shown that when an AI system is overused, users can lose the ability to think critically or make decisions. Learners are challenged to evaluate the credibility of AI and recognize algorithmic biases, which may degrade the analytic and evaluative skills required for academic proficiency (Zhai et al., 2024). These results highlight the importance of ICT courses that promote both operational concepts and cognitive skills in the use of digital tools.

Efforts to obtain informed consent and ensure transparency remain a persistent obstacle to deploying AI in education. Skulmowski (2025) highlighted serious issues with obtaining meaningful (informed) consent for AI-driven educational research, as AI technology is too complex for traditional consent to be sufficient. The study recommends dynamic consent models that adapt to changes in AI, along with ongoing transparency about data collection and usage.

Cross-cultural studies of privacy indicate substantial differences in privacy expectations and in regulatory strategies between various educational settings. Western research highlights individual privacy rights and the request for transparent AI technologies, whereas Asian research demonstrates an acceptance of AI authority and prioritizes efficiency gains through privacy protection (Al-Zahrani and Alasmari, 2024). The cultural differences have significant consequences in the context of transnational educational cooperation and student exchange.

Factors Influencing AI Adoption Intentions

Theoretical background for AI adoption intention in education context: The existing theoretical framework, the Technology Acceptance Model (TAM), is based on research that adopts TAM as the theoretical framework with some modifications to its principal factors because AIs have different features compared to traditional technologies. TAM has the highest applicability and consistently identifies perceived usefulness as a strong predictor of adoption intentions in educational settings as well (Almaiah et al., 2024). Expanded TAM applications include AI-specific constructs, such as confidence in the decision of an artificial intelligence agent (i.e., AI), anxiety toward it, perceived level of its own “intelligence,” and trust in the system.

The Theory of Reasoned Action (TRA) has been used to provide useful insights into AI adoption. In a study of 150 academics, an investigation into the factors that influenced AI writing tools use found that attitude ($\beta = 0.472$, $p < 0.001$) and subjective norms ($\beta = 0.588$, $p < .05$) significantly affected the intention to adopt AI, as measured by attitudes toward its usage behavior (Al-Suqri and Al-Kharusi, 2015). The Theory of Planned Behavior expands on TRA by adding perceived behavioral control, showing that self-efficacy and resource availability significantly moderate the relationship between intentions and actual AI-use behavior.

The Unified Theory of Acceptance and Use of Technology (UTAUT) has higher predictive power in Complex Learning Environments. One study conducted between 2008 and 2022 indicates that performance expectancy had the most significant impact on behavioral intention in higher education, followed by effort expectancy, social influence, and facilitating conditions (Xue et al., 2024). Extensions of UTAUT2, including hedonic motivation, price value, and habit, better fit the model, whereas trust and privacy prove to be additional essential constructs for AI technologies.

AI-specific variables significantly improve traditional technology acceptance models. Key predictors that remain consistently significant are perceived usefulness and performance expectancy, which are the strongest predictors. Trust plays a crucial role in AI-specific applications, while social influence and subjective norms are significant in academic settings. Facilitating conditions are vital for actual usage, and attitudes toward AI serve as a mediating factor in other relationships (Li et al. 2024).

The negative relationship between AI anxiety and adoption intentions remains relatively stable, while the positive relationship between AI confidence and usage intention appears quite minimal. Readiness toward AI refers to the degree of preparedness in using the technology, whereas perceived AI intelligence is associated with perceptions of usefulness. Ethical concerns are significant moderators of adoption decisions, especially among humanities and social science students (Kim et al., 2025).

There are significant differences in the intention to adopt due to demographic characteristics. Younger students also exhibit stronger adoption intentions and there are mixed gender results—some studies supporting a male preference for self-expression through technology while others find no significant differences. STEM disciplines lead in the use of AI

compared to humanities and social sciences, with early career researchers being more likely adopters than their senior colleagues (Xue et al, 2024; Kim et al., 2025; Li et al., 2024).

Cross-cultural validation research shows that basic theoretical groups are preserved across different cultural settings, though their interpretations of importance vary. Stronger social influence effects are observed in collectivist cultures, with power distance affecting authority roles in adoption decisions and uncertainty avoidance influencing risk perception regarding AI use (Xue et al, 2024).

Significance of the Study

As the use of AI in education has increased, especially with the rise of generative AI tools, a need to explore the implications of using these systems in education has emerged. It became important to investigate the current practices in the area and establish policies that regulate the use of AI tools. AI tools have allowed students and researchers to generate large quantities of text. However, using AI in such a way is considered unethical and leads to academic misconduct as this generated text does not reflect the actual skills of the students and also might contain inaccurate information.

The study's significance arises from the role of the educational system in the country's future. Quality education arises from a fair and credible educational practice that considers graduating students with skills that align with market needs. However, the use of AI in education might endanger the integrity of the educational process and compromise the whole educational system.

The importance of the study is represented in the need to unveil the current ethical practices among faculty of Arts students while dealing with AI. Hence, determining such practices will eventually lead to better ethical use of AI tools in academia and improve educational outputs.

Aims of the Study

This paper aims to broadly investigate the infusion of AI in higher education experiences of Sultan Qaboos University students. This research sheds light on different academic considerations regarding adopting AI and could be useful for policymakers, educators, or institutions when deciding how to adopt AI technologies into education ethically. The aims of this study are to:

1. Assess students' attitudes and awareness of AI-driven learning design and its effects on academic honesty, privacy, and data protection.
2. Examine how students view the opportunities and challenges of adopting AI in education, such as improving learning outcomes and promoting academic fairness.
3. Explore determinants that impact the intention of students to use AI in their future academic work and provide suggestions for ethical and effective utilization of AI technologies directed at Sultan Qaboos University.

Research Hypotheses and Theoretical Framework

The study's hypotheses were established based on the Theory of Reasoned Action (TRA), which we considered the best theory to address the research aims (Al-Suqri & Al-Kharusi, 2015; Shehata & Alnadabi, 2022) in addition to previous literature on technology adoption in educational contexts.

TRA was adopted as the theoretical framework for this study as it effectively explains how attitudes influence behavioral intentions, particularly in contexts of technology adoption. Hence, two sets of hypotheses were formulated to examine (1) factors influencing students' attitudes toward AI and (2) determinants of students' intentions to use AI in educational settings.

Model 1: Factors Influencing Attitudes Toward AI

H1: AI Tool Usage → Attitudes Toward AI

Higher levels of AI tool usage and applications positively influence students' attitudes toward AI in education.

H2: Awareness and Knowledge → Attitudes Toward AI

Greater awareness and knowledge of AI applications positively influence students' attitudes toward AI in education.

H3: Privacy and Security Concerns → Attitudes Toward AI

Higher levels of privacy and data security concerns negatively influence students' attitudes toward AI in education.

Model 2: Determinants of Behavioral Intentions

H4: AI Tool Usage → Behavioral Intentions

Higher levels of AI tool usage and applications positively influence students' intentions to use AI in the future.

H5: Awareness and Knowledge → Behavioral Intentions

Greater awareness and knowledge of AI applications positively influence students' intentions to use AI in the future.

H6: Attitudes → Behavioral Intentions

More positive attitudes toward AI positively influence students' intentions to use AI in the future.

H7: Opportunities and Challenges → Behavioral Intentions

Perceived opportunities and challenges associated with AI use influence students' intentions to use AI in the future.

H8: Academic Fairness and Integrity → Behavioral Intentions

Perceptions of AI's role in academic fairness and integrity influence students' intentions to use AI in the future.

Methodology

This study aimed to analyze the factors influencing the use of AI tools among humanities and social sciences students at Sultan Qaboos University, focusing on their attitudes, knowledge, and intentions related to AI in education. A quantitative research design was used, employing a structured questionnaire to collect data from a representative sample of students through an in-person survey, using random sampling to ensure diversity. The researchers designed a questionnaire that consisted of seven sections. The questionnaire aimed to measure the Use and Applications of AI in Education, Awareness and Knowledge, Attitudes and Personal Standards, Privacy and Data Security, Opportunities and Challenges, Academic Fairness and Integrity, and Future Intention to Use.

The questionnaire was pretested with a small group of social science and humanities students to ensure clarity and validity. After revisions, the final version was distributed using students' emails, which resulted in the retrieval of 255 valid questionnaires (Table 1). We limited data collection to academic departments that fall under the social sciences and humanities disciplines. The collected data was coded and analyzed using SPSS software, and then data were analyzed using descriptive statistics to summarize demographic information, and patterns of AI usage, t-tests, and ANOVA were employed to examine differences between subgroups within the sample based on demographic factors.

Table 1
Demographic Characteristics

Variable	Categories	Frequency	Percentage
Gender	Male	112	43.9
	Female	143	56.1
	Total	255	100%
College	Information Studies department	43	16.9
	Sociology department	14	5.5
	Law	26	10.2
	Economics department	40	15.7
	Psychology department	7	2.7
	English language department	61	23.9
	Geography department	45	17.6
	Media Studies department	16	6.3
	Music department	3	1.2
	Total	255	100%
Academic Level	First year	34	13.3
	Second year	35	13.7
	Third year	48	18.8
	Fourth year	69	27.1

Fifth year	17	6.7
Six year	9	3.5
Seventh year	6	2.4
Postgraduate	37	14.5
Total	255	100%

This approach enabled a comprehensive analysis of the factors influencing students' engagement with AI tools in education. The methodology provides valuable insights into the key elements affecting AI adoption in higher education, offering a foundation for future strategies and policy development to enhance AI integration in academic environments.

Correlation and regression analyses were conducted to explore relationships between variables, particularly focusing on the hypothesized relationships outlined in the study's conceptual framework. These relationships included the impact of expected AI use and awareness on attitudes toward AI use, the influence of comfort and privacy concerns on subjective norms, and the effects of attitudes and subjective norms on behavioral intention to use AI. Additionally, the study examined how perceptions of academic fairness and integrity related to both attitudes and behavioral intentions regarding AI use in education.

Data Analysis

Descriptive statistics were used to analyze the data, summarizing demographic characteristics and AI tool usage patterns. Results were effectively presented in tables and graphs, aiding interpretation. This allowed for a deeper understanding of key factors that may influence student engagement with AI tools for learning.

Reliability Results

The analysis's results are summarized in Table 2 below, which provides the number of items in each section along with their corresponding Cronbach's Alpha values.

Table 2

Cronbach's Alpha Reliability Analysis

Section	Dimensions	No. of items	Cronbach's Alpha
1	AI Tool Usage and Applications	6	0.859
2	Awareness and Knowledge	4	0.769
3	Attitudes and Personal Standards	4	0.828
4	Privacy and Data Security Concerns	4	0.750
5	Opportunities and Challenges	4	0.691
6	Academic fairness and integrity	4	0.655
7	Intentions for Future AI Use	4	0.823
Total		30	0.941

As the table demonstrates, the reliability analysis showed varying degrees of internal consistency across the sections of the questionnaire. The AI Tool Usage and Applications section

demonstrated the highest reliability ($\alpha = 0.859$), followed by Opportunities and Challenges ($\alpha = 0.691$) and Academic Fairness and Integrity ($\alpha = 0.655$), with the latter two remaining within acceptable ranges despite being lower. Notably, the overall questionnaire achieved high reliability ($\alpha = 0.941$), confirming its effectiveness in measuring students' AI usage patterns, awareness, and attitudes.

AI Tool Usage and Applications

According to the data presented in Table 3, the respondents generally agree on the benefits of using AI tools for various academic tasks, with the highest mean score (3.90) indicating that AI saves time and effort in completing academic assignments, followed by agreement that AI improves work quality (mean = 3.67). Students also agree they regularly use AI tools for lecture preparation and projects (mean = 3.63) and understanding complex topics (mean = 3.66), while their use of AI for searching academic sources shows slightly lower agreement (mean = 3.49). The only neutral response relates to using AI for summarizing articles and lectures (mean = 3.36), suggesting that while students generally have a positive attitude toward AI tools in academic work, they show less enthusiasm for its summarization capabilities.

Table 1

AI Tool Usage and Applications

#	Statement	Mean	Std.	Decision	Rank
q1.1	I regularly use AI tools to prepare lectures and academic projects	3.63	0.912	Agree	4
q1.2	Using AI saves me time and effort in completing my academic tasks	3.9	0.944	Agree	1
q1.3	I use AI applications to search for academic sources	3.49	1.034	Agree	5
q1.4	AI helps improve the quality of the academic work I submit	3.67	0.976	Agree	2
q1.5	I use AI tools to summarize articles and lectures	3.36	1.037	Neutral	6
q1.6	I use AI tools to facilitate understanding of complex topics	3.66	1.034	Agree	3

Awareness and Knowledge

Regarding students' awareness and knowledge of AI (Table 4), the analysis of students' awareness and knowledge of AI in education reveals moderate understanding levels. Students demonstrated awareness regarding AI-related risks (mean = 3.45), particularly concerning privacy, ethics, and data security implications. However, they showed neutral comprehension of fundamental AI concepts (mean = 3.25) and limited ability to differentiate AI from other educational digital tools (mean = 3.32). Similarly, students expressed uncertainty about whether AI tools require specialized technical skills (mean = 3.30). These findings suggest a need for enhanced educational initiatives to improve students' understanding of AI technology, its unique

characteristics compared to traditional tools, and the technical competencies required for its effective use in academic settings.

Table 2

Awareness and Knowledge

#	Statement	Mean	Std.	Decision	Rank
q2.1	I am fully familiar with the concept of AI and its applications in education	3.25	0.829	Neutral	4
q2.2	I know enough about the difference between AI and other technologies used in education	3.32	0.983	Neutral	2
q2.3	I believe using AI in education requires special technical skills	3.3	0.971	Neutral	3
q2.4	I am sufficiently aware of the potential risks of using AI in education	3.45	0.995	Agree	1

Attitudes and Personal Standards

In terms of attitudes and personal standards, the results of the analysis (Table 5) showed that the respondents expressed positive attitudes toward AI, with most statements falling into the “agree” category. The highest mean score (3.73) reflects agreement that AI use should be an integral part of higher education curricula, indicating strong support for embedding AI into academic systems.

Respondents also agree that their peers encourage the use of AI (mean = 3.63) and that AI enhances their academic efficiency (mean = 3.57). These findings highlight a general perception that AI not only improves academic performance but is also socially supported within the student community.

Additionally, students feel comfortable using AI to complete academic tasks (mean = 3.42), although this ranks lowest among the four statements, suggesting that while students are comfortable with AI, there may still be some hesitancy compared to other aspects of AI use.

Table 3

Attitudes and Personal Standards

#	Statement	Mean	Std.	Decision	Rank
q3.1	I feel comfortable using AI in completing my academic tasks	3.42	1.008	Agree	4
q3.2	My peers encourage the use of AI in education	3.63	0.963	Agree	2
q3.3	I believe using AI in education enhances my academic efficiency	3.57	1.017	Agree	3
q3.4	AI use should be an integral part of higher education curricula	3.73	1.009	Agree	1

Privacy and Data Security Concerns

The findings regarding students' privacy and data security concerns in AI education (Table 6) reveal varying levels of awareness and concern. For instance, the data showed that students strongly agreed on the need for clear privacy policies in AI educational tools (mean = 3.78) and institutional transparency regarding AI implementation and data collection practices (mean = 3.76). While students showed interest in understanding data protection mechanisms (mean = 3.53), they expressed neutral views about potential privacy risks associated with AI tools (mean = 3.11). These findings suggest that while students prioritize institutional accountability and transparency in AI implementation, they may lack a comprehensive understanding of specific data security risks, highlighting the importance of educating students about the potential privacy implications of AI technology in educational settings.

Table 4
Privacy and Data Security Concerns

#	Statement	Mean	Std.	Decision	Rank
q4.1	Using AI tools may expose my personal data to risks	3.11	1.046	Neutral	4
q4.2	I am interested in knowing how my personal data is protected when using AI tools	3.53	1.071	Agree	3
q4.3	There should be clear policies to protect privacy when using AI in education	3.78	0.984	Agree	1
q4.4	Universities should be transparent about how AI tools are used and what data is collected	3.76	0.941	Agree	2

Opportunities and Challenges

In Table 7, the analysis of opportunities and challenges in AI education reveals a balanced perspective among students. The students strongly agreed that AI presents opportunities for improving educational quality (mean = 3.66) and fostering creativity and self-learning (mean = 3.64). However, students maintained neutral stances regarding technical literacy barriers (mean = 3.38) and legal-ethical challenges (mean = 3.30). These findings suggest that while students are optimistic about AI's potential to enhance education and promote innovation, they don't perceive technical competency requirements or legal-ethical considerations as significant barriers to AI adoption, indicating a pragmatic approach to incorporating AI in their educational experience.

Table 5
Opportunities and Challenges

#	Statement	Mean	Std.	Decision	Rank
q5.1	I believe using AI in education is an opportunity to improve the quality of education	3.66	0.912	Agree	1
q5.2	The biggest challenge in using AI in education is students' lack of knowledge and technical skills	3.38	0.93	Neutral	3
q5.3	AI application in education opens new horizons for creativity and self-learning	3.64	0.97	Agree	2

q5.4	Legal and ethical challenges may hinder the application of AI in education	3.3	0.991	Neutral	4

Academic Fairness and Integrity

As the data below suggests (Table 8), students' perceptions of academic fairness and integrity regarding AI are equally mixed. Students do not deny the need to leverage AI to maintain integrity in academics, yet there are apprehensions regarding its effect on fairness and cheating reduction.

"Establishing laws and policies to regulate AI use is necessary to ensure academic integrity" had the highest mean score of 3.78, making it clear the extent to which students agree that regulatory frameworks are essential in protecting the quality of higher education.

Students deem AI to have a more positive potential impact on academic integrity when it is analyzed for unoriginal work (mean = 3.47). This implies that they regard AI-based tools for detecting plagiarism and authenticating academic tests as necessary.

However, there appears to be mixed feedback on whether AI promotes fairness in assessments (mean = 3.20) or reduces academic cheating (mean = 3.17). These neutral responses show some ambiguity or skepticism about whether AI can truly be effective in preventing biased evaluations and cheating.

Table 6
Academic Fairness and Integrity

#	Statement	Mean	Std.	Decision	Rank
q6.1	I believe AI use enhances academic fairness in assessment	3.2	0.911	Neutral	3
q6.2	AI use reduces cases of academic cheating	3.17	0.992	Neutral	4
q6.3	AI helps improve academic integrity by detecting unoriginal work	3.47	0.841	Agree	2
q6.4	Establishing laws and policies to regulate AI use is necessary to ensure academic integrity	3.78	0.847	Agree	1

Intentions for Future AI Use

According to Table 9, the analysis of students' future intentions regarding AI use in education reveals strong positive inclinations. Students showed highest agreement in their eagerness to learn more about AI tools (mean = 3.75), followed by recognition of AI's inevitable increased role in education (mean = 3.71). They also expressed strong agreement that AI would support their academic goals (mean = 3.67) and demonstrated a clear intention to use AI tools more effectively in the future (mean = 3.64). These consistently high scores across all measures indicate students' proactive approach toward AI integration, their recognition of its growing importance in education, and their commitment to leveraging AI tools for academic success.

Table 7
Intentions for Future AI Use

#	Statement	Mean	Std.	Decision	Rank
q7.1	I intend to use AI tools more effectively in my academic future	3.64	0.857	Agree	4
q7.2	Using AI will help me achieve my academic goals	3.67	0.879	Agree	3
q7.3	Increasing reliance on AI in education is inevitable in the future	3.71	0.976	Agree	2
q7.4	I will benefit from learning more about how to use AI tools in education	3.75	0.925	Agree	1

Regression Analysis

Building on the descriptive findings and guided by our theoretical framework based on the Theory of Reasoned Action, we conducted regression analyses to examine the factors influencing students' attitudes toward AI and their behavioral intentions to use AI in education. This analysis addresses our research objectives regarding the determinants of AI adoption and provides empirical evidence for our hypothesized relationships.

Testing the Research Models

Two regression models were tested: (1) factors influencing attitudes toward AI, and (2) determinants of behavioral intentions to use AI. This two-stage approach aligns with previous research by Chan and Hu (2023) and Zhou et al. (2024), who emphasized the importance of understanding both attitudinal formation and behavioral intentions in technology adoption.

Model 1: Factors Influencing Attitudes Toward AI

The first regression model examined factors influencing students' attitudes toward AI in education. The model explained 47.9% of the variance in attitudes ($R^2 = .479$, Adjusted $R^2 = .472$, $F(3,251) = 76.834$, $p < .001$), indicating substantial explanatory power as illustrated in Tables 10 and 11.

Table 8
Model Fit and Statistical Significance

Model Summary						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.692 ^a	.479	.472	.58936		
ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	80.063	3	26.688	76.834	.000 ^b
	Residual	87.183	251	.347		
	Total	167.246	254			

Table 9
Coefficients and Interpretation

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.578	.203		2.840	.005
	AI Tool Usage and Applications	.452	.068	.423	6.686	.000
	Awareness and Knowledge	.220	.067	.198	3.275	.001
	Privacy and Data Security Concerns	.180	.071	.170	2.555	.011

The results showed that:

- AI tool usage significantly predicted attitudes ($\beta = .423$, $p < .001$), supporting H1 and aligning with findings from Acosta-Enriquez et al. (2024).
- Awareness and knowledge significantly predicted attitudes ($\beta = .198$, $p = .001$), supporting H2 and confirming Vázquez-Parra et al.'s (2024) findings.
- Contrary to H3 and our expectations based on Al-Zahrani and Alasmari (2024), privacy and security concerns positively predicted attitudes ($\beta = .170$, $p = .011$).

Model 2: Determinants of Behavioral Intentions

The second model examined factors influencing intentions to use AI, explaining 60.6% of the variance ($R^2 = .606$, Adjusted $R^2 = .599$, $F(5,249) = 76.736$, $p < .001$). The results are outlined in tables 12 and 13.

Table 10
Model Fit and Statistical Significance

Model Summary						
Model		R	R Square	Adjusted R Square	Std. Error of the Estimate	
1		.779 ^a	.606	.599	.46615	
ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	83.374	5	16.675	76.736	.000
	Residual	54.108	249	.217		
	Total	137.481	254			

Table 11*Coefficients and Interpretation*

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.322	.189		1.705	.089
	AI Tool Usage and Applications	.259	.056	.267	4.588	.000
	Awareness and Knowledge	-.038	.058	-.037	-.647	.519
	Attitudes and Personal Standards	.329	.051	.363	6.495	.000
	Opportunities and Challenges	.201	.059	.187	3.420	.001
	Academic fairness and integrity	.199	.059	.171	3.379	.001

The analysis revealed:

- AI tool usage positively predicted intentions ($\beta = .267$, $p < .001$), supporting H4
- Awareness and knowledge did not significantly predict intentions ($\beta = -.037$, $p = .519$), failing to support H5
- Attitudes strongly predicted intentions ($\beta = .363$, $p < .001$), supporting H6
- Opportunities and challenges predicted intentions ($\beta = .187$, $p = .001$), supporting H7
- Academic fairness and integrity predicted intentions ($\beta = .171$, $p = .001$), supporting H8

Discussion

This study offers comprehensive insights into the perspectives of social science students on AI adoption in higher education, presented through a six-dimensional framework. The findings reveal complex patterns of engagement that both support and challenge existing understanding of educational technology integration. Each dimension of our survey contributes unique insights to the broader understanding of AI adoption among social science students at Sultan Qaboos University.

The high levels of agreement that AI saves time and effort and improves work quality align strongly with recent international research demonstrating widespread efficiency gains from AI tools. Vieriu and Petrea (2025) found that 49.4% of engineering students specifically cited timesaving as AI's primary advantage, with students reporting reductions of up to 50% in study

hours when effectively integrating AI tools. This result indicates that students from all disciplines view AI as a core value proposition for academic productivity. The overwhelming consensus that AI can aid in understanding complex topics is consistent with general trends we see in relation to the role of AI for personalized learning. Chan and Hu (2023) found that immediate response availability was rated highly by Hong Kong students. In the same study, personalized feedback capabilities also received high scores. This pattern across educational contexts suggests that AI's ability to provide on-demand explanations addresses a cross-disciplinary student need.

However, the neutral attitude toward AI for summarization tasks reveals a subtlety in students' preferences regarding AI applications. This indicates that students can make nuanced distinctions between AI tasks they find beneficial and those that might not aid their learning. The relatively low enthusiasm for summarization may stem from concerns about passive learning; it could also reflect an awareness that the ability to summarize is a basic academic skill best left for students to develop on their own. The Theory of Reasoned Action explains these usage patterns well, with strong positive attitudes toward efficiency and quality improvements creating highly favorable subjective norms for continued use, while the more cautious approach to summarization shows that students are still reflecting on the role AI should play in their learning.

The low levels of AI awareness found in our survey highlight an educational policy issue caused by the gap between usage and understanding. While students indicated that they had a basic sense of AI safety, their understanding of core AI concepts remains limited and neutral, and they struggle to distinguish digital educational tools that involve AIs from those that do not. This theme reflects documented knowledge gaps in AI literacy studies. Laupichler et al. (2023) observed significant variation in AI literacy among German college students: although they frequently use AI, most only have a basic understanding of its concepts. Their validated survey instrument revealed concerning gaps in understanding how AI makes decisions, the implications for data privacy, and the limitations of AI systems—findings that directly align with our own results.

The dual-process model of cognition provides a theoretical explanation for this gap. Surface-level processing makes risk awareness easily accessible through media exposure and peer discussions, while deep understanding of AI fundamentals requires effortful learning and systematic education. Students can readily articulate concerns about AI risks without necessarily understanding the technical mechanisms underlying these risks.

While our regression analysis demonstrated that awareness and knowledge significantly predicted positive attitudes toward AI ($\beta = 0.198$, $p = 0.001$), this finding should be interpreted with caution, given the moderate levels of awareness observed in our descriptive results. The statistical significance may reflect the relationship between basic risk awareness and attitude formation; however, the moderate awareness levels suggest that a deeper understanding remains limited. This relationship warrants further longitudinal investigation to determine how systematic AI education and knowledge development influence attitude formation over time.

This knowledge gap has important implications for educational practice. Kim et al. (2024) cautioned that students might interact passively with AI without adequate knowledge,

applying AI suggestions without deeper reflection. Our findings suggest that educational institutions should develop comprehensive AI literacy programs that move beyond awareness to foster a functional understanding of AI capabilities and limitations.

Positive attitudes toward AI were observed across all measures, showing that students are prepared for the institutional integration of AI. The strongest agreement is on the role of AI in higher education curricula, which aligns with international research indicating that students are overwhelmingly supportive of institutions adopting AI. For example, Katsantonis and Katsantonis (2024) reported that 65.2% of Greek students agree that universities should provide AI education, while 77.3% believe that future careers will require knowledge of AI. The high consensus on peer influence aligns with the influential role peers play in technology adoption within educational settings. According to the Theory of Reasoned Action, subjective norms (i.e., peer attitudes and behaviors) significantly impact individual intentions. Al-Bukhrani et al. (2025) demonstrated that subjective norms greatly influence AI adoption intentions in academic environments, highlighting why peer recommendation is an important factor in our study.

The results that AI improves academic efficiency reflect broader research on perceived usefulness in technology acceptance models. The Technology Acceptance Model consistently shows that perceived usefulness is the strongest factor influencing technology acceptance intentions, meaning students' perceptions of AI's efficiency benefits provide a solid foundation for continued use. However, the slightly lower agreement with AI comfort suggests that some hesitation may still accompany positive attitudes. This pattern could be due to AI's emerging role in education, where students recognize the benefits but are still adjusting to new ways of learning and working (Ma et al., 2025; Alshammari and Alkhwalidi, 2025).

One of the most theoretically interesting outcomes that our study revealed is a positive association between privacy and security concerns to favorable attitudes toward AI. This result is inconsistent with prior work (e.g., Al-Zahrani and Alasmari, 2024) that reported an adverse effect from privacy concerns on attitudes towards AI. This apparent paradox can be reconciled by well-established models from privacy studies though. The best use is offered by the Privacy Calculus Theory, which suggests individuals weigh risks and benefits when deciding whether to uptake technologies that require sharing personal information. Users may be more likely to consider adopting technology in a privacy-preserving manner when the benefits outweigh the risks.

The Privacy Paradox literature offers some explanation for this result. Dienlin et al. (2023) discovered in a longitudinal study that privacy concerns are often poor predictors of protective behaviors, especially for technologies where utility is very high. Educational environments could be such high-utility settings, where the academic benefits of AI tools outweigh privacy concerns for most students. The fact that we found students care a lot about having clear privacy policies and institutional transparency aligns with this idea as do their neutral opinions on personal data risks. Students seem to understand that privacy matters are essential at the institutional level, but they perceive it as less personally significant when faced with barriers to adopting AI.

In this way, we believe that students' views on AI applications and challenges reflect a form of "technological pragmatism"—that is, their enthusiastic use of technology without ignoring potential obstacles in implementation. This high convergence indicates that students believe in AI's potential to transform the quality of education positively and to create opportunities for creativity and self-learning. These findings align with broader research on the learning benefits of AI. Wang and Fan (2025) presented results from a meta-analysis of 51 studies, showing that ChatGPT has significant positive effects on learning performance but only moderate changes in students' perceptions of their own or others' learning processes, as well as higher-order thinking skills. Students' confidence in the potential for education to improve may be more than just naivety.

But relatively neutral attitudes toward technical literacy barriers and legal-ethical challenges suggest that students do not see these factors as major obstacles to adopting AI. This perspective could reflect their confidence in their ability to adapt and the support from institutions, or it may indicate a lack of understanding of how complex responsible AI implementation can be. The neutral stance on technical literacy barriers sharply contrasts with the clear evidence of AI illiteracy among students, implying that many may underestimate the knowledge and skills required for successful integration.

Student perspectives on academic fairness and integrity reveal complex attitudes toward AI's role in maintaining academic standards. The exceptionally strong agreement on the need for regulatory frameworks demonstrates student recognition that AI integration requires careful governance to preserve educational integrity. This finding receives comprehensive validation from international research. Chan (2023) found that both students and teachers strongly agreed that institutions need AI management plans. The consistency of these findings across different educational contexts suggests that the development of a regulatory framework represents a universal priority for AI integration in higher education.

The neutral responses regarding AI's ability to enhance assessment fairness and reduce academic cheating reflect broader institutional struggles with these concepts. Recent research by BestColleges (2024) found that 51% of students consider AI use in assignments as cheating, while 20% disagree, indicating the conceptual ambiguity our findings capture. This uncertainty suggests that clear guidelines and consistent institutional policies are crucial for helping students understand the appropriate use of AI. However, students do recognize AI's potential for detecting unoriginal work, suggesting awareness of AI's capabilities for maintaining academic integrity through detection rather than prevention.

The strong demand for regulatory frameworks combined with uncertainty about AI's effectiveness in preventing cheating suggests that students view institutional governance as essential for resolving the tensions between AI benefits and academic integrity requirements. This perspective aligns with broader calls for comprehensive AI ethics frameworks in educational settings. The findings also reflect the transitional nature of academic integrity concepts in the age of AI, where traditional notions of original work and appropriate assistance are being challenged by AI capabilities, requiring new frameworks for understanding academic honesty.

The study's findings provide strong support for the Theory of Reasoned Action while revealing important nuances in its application to AI adoption. The significant positive relationships between AI tool usage and attitudes and between attitudes and behavioral intentions confirm TRA's core propositions. However, the unexpected positive correlation between privacy concerns and attitudes suggests that traditional technology acceptance models may require adaptation to account for AI-specific characteristics. The findings also contribute to an understanding of the Technology Acceptance Model in educational contexts, where the strong emphasis on perceived usefulness confirms the central proposition of TAM, while the social influence effects highlight the importance of subjective norms in academic environments.

The study's findings have significant implications for educational policy and practice. The strong student support for AI integration, combined with identified knowledge gaps, suggests that institutions should prioritize comprehensive AI literacy programs alongside the implementation of technology. The regulatory framework imperative indicates that successful AI integration requires clear policies and guidelines developed through inclusive stakeholder engagement. The privacy-attitude correlation suggests that transparency and clear data governance policies may actually enhance, rather than hinder, AI adoption. This indicates that institutions should invest in comprehensive privacy frameworks that address student concerns while maintaining the benefits that drive positive attitudes toward AI tools.

Several limitations should be acknowledged in interpreting these findings. The cross-sectional design limits causal inferences, while the focus on social science students may limit generalizability to other disciplines. The rapid pace of AI development means that student attitudes and usage patterns may evolve quickly, requiring longitudinal research to track changes over time. Future research should investigate the relationship between AI literacy and adoption outcomes, examine disciplinary differences in AI integration patterns, and develop comprehensive frameworks for measuring AI readiness in educational contexts. Cross-cultural validation of these findings would enhance understanding of how cultural factors influence AI adoption in higher education.

This comprehensive examination of social science students' perspectives on AI adoption reveals a complex landscape of enthusiasm tempered by recognition of implementation challenges. Students demonstrate a sophisticated understanding of AI benefits while calling for institutional frameworks to address concerns regarding privacy, integrity, and governance. The findings suggest that successful AI integration requires coordinated attention to technical implementation, educational support, and policy development to realize the transformative potential of AI in higher education while maintaining academic values and standards.

Conclusion

This study examines the perceptions of social science students regarding artificial intelligence, particularly at Sultan Qaboos University, and aims to understand their attitudes and intentions toward AI adoption. We believe that AI deployment could be very useful in maintaining a fair equilibrium among all stakeholders within academia. It could also expose the promises and perils of AI in higher education, with enormous implications for educational policymakers and practitioners.

The study illustrated that most students believe AI integration improves efficiency and work quality. However, enthusiasm is hindered by the gap between using practical AI solutions and fully understanding how to apply them. The results of this study centered on the tangible reality of student interactions with AI during learning activities and how it influences their beliefs about more general applications of AI in education. A significant result was found regarding the complex interplay between privacy concerns and attitudes toward AI.

Unlike previous research, individuals with higher levels of privacy awareness had more positive views on AI than their peers, indicating that a well-informed engagement with technology is complex and does not always result in negative perceptions. This emphasizes the importance of comprehensive AI education, which should include an understanding of both technical capabilities and ethical responsibilities.

The study also had significant implications for promoting academic integrity and adopting AI technologies. Contrary to the findings of the literature review, students are generally unconcerned about strict AI regulatory frameworks and remain skeptical of AI's effectiveness in reducing academic misconduct. This suggests the need for well-thought-out regulatory policies to maximize the benefits of AI while adhering to academic ethics standards.

The research findings have added to the growing body of literature that paints a more complete picture of this potentially novel paradigm in education. Future research could look into the long-term impact and efficacy of incorporating AI into learning outcomes and effective pedagogy for literacy development consumption among students on this topic (and others), as well as the relationship between usage patterns and academic integrity. This study has several limitations, including the fact that participants were self-selected and that it only focused on social science students at one institution. Future research avenues could include longitudinal institutional or system-level observations following AI adoption across a wide range of subject categories.

Since AI can reshape the learning environments, it is important to understand student perceptions so this change can be well-integrated. It establishes a basis for making choices in AI implementation around the necessity of maintaining ethical and academic standards in step with technological advancement. The outcomes highlight the need for a sensible framework to integrate AI into higher education based on technological potential, student requirements as well as ethical concerns together with institutional pressures.

Acknowledgement

The research leading to these results has received funding from Sultan Qaboos University under the Deanship of research funding Program. Funding Agreement No [RF/ART/INFO/24/02]

Declarations

Ethical Approvals

This research was conducted in strict adherence to ethical standards and received full approval from the Sultan Qaboos University Research Ethics Committee (Approval number: 2024-09-10). The university reviewed and approved the study protocol, confirming that the research posed minimal risk to participants and was conducted in compliance with ethical guidelines, including the Declaration of Helsinki and institutional regulations governing research involving human participants.

Informed Consent

Informed consent was obtained from all participants prior to their involvement in the study. Potential participants were approached through official university communication channels, where they were provided with comprehensive information about the study's objectives, procedures, and their rights as participants. All participants completed a consent form, available in Arabic, agreeing to participate, to use their data for research purposes, and to publish anonymized findings. They were informed of the confidentiality of their responses, the aggregation of data for analysis, and their right to withdraw from the study at any time without consequence. All documentation and data collection procedures were conducted in accordance with institutional guidelines for protecting participant privacy and data security.

AI Use Statement

Generative artificial intelligence (AI) was used in the preparation of this manuscript for grammar and style refinement. The AI tool was not used to generate, analyze, or interpret research data, nor to create original scholarly content. All content was reviewed, verified, and approved by the authors, who take full responsibility for the accuracy and integrity of the work.

Competing Interests

All authors declare no competing interests.

References

- Acosta-Enriquez, B. G., Arbulú Ballesteros, M. A., Huamaní Jordan, O., López Roca, C., & Saavedra Tirado, K. (2024). Analysis of college students' attitudes toward the use of ChatGPT in their academic activities: Effect of intent to use, verification of information and responsible use. *BMC Psychology*, 12(1), 255. <https://doi.org/10.1186/s40359-024-01764-z>
- Al-Bukhrani, M. A., Alrefae, Y. M. H., & Tawfik, M. (2025). Adoption of AI writing tools among academic researchers: A Theory of Reasoned Action approach. *PLOS ONE*, 20(1), e0313837. <https://doi.org/10.1371/journal.pone.0313837>
- Al-Maskri, M., Al-Mukhini, S., & Amzat, I. H. (2012). Improving education system in Oman through school curriculum, teaching methods and evaluation: What is needed? *OIDA International Journal of Sustainable Development*, 3(10), 39–60. <https://ssrn.com/abstract=2047736>
- Al-Suqri, M. N., & Al-Kharusi, R. M. (2015). Ajzen and Fishbein's theory of reasoned action (TRA) (1980). In *Information seeking behavior and technology adoption: Theories and trends* (pp. 188–204). IGI Global. <https://doi.org/10.4018/978-1-4666-8156-9.ch012>
- Al-Zahrani, A. M., & Alasmari, T. M. (2024). Exploring the impact of artificial intelligence on higher education: The dynamics of ethical, social, and educational implications. *Humanities and Social Sciences Communications*, 11(1), 1–12. <https://doi.org/10.1057/s41599-024-03432-4>
- Allam, A. H., Elteuacy, N. K., Alabdallat, Y. J., Owais, T. A., Salman, S., & Ebada, M. A. (2024). Knowledge, attitude, and perception of Arab medical students towards artificial intelligence in medicine and radiology: A multi-national cross-sectional study. *European Radiology*, 34(7), 1–14. <https://doi.org/10.1007/s00330-023-10509-2>
- Almaiah, M. A., Alfaisal, R., Salloum, S. A., Hajjej, F., Thabit, S., El-Qirem, F. A., Lutfi, A., Alrawad, M., Al Mulhem, A., & Al-Marooof, R. S. (2024). Examining the impact of artificial intelligence and social and computer anxiety in e-learning settings: Students' perceptions at the university level. *Electronics*, 13(7), 1298. <https://doi.org/10.3390/electronics11223662>
- Almaraz-López, C., Almaraz-Menéndez, F., & López-Esteban, C. (2023). Comparative study of the attitudes and perceptions of university students in business administration and management and in education toward artificial intelligence. *Education Sciences*, 13(6), 609. <https://doi.org/10.3390/educsci13060609>
- Alneyadi, S., Wardat, Y., Alshannag, Q., & Abu-Al-Aish, A. (2023). The effect of using smart e-learning app on the academic achievement of eighth-grade students. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(4), em2248. <https://doi.org/10.29333/ejmste/13067>
- Alshammari, S. H., & Alkhwalidi, A. F. (2025). An integrated approach using social support theory and technology acceptance model to investigate the sustainable use of digital

- learning technologies. *Scientific Reports*, 15(1), 342. <https://doi.org/10.1038/s41598-024-83450-z>
- Alzadjali, A. H. H. (2019). Policies and initiatives for the internationalization of higher education in Oman. In *Policies and initiatives for the internationalization of higher education* (pp. 12–31). IGI Global. <https://doi.org/10.4018/978-1-5225-5231-4.ch002>
- Alzahrani, L. (2023). Analyzing students' attitudes and behavior toward artificial intelligence technologies in higher education. *International Journal of Recent Technology and Engineering*, 11(6), 65–73. <https://doi.org/10.35940/ijrte.F7475.0311623>
- Ayasrah, F., Alarabi, K., Mansouri, M., Fattah, H., & Al-Said, K. (2024). Enhancing secondary school students' attitudes toward physics by using computer simulations. *International Journal of Data and Network Science*, 8(1), 369–380. <https://doi.org/10.5267/j.ijdns.2023.9.017>
- BestColleges. (2024). *56% of college students have used AI on assignments or exams*. BestColleges Research. <https://www.bestcolleges.com/research/most-college-students-have-used-ai-survey/>
- Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education*, 21(1), 36. <https://doi.org/10.1186/s41239-023-00436-z>
- Brown, M., McCormack, M., Reeves, J., Brooks, C. D., & Grajek, S. (2020). *2021 EDUCAUSE Horizon Report: Teaching and learning edition*. EDUCAUSE. <https://library.educause.edu/-/media/files/library/2021/4/2021hrteachinglearning.pdf>
- Buabbas, A. J., Miskin, B., Alnaqi, A. A., Ayed, A. K., Shehab, A. A., Syed-Abdul, S., & Uddin, M. (2023). Investigating students' perceptions towards artificial intelligence in medical education. *Healthcare*, 11(9), 1298. <https://doi.org/10.3390/healthcare11091298>
- Cabero-Almenara, J., Guillén-Gámez, F. D., Ruiz-Palmero, J., & Palacios-Rodríguez, A. (2024). Teachers' digital competence and artificial intelligence: A review study and future research. *Computers & Education*, 215, 105040. <https://doi.org/10.1111/bjet.13151>
- Cardon, P., Fleischmann, C., Aritz, J., Logemann, M., & Heidewald, J. (2023). The challenges and opportunities of AI-assisted writing: Developing AI literacy for the AI age. *Business and Professional Communication Quarterly*, 86(3), 257–295. <https://doi.org/10.1177/23294906231176517>
- Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20(1), 38. <https://doi.org/10.1186/s41239-023-00408-3>
- Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1), 43. <https://doi.org/10.1186/s41239-023-00411-8>

- Chan, C. K. Y., & Lee, K. K. (2023). The AI generation gap: Are Gen Z students more interested in adopting generative AI such as ChatGPT in teaching and learning than their Gen X and millennial generation teachers? *Smart Learning Environments*, 10(1), 60. <https://doi.org/10.1186/s40561-023-00269-3>
- Chen, Y., Jensen, S., Albert, L. J., Gupta, S., & Lee, T. (2023). Artificial intelligence (AI) student assistants in the classroom: Designing chatbots to support student success. *Information Systems Frontiers*, 25(1), 161–182. <https://doi.org/10.1007/s10796-022-10291-4>
- Chronicle of Higher Education. (2024, March 15). How are students really using AI? *The Chronicle of Higher Education*. <https://www.chronicle.com/article/how-are-students-really-using-ai>
- Dienlin, T., Masur, P. K., & Trepte, S. (2023). A longitudinal analysis of the privacy paradox. *New Media & Society*, 25(5), 1043–1064. <https://doi.org/10.1177/14614448211016316>
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., & Ahuja, M. (2023). “So what if ChatGPT wrote it?” Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management*, 71, 102642. <https://doi.org/10.1016/j.ijinfomgt.2023.102642>
- Harry, A., & Sayudin, S. (2023). Role of AI in education. *Interdisciplinary Journal and Humanity (INJURITY)*, 2(3), 260–268. <https://doi.org/10.58631/injury.v2i3.52>
- Holmes, W., Porayska-Pomsta, K., Holstein, K., Sutherland, E., Baker, T., Shum, S. B., Santos, O. C., Rodrigo, M. T., Cukurova, M., & Bittencourt, I. I. (2022). Ethics of AI in education: Towards a community-wide framework. *International Journal of Artificial Intelligence in Education*, 32, 504–526. <https://doi.org/10.1007/s40593-021-00239-1>
- Jia, X.-H., & Tu, J.-C. (2024). Towards a new conceptual model of AI-enhanced learning for college students: The roles of artificial intelligence capabilities, general self-efficacy, learning motivation, and critical thinking awareness. *Systems*, 12(3), 74. <https://doi.org/10.3390/systems12030074>
- Katsantonis, A., & Katsantonis, I. G. (2024). University students’ attitudes toward artificial intelligence: An exploratory study of the cognitive, emotional, and behavioural dimensions of AI attitudes. *Education Sciences*, 14(9), 988. <https://doi.org/10.3390/educsci14090988>
- Kiemde, S. M. A., & Kora, A. D. (2022). Towards an ethics of AI in Africa: Rule of education. *AI and Ethics*, 2(1), 35–40. <https://doi.org/10.1007/s43681-021-00106-8>
- Kim, J., Ham, Y., & Lee, S.-S. (2024). Differences in student-AI interaction process on a drawing task: Focusing on students’ attitude towards AI and the level of drawing skills. *Australasian Journal of Educational Technology*, 40(1), 19–41. <https://doi.org/10.14742/ajet.8859>

- Kim, J., Yu, S., Detrick, R., & Li, N. (2024). Exploring students' perspectives on generative AI-assisted academic writing. *Education and Information Technologies*, 30(1), 1265–1300. <https://doi.org/10.1007/s10639-024-12878-7>
- Kim, J. J., Soh, J., Kadkol, S., Solomon, I., Yeh, H., Srivatsa, A. V., Leow, A. D., Langenecker, S. A., Garnett, M. F., & Ajilore, O. (2025). AI anxiety: A comprehensive analysis of psychological factors and interventions. *AI and Ethics*. Advance online publication. <https://doi.org/10.1007/s43681-025-00686-9>
- Kochis, M., Parsons, M. Q., Rothman, D., Petrusa, E., & Phitayakorn, R. (2024). Medical students' perceptions and use of educational technologies and artificial intelligence chatbots as educational resources. *Global Surgical Education—Journal of the Association for Surgical Education*, 3(1), 1–11. <https://doi.org/10.1007/s44186-024-00292-z>
- Laupichler, M. C., Aster, A., Meyerheim, M., Raupach, T., & Mergen, M. (2024). Medical students' AI literacy and attitudes towards AI: A cross-sectional two-center study using pre-validated assessment instruments. *BMC Medical Education*, 24(1), 401. <https://doi.org/10.1186/s12909-024-05400-7>
- Laupichler, M. C., Aster, A., Schirch, J., & Raupach, T. (2023). Artificial intelligence literacy in higher and adult education: A scoping literature review. *Computers and Education: Artificial Intelligence*, 4, 100101. <https://doi.org/10.1016/j.caeai.2022.100101>
- Li, W., Zhang, X., Li, J., Yang, X., Li, D., & Liu, Y. (2024). An explanatory study of factors influencing engagement in AI education at the K-12 level: An extension of the classic TAM model. *Scientific Reports*, 14(1), 13922. <https://doi.org/10.1038/s41598-024-64363-3>
- Ma, J., Wang, P., Li, B., Wang, T., Pang, X. S., & Wang, D. (2025). Exploring user adoption of ChatGPT: A technology acceptance model perspective. *International Journal of Human–Computer Interaction*, 41(2), 1431–1445. <https://doi.org/10.1080/10447318.2024.2314358>
- Macaulay, T. (2020, November 20). *Study: Only 18% of data science students are learning about AI ethics*. The Next Web. <https://thenextweb.com/news/study-only-18-of-data-scientists-are-learning-about-ai-ethics>
- Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences*, 13(9), 856. <https://doi.org/10.3390/educsci13090856>
- Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguyen, B.-P. T. (2023). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, 28(4), 4221–4241. <https://doi.org/10.1007/s10639-022-11316-w>
- Schiff, D. (2022). Education for AI, not AI for education: The role of education and ethics in national AI policy strategies. *International Journal of Artificial Intelligence in Education*, 32(3), 527–563. <https://doi.org/10.1007/s40593-021-00270-2>

- Shehata, A., & Alnadabi, K. (2022). Factors affecting undergraduate students' information sharing behaviour when dealing with COVID-19 misinformation: The theory of reasoned action. *Information Research*, 27(Special issue). <https://doi.org/10.47989/irisic2221>
- Shneiderman, B. (2020). Human-centered artificial intelligence: Reliable, safe & trustworthy. *International Journal of Human–Computer Interaction*, 36(6), 495–504. <https://doi.org/10.1080/10447318.2020.1741118>
- Skulmowski, A. (2025). Informed consent in educational AI research needs to be transparent, flexible, and dynamic. *Mind, Brain, and Education*, 19(1), 32–36. <https://doi.org/10.1111/mbe.12435>
- Vázquez-Parra, J. C., Henao-Rodríguez, C., Lis-Gutiérrez, J. P., & Palomino-Gámez, S. (2024). Importance of university students' perception of adoption and training in artificial intelligence tools. *Societies*, 14(8), 141. <https://doi.org/10.3390/soc14080141>
- Vieriu, A. M., & Petrea, G. (2025). The impact of artificial intelligence (AI) on students' academic development. *Education Sciences*, 15(3), 343. <https://doi.org/10.3390/educsci15030343>
- Von Garrel, J., & Mayer, J. (2023). Artificial intelligence in studies—Use of ChatGPT and AI-based tools among students in Germany. *Humanities and Social Sciences Communications*, 10(1), 1–9. <https://doi.org/10.1057/s41599-023-02304-7>
- Wang, J., & Fan, W. (2025). The effect of ChatGPT on students' learning performance, learning perception, and higher-order thinking: Insights from a meta-analysis. *Humanities and Social Sciences Communications*, 12, 621. <https://doi.org/10.1057/s41599-025-04787-y>
- Wells, C., Kolek, E., Williams, E., & Saunders, D. (2024). Student perspectives on the use of generative artificial intelligence technologies in higher education. *International Journal for Educational Integrity*, 20(1), 4. <https://doi.org/10.1007/s40979-024-00149-4>
- White, J. D. (2023). Academic integrity in the age of AI. *EDUCAUSE Review*. <https://er.educause.edu/articles/sponsored/2023/11/academic-integrity-in-the-age-of-ai>
- Xue, L., Rashid, A. M., & Ouyang, S. (2024). The unified theory of acceptance and use of technology (UTAUT) in higher education: A systematic review. *SAGE Open*, 14(1). <https://doi.org/10.1177/21582440241229570>
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education—Where are the educators? *International Journal of Educational Technology in Higher Education*, 16(1), 39. <https://doi.org/10.1186/s41239-019-0171-0>
- Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review. *Smart Learning Environments*, 11(1), 28. <https://doi.org/10.1186/s40561-024-00316-7>
- Zhou, X., Zhang, J., & Chan, C. (2024). Unveiling students' experiences and perceptions of artificial intelligence usage in higher education. *Journal of University Teaching and Learning Practice*, 21(6). <https://doi.org/10.53761/xzjprb23>

Enhancing Oral Language Skills with Pi AI: A Study on Speaking and Pronunciation Gains

Behnam Behforouz

University of Technology and Applied Sciences, Shinas, Oman; Sohar University, Oman

Afrooz Poorghorban

Islamic Azad University, Central Tehran Branch, Iran

Ali Al Ghaithi

Sohar University, Oman

Abstract

Learners often struggle with speaking and pronunciation due to insufficient practice and feedback opportunities in real situations, which classroom instruction cannot provide adequately. This paper examined the effectiveness of Pi AI, an AI-powered chatbot, in improving speaking and pronunciation among Omani EFL learners. In this investigation, 60 students were randomly divided into experimental ($n = 30$) and control groups ($n = 30$). Speaking pretests were conducted to ensure all participants had similar speaking skills. While both groups received regular classroom instruction, the experimental group received additional practice through Pi AI for a month of treatment period. Speaking posttests were conducted to compare the results with the pretests. Findings showed that the experimental group performed better than their peers in the control group on both speaking and pronunciation posttests. The findings are helpful for students, teachers, and educational institutions.

Keywords: AI-driven learning tool; Pi AI; speaking skills; pronunciation

Behforouz, B., Poorghorban, A., & Al Ghaithi, A. (2026). Enhancing oral language skills with Pi: A study on speaking and pronunciation skills. *Online Learning*, 30(1), pp. 507-530. <https://doi.org/10.24059/olj.v30i1.4928>

Introduction

Speaking skills are significant in communication, mainly when the mother tongue is not used, and the communication medium is a foreign language. English is extensively used globally for communication. Particular attention should be paid to improving EFL learners' speaking skills (Akhter et al., 2020). EFL learners must acquire proficiency in spoken English since it reflects their understanding of the English language (Nazara, 2011). The efficacy of English speaking is assessed by the precision and fluency with which a speaker employs spoken language in conversation (Brown & Lee, 2015; Dao, 2017; Manurung, 2015).

According to Huy et al. (2024), speaking is essential in acquiring and instructing foreign languages. Using a foreign language enables pupils to articulate their concepts verbally. He also thinks that students should practice speaking within quotidian contexts to get proficiency. Consequently, the instructor should give students supplementary speaking opportunities, including activities or examples that engage them in genuine communication scenarios (Aldosari, 2024).

Speaking is an essential ability for students of second languages to engage with both native and non-native speakers and to navigate daily life (Jabber & Mahmood, 2020; Kohn & Hoffstaedter, 2017; Li & Chan, 2024; Wan & Moorhouse, 2024), significantly influencing their entire growth in language (Fathi et al., 2024). Individuals possessing significant speaking proficiency might excel in other language competencies and enhance their speaking abilities through collaborative practice (Rahimi & Fathi, 2022). Students with fluency in English will encounter improved prospects for future educational advancement; nonetheless, mastery must occur both in academic settings and real-world contexts (Alsalihi, 2020). Engagement in speaking enhances pronunciation abilities and overall language proficiency in EFL (English as a Foreign Language) students. Language proficiency is linked to students' academic success and is integral to national and individual economic advancement; specifically, a nation's progress is directly associated with its English language competencies (Muslimah et al., 2021). Acquiring proficiency in English necessitates engagement with several elements of English-speaking cultures. This exposure cultivates cross-cultural understanding, empathy, and appreciation, facilitating the dismantling of cultural boundaries and advancing global harmony. Proficient English-speaking abilities promote an individual's personal and professional development. It enhances self-assurance and broadens networking opportunities (Paudel, 2024).

Speaking is the most arduous skill for several EFL learners, necessitating linguistic and cultural competence. Shumin (1997) asserts that proficiency in the grammar and vocabulary of a foreign language is insufficient for achieving fluency. Students must collaborate to acquire the skill. Nonetheless, their restricted use of language in real-world contexts complicates EFL learners' ability to articulate appropriate English in the classroom. As Thornbury and Slade (2006) stated, speaking challenges may originate from the instructor, the curriculum, the resources, or the students themselves. Shumin (2002) says that speaking English presents the most significant challenge for learners. EFL students often exhibit stuttering when conversing in English. This arises from pupils' lack of exposure to authentic circumstances where they may speak and express themselves in English. Furthermore, pupils lack exposure to the cultural backgrounds of native English speakers (Aldosari, 2024).

Unfortunately, speaking proficiency is underappreciated in schools. Educators primarily emphasize conventional techniques that foster rote memorization, making students passive recipients of information. They have little inclination to acquire proficiency in English. The acquisition of English becomes a daunting challenge for them, prompting some to abandon their studies. In EFL courses, emphasis is placed on reading and writing. This crucial ability is entirely overlooked. Consequently, learners struggle to articulate even a single statement. Recently, speaking skills have been emphasized to achieve desired objectives. Moreover, English is a conduit for career prospects and effective navigation within this global community (Akhter et al., 2020). Bueno et al. (2006) assert that EFL learners encounter difficulties with speaking skills. For them, conversing in English is a formidable challenge. This problem involves several aspects. An inadequate teaching style is one of them. Educators neglect the development of speaking skills. They emphasize reading and writing. The absence of practice is another contributing element. Students are rarely allowed to develop their speaking skills. Shyness and a deficiency of confidence are other contributing factors. Speaking is considered a crucial ability. Baek and Lee (2018) and Chen and Hwang (2019) identified outdated instructional methods in EFL English classes that lacked renewal or enhancement, resulting in inadequate practice and restricted exposure to English speaking.

Innovative technology has provided L2 language learners the chance to improve speaking skills through significant interactions (Bower & Kawaguchi, 2011). Recent decades have witnessed substantial technological advancements that have revolutionized schooling. Technology in education can enhance motivation and comprehension, resulting in superior learning outcomes and increased instructional efficacy (Afendi et al., 2022). Specifically, artificial intelligence (AI) technologies can enhance student learning and augment the function of educators in the short to medium term (Reiss, 2021). AI technologies are expected to offer a more flexible approach to education. This will offer a learning environment customized to the specific demands of each learner (Arbi, 2024). This parallels the assertion of Yahya et al. (2023) that artificial intelligence can facilitate the creation of adaptive learning systems capable of tailoring educational resources and methodologies to align with students' unique competencies and preferences. AI technology is an interactive educational partner and a supportive resource throughout the learning process. AI can identify each student's strengths and weaknesses by providing adaptive learning solutions (Ronsumbre et al., 2023). This leads to more individualized education. This phenomenon creates a complete learning environment and ecosystem that improves education quality through efficient cooperation between teachers and artificial intelligence technologies. AI technology can evaluate students' speaking, listening, writing, and reading skills in English language acquisition. The AI learning system can create a tailored educational program depending on every student's ability level and needs. A student with more speaking ability might be given challenging tasks or materials to improve their skills (Arbi, 2024).

According to El Shazly (2021), AI technologies are good learning tools because of their flexibility, interaction, and learner-centered approach, which are vital for enhancing speaking skills. Furthermore, artificial intelligence has shown its ability to inspire student enthusiasm and improve interactive language learning strategies, which is particularly important in a new academic context (Wekke et al., 2017). Among AI technologies, chatbots are mostly used in education (Colace et al., 2018). AI voice chatbots benefit educational environments since they can converse

with the same speed and clarity as people using speech recognition and natural language processing algorithms (Kaplan, 2016; Duong & Suppatsere, 2024).

The domain of EFL has experienced the beneficial impact of AI recently (Hamuddin, 2018; Junaidi, 2020). AI systems using automated speech recognition technology demonstrate a capacity comparable to human understanding by identifying and interpreting learners' speech. This ability is especially beneficial when native English speakers are not easily accessible, significantly enhancing learners' speaking proficiency (Junaidi, 2020; Zou et al., 2020; Soleimani et al., 2022).

According to Kim (2017), the AI voice chatbot might engage consumers in meaningful negotiations. It might also reiterate or recontextualize a comment to improve the negotiation process. Colace et al. (2018) noted that using the AI voice chatbot was a novel approach linking technological tools with educational settings, improving students' communicative and customized learning experiences and promoting their speaking skills. Adamopoulou and Moussiades (2020) found the AI voice chatbot quite effective by conversing with several users simultaneously on a messaging network. Kim (2018) also discovered that the AI voice chatbot provided the students with fluent and human-like English communication, producing practical input.

Hill et al. (2015) looked at human-human communication concerning AI-human interactions and found that students had a more extended involvement with AI than their relationships with peers. Kang (2022) looked into how students interacted with artificial intelligence instead of natural speakers and found that AI significantly improved their speaking abilities. AI-assisted learning also helps the students' general speaking ability, including fluency, grammatical correctness, vocabulary, and pronunciation (Junaidi (2020).

Literature Review

Artificial Intelligence in Learning Context

Fryer and Carpenter (2006) found that AI voice chatbots might facilitate discussions among students on identical topics using text and speech interactions. Ahmad et al. (2018) demonstrated that AI voice chatbots can consistently comprehend and reply to user questions while managing a significant number of participants. Çakmak (2022) observed that AI speech chatbots may interact with learners like native speakers, enhancing their interest in speaking (Duong & Suppatsere, 2024).

Kim et al. (2021) examined how an AI voice chatbot affected EFL students' speaking ability. The study covered 49 undergraduate EFL students with two separate degrees of English competence. The people participated in a 14-week research comprising verbal interactions with one of three AI speech chatbots: Replika, Andy, and Google Assistant. Methodological tools for the study included surveys, pre-speaking and post-speaking assessments, and interviews. The study results showed that the participants enhanced their word stress, intonation, and pronunciation following the intervention. Still, while intermediate-level students showed notable progress, low-level pupils did not become more fluent. The study found that pupils had more opportunities for speaking practice as they were unconcerned about losing face from errors. Unrestricted time for

contact with the AI voice chatbot improved their pronunciation, confidence, involvement, and speaking preferences. Still, the research showed that inadequate speech recognition capabilities made students uneasy during verbal encounters with the AI voice chatbot.

Çakmak (2022) investigated the interactive impact of an AI voice chatbot on students' speaking performance, involving 90 EFL students from a Turkish institution who engaged in English-speaking practice with Replika over 12 weeks. The study used a questionnaire to examine students' impressions about using Replika for English-speaking practice. The investigation disclosed both beneficial and detrimental outcomes. Using Replika for English practice markedly enhanced the students' speaking proficiency relative to in-person practice. The study revealed that students' anxiety persisted unabated, owing to apprehensions over Replika's understanding of specific situations. Çakmak (2022) said interaction with an AI voice chatbot significantly improved pupils' English-speaking proficiency.

Duong and Suppasetseree (2024) examined how an AI voice chatbot affected Vietnamese students' English communication abilities and assessed their opinions on its use. Thirty undergraduate students participated in an eight-week quasi-experiment run across eight weeks. They participated in English-speaking exercises monthly, using an artificial intelligence voice chatbot. The pupils' English-speaking abilities improved with the AI chatbot ($p < 0.05$). All the students said that using suitable hedging phrases, grammatical structures, and vocabulary had improved their speaking skills. The results show that adding artificial intelligence avatars could be beneficial, but technological issues and sample size limitations also existed.

Zou et al. (2023) examined the efficacy of AI speech evaluation programs with automated feedback in aiding EFL learners to enhance their speaking skills. Forty Chinese EFL students participated in speaking exercises with AI tools like Liulishuo and EAP Talk. The findings revealed that most participants saw improvements in their speaking skills, encompassing fluency, pronunciation, and vocabulary, due to the use of the AI applications. The authentic enhancement was validated by the significantly elevated average results in posttests compared to pretests. The participants favored intuitive feedback, including scores and highlighted colors, along with practice suggestions from the computers. The research concluded that AI speech assessment tools with good feedback can enhance speaking proficiency in EFL learners.

Makhlouf (2021) examined the effect of the AI-based smartphone software ELSA Speak on improving the accuracy and fluency of oral communication abilities among 20 Saudi engineering students. Participants were required to use the ELSA Speak tool to enhance their English-speaking skills. Fluency, exact pronunciation, vocabulary, and grammar were the key goals. The main findings showed that the AI-based application caused statistically significant improvement in the learners' fluency, accuracy, and speaking ability from the pretest to the posttest.

Maknun (2020) studied how Orai, an artificial intelligence-driven tool, helped students in a foreign language enhance their public speaking abilities. The treatment and control groups consisted of sixty students from the English Department. Six treatment sessions were held for the experimental group, during which Orai provided comments on speech metrics, including confidence, conciseness, tempo, unnecessary words, gestures, and pauses. The control group did not use Orai. Apart from pretests and posttests, Orai's assessment features were used to collect

data. With the Orai group demonstrating a faster development in speaking skills following the treatments, the treatment and control groups showed a significant difference in speaking competency.

Examining the use of artificial intelligence technologies in the pragmatic context of English language learning is vital. It would show how artificial intelligence could help to provide interesting instructional materials and improve the learning of English language competence (Arbi, 2024). Though earlier research has looked at the influence of artificial intelligence in a language learning environment, much more knowledge is still needed on how it affects the speaking abilities of EFL students. Thus, further study is required to define AI's role in enhancing the speaking skills of EFL students (Qiao & Zhao, 2023). Moreover, it is unclear how well artificial intelligence speaking assessment tools help language students improve their speaking abilities (Heil et al., 2016; Loewen et al., 2019, 2020); thus, more empirical evidence is needed (Burston, 2015; Zhang & Zou, 2022). Moreover, spoken comments have to help EFL students (Shute, 2008).

Studying spelling techniques, Al Balushi and Al Seyabi (2016) found that Omani EFL students mostly use spelling techniques, including sounding out, syllabification, and visual checking, suggesting that the learners attempt to link spelling with pronunciation. El Shorbagi et al. (2017) did another study on the first-grade basic education program in Omani pupils, revealing the disparity and necessity for efficient phonemic and phonological awareness initiatives. Limited to specific plosive and affricate sounds, Al Yaqoobi et al. (2016) investigated Omani EFL students' mistakes in particular consonant sounds. Focusing on Omani students' views on low English competence in Oman, Al Mahrooqi (2012) found some reflections on phonological characteristics. While discussing the improvement of speaking and pronunciation, it was considered one of the most difficult tasks for Omani EFL learners, and many people blame the few opportunities for actual language practice and individual feedback. Traditional classroom teaching plays an important role; however, sometimes, it cannot give learners customized and interactive support to achieve fluency and pronunciation. AI tools, like Pi AI, propose the opposite by creating an immersive, interactive, and self-dictated learning environment. The present study attempts to fill in the gap existing in the pedagogical approach so far, considering the effectiveness of Pi AI in improving speaking and pronunciation among Omani EFL learners. Pi AI was chosen for this research because of its unique focus on emotionally intelligent and conversational interactions, distinguishing it from other task-oriented or fact-based artificial intelligence technologies. Unlike traditional AI chatbots that primarily provide information or corrections, Pi AI is meant to maintain natural conversation, provide sympathetic replies, and establish rapport with users. These qualities fit the educational goals of encouraging continuous speaking practice and lowering anxiety among EFL students. Its simple mobile interface helps to provide access and ongoing engagement outside the classroom. This research is relevant because it might revolutionize language learning by incorporating and using AI technology in delivering immediate and tailored feedback apart from accurate language exchange. Thus, the research proceeds to answer the following questions:

1. Does Pi AI affect the speaking performance of Omani EFL learners?
2. Does Pi AI affect the pronunciation of Omani EFL learners?

Methodology

Participants

The study's sample comprised 60 Omani EFL learners, randomly allocated to control and experimental groups; 30 students were in the control group and 30 in the experimental one. This number of students was used as the sample population based on their availability within the research timeframe. The students were native Arabic speakers aged 19 to 21 years, except one of the candidates in the experimental group, an external student called a working student, at 40. The institution's assessments revealed that these students have intermediate proficiency in the English language. The Preparatory Studies Center within the college does not focus on the age and gender of participants.

The national curriculum of Oman requires participants to fulfill one to two academic years in the General Foundation Program (GFP). The GFP program is compulsory and a requirement for higher education in Oman. Consequently, to gain admission to specialized departments, the GFP program offers students a variety of disciplines, including English, Mathematics, and Information Technology, using English as the language of teaching.

Instrumentation

A few instruments were employed in this study to collect the required information regarding the students' speaking.

Speaking Package

One of the instruments used in this study was the speaking package for the assessment. The speaking exam has three sections. In section 1, there are 31 situations with 3 to 4 questions in each situation on familiar topics such as hometown, living with the family, like and dislikes, etc., 5 minutes specified to this section. In the second section, with 30 situations and approximately 5 to 6 minutes, some answers will be given to the students, and they must make questions for the responses; this section aims to measure students' grammatical knowledge in using tenses. The last part of the exam contains 17 picture stories and maps. Students can select picture stories or maps to make their own stories. In the former case, students are given 1 minute, a pen and paper, to write down some prompts and utterances for their speaking; in the latter one, students are given 1 minute to read the map and familiarize themselves with the places within the map. Students have 1 to 2 minutes for this section. The speaking exam is out of 20 for the intermediate students; their marking criteria are task achievement, lexical resources, grammar, and pronunciation, and each criterion carries 5 marks. Two examiners listen to the students, and their voices are recorded accordingly. The discrepancy between the markers must not be more than 3 scores.

Pi Application

The second and most important data-gathering source was the Pi Application, which could be freely downloaded from the App Store or Google Play. This tool was used to give extra practice to experimental group students. Toolify.ai (2023) stated that Pi represents Personal Intelligence and is a sophisticated chatbot particularly developed for language learners. In contrast to conventional chatbots, Pi is designed to deliver tailored replies and facilitate substantive dialogues.

It transcends mere question-answering and emphasizes aiding users in enhancing their language proficiency through interactive dialogue. Pi presents three distinctive attributes that differentiate it from other chatbots:

- (a) Dialogue Format, in which Pi employs a conversational approach, enabling users to participate in seamless and fluid dialogues. Whether you pose a question, wish to make a declaration, or engage in dialogue, Pi is there to answer and interact with you as though you were conversing with a native speaker.
- (b) Accessibility of the Platform. In contrast to several chatbots restricted to a singular platform, Pi is operable across various platforms to enhance language abilities at any time and location.
- (c) Customization. The most notable characteristic of Pi, analyzes the preferences, objectives, and dialogue history. Pi customizes its replies to address your particular requirements. Increased interaction with Pi enhances its comprehension and adaptation to your conversational style, rendering it a customized language-learning assistant.

Like ChatGPT, Pi lets you input your message into the chat interface. Unlike other chatbots, Pi enhances customization with its speech function. Activating the audio feature allows Pi to vocalize its responses, improving the conversational experience via immersion and engagement. Pi has several advantages for language learners, including Engaging in a dialogic approach, availability of the platform on Instagram, WhatsApp, and Facebook Messenger, and tailored replies informed by your choices and dialogue history. Pi offers two methods for engaging in conversations: text-based and voice-based. To communicate with Pi via the text-based approach, just input your message into the chat interface. You may pose inquiries, convey assertions, or initiate a dialogue. Pi will answer appropriately, facilitating a tailored dialogue. Although Pi lacks an integrated speech-to-text functionality, it is nevertheless possible to engage in voice-based dialogues. Windows users can employ voice-to-text functionality on their devices. This enables real-time communication with Pi, akin to conversing with a native English speaker. A significant advantage of Pi is its superior speech quality. The voices used in Pi's audio function are crafted to sound authentic and captivating, eschewing any artificial or unnatural tones. In addition, it guarantees that your engagements with Pi are seamless and pleasurable. Pi is an exceptional resource for enhancing English fluency and language assessment preparation (Toolify.ai, 2023).

Pi can be your virtual language tutor to improve your English proficiency. It can enhance your fluency, augment your lexicon, and hone your linguistic abilities. Engaging in tailored dialogues may provide significant practice and strengthen your confidence. Pi can be your evaluator when preparing for language assessments such as the IELTS speaking test. Through the simulation of examination circumstances, Pi aids in acclimating to the exam style and enhancing your speaking abilities. Eliminate the inconvenience of locating discussion partners or participating in costly speaking courses. Even without intensive language study, Pi may be an enjoyable talking companion. Whether you want light-hearted talks or profound conversations, Pi's customization guarantees an authentic and entertaining conversational experience. Pi's primary power is in its capacity to acquire knowledge about you and tailor its replies accordingly. Providing Pi with background information on your personal history and objectives enables it to

offer customized advice, recommendations, and discussion topics. It adjusts to your learning preferences, guaranteeing that each connection is individualized and significant (Toolify.ai, 2023).

The first theory based on which Pi was employed in this study was the Technology Acceptance Model (TAM). The TAM, established by Davis (1986), elucidates the determinants affecting humans' choices to embrace or dismiss new technology. The concept asserts that perceived utility and ease of use are the primary factors influencing an individual's desire to use a technology, which ultimately affects the practical use of the technology. The TAM defines perceived utility as the degree to which a technology is believed to enhance work performance and perceived ease of use as the extent to which the technology is considered user-friendly. In conjunction with additional external variables like social impact, the characteristics above shape an individual's attitude towards technology usage, affecting their desire to use it. The TAM has been extensively used and evaluated across several contexts, including higher education. Using the core principles of TAM, it serves as a practical framework for examining the integration of artificial intelligence in educational environments. Artificial intelligence, including chatbots (e.g., ChatGPT, ChatSonic), necessitates evaluation in higher education; hence, the TAM offers a framework for analyzing the findings. Chatbots are computer programs engineered to replicate human communication, serving various functions such as delivering student assistance, responding to inquiries, and facilitating individualized learning experiences. The TAM may be used in higher education to help students understand the adoption of chatbots as an emerging technology. Students may regard chatbots as beneficial if they deliver prompt and precise information, assist with academic work, and provide tailored advice. Conversely, students may find chatbots challenging to use if they necessitate advanced technological proficiency or lack user-friendliness. Besides perceived utility and simplicity of use, social influence may also affect students' adoption of chatbots. Students who observe their friends or professors using chatbots may be more inclined to embrace them. The TAM offers a valuable framework for comprehending and forecasting students' adoption of chatbots in higher education. Educators may formulate more effective interventions to foster their adoption and improve students' learning experiences by discerning the aspects that affect students' attitudes and intentions toward chatbot usage (Tarisayi, 2024).

Sociocultural Theory was the second theory evaluated in the study's design and instrumentation. Sociocultural Theory, formulated by Russian psychologist Lev Vygotsky, is crucial in second language learning. From a sociocultural standpoint, learning is regarded as fundamentally social before becoming an individual. Consciousness and conceptual development are seen mostly as inter-mental phenomena. Phenomena are shared amongst individuals; subsequently, individuals develop their awareness, evolving into an intra-mental phenomenon. Language is the principal symbolic tool for enhancing awareness (Mitchell & Myles, 2004).

AI may identify gaps in teaching and learning by assessing student performance data, determining their individual Zone of Proximal Development (ZPD), and equipping educators with insights into their students' existing abilities and pathways for improvement. AI implements a dual-teacher model that optimizes administrative tasks and enhances efficiency by alleviating teachers from repetitive duties, such as distributing assignments and addressing frequently asked

questions, allowing them to concentrate on student mentorship and individualized communication that machines cannot replicate. Educators have begun collaboration with AI helpers to optimize student achievements. Consequently, they possess more significant control over the scope and quantity of scaffolding, allowing pupils to operate fully autonomously. In the era of AI, teachers are tasked with providing targeted feedback to pupils and guiding them until they achieve mastery of the activity independently. The teacher offers targeted support for skills outside the pupils' capabilities, allowing them to accomplish tasks independently to the greatest extent feasible. In the era of AI, teachers are tasked with providing targeted feedback to pupils and guiding them until they achieve mastery of the activity independently (Zhou, 2020).

Procedures

This study was conducted in January 2025 in one of the universities in Oman's North Al Batinah region. Before the main round of the study, the study's approval and the ethical consideration form were received from the Research Department and students. It was thoroughly explained to the students that their participation in this study was voluntary and their performance would not affect their regular studies and assessments. The study was conducted in one month. In the first three days of the study, pretests of speaking were undertaken to ensure students' speaking skills homogeneity. Later, the control group continued their regular and daily training in the speaking classes with their teacher face-to-face. The class teacher used the in-house training materials, slides, and practice materials for the students. Various speaking techniques were also used, such as group work, pair work, and individual activities.

On days four and five of week one, the researcher conducted a 60-minute orientation session for the experimental group to familiarize students with the Pi application's features, including voice recognition capabilities, conversation simulation functions, and vocabulary-building tools. Technical support was available throughout the study to assist with any application-related issues. The researcher created a Microsoft Teams group for the experimental group and requested that the students send any problems or questions they might have through Microsoft Teams.

The students studied English for 4 hours per day, covering different skills (reading, writing, listening, and speaking), and the teacher allocated 1 hour from these 4 hours to conduct speaking sessions with both groups in the three weeks. This ensured that the time allocated to speaking practice was consistent across both the control and experimental groups. Each 60-minute session followed a structured format: a 10-minute introduction, 10-minute individual preparation with Pi, a 20-minute paired conversation, a 10-minute reflection period, and a final 10-minute whole-class summary discussion. To collect qualitative data about student experiences with the Pi application, participants completed a short feedback form after each session, rating their comfort level, perceived usefulness, and engagement.

In week 2, the control and experimental groups started regular and daily training in the speaking classes with their teacher face-to-face. The class teacher used the in-house training materials, slides, and practice materials for the students. In the control group, the speaking techniques included structured role-plays where students enacted real-life scenarios, information-gap activities requiring students to exchange missing details, debate sessions on curriculum topics,

and timed presentations with peer feedback. These activities were carefully designed to parallel the communication practice in the experimental group while using traditional face-to-face methods instead of AI assistance. Various speaking techniques were also used, such as group work, pair work, and individual activities. These sessions were conducted in a traditional classroom with standard audiovisual equipment. Each week followed a structured syllabus covering topics including week 2: describing places and giving directions; week 3: expressing opinions on current events; week 4: problem-solving scenarios in workplace contexts.

Although the experimental group experienced similar training sessions, activities, and materials, the application of Pi was used as the facilitator in their learning practice. Students were told to install the application on their mobile phones initially. Learners were divided into pairs to start the procedure, ensuring that each group included various students. Because of this diversity, there was an engaging discussion of viewpoints and ideas, which led to a deeper comprehension of different concepts. Students worked in couples, taking turns using the Pi program to ask various questions on a particular subject assigned by the teacher each session. Pairs then answered Pi's inquiries. Through this cooperative conversation, students could share personal stories, learn from their friends, and develop their speaking abilities. Learners switched partners and worked through a new set of questions after debating each one. By exposing students to various perspectives, this rotation made sure they interacted with several peers, which improved their communication skills and deepened their comprehension. The partners kept switching places until every student spoke with another student about every question.

Students' confidence in voicing their opinions was strengthened, and their prolonged exposure to various viewpoints created a dynamic learning atmosphere. Depending on numerous contextual and cognitive elements, users of artificial intelligence in the experimental group encountered both facilitation and interference. From a convenience standpoint, artificial intelligence usually offers quick access to data, tailored feedback, and automation of mundane activities. These qualities could improve student autonomy and drive and help to lower the cognitive load linked with task complexity. However, it interferes when the technology causes distraction, misunderstanding, or conflict with the user's goals. Users started to doubt or lose interest in AI results that were too general or contextually unsuitable. Moreover, poor digital literacy, insufficient training, or a lack of openness in artificial intelligence systems could allow users to misuse technologies or become overly dependent on them, promoting superficial involvement and lowering critical thinking. The students were told to contact their teachers immediately in these problematic situations. Pi provided a supportive environment where the students could prepare and practice the valuable words, phrases, and utterances individually before a pair or group discussion. Students practiced these techniques of using Pi 180 minutes weekly in two sessions with 90 minutes of practice. In the last three days of the treatment, speaking posttests were conducted to determine the results of implementing Pi in the speaking class and compare the experimental group's performance with their counterpart in the control group.

Data Analysis

This section analyzes the data collected to measure the impact of Pi as the learning facilitator on the speaking and pronunciation of EFL learners. In the beginning, a normality test was run to

select suitable parametric or nonparametric tests for the data analysis, and the results can be seen in Table 1.

Table 1
The Results of the Shapiro-Wilk Test of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
pretest	.899	60	.000
posttest	.917	60	.001

Table 1 shows that the datasets for both pretest and posttest scores are significantly different from a normal distribution. Specifically, the Shapiro-Wilk test conducted on the pretest resulted in a statistic of 0.899 with $df = 60$ and a p-value of 0.000, and the posttest resulted in a statistic of 0.917 with $df = 60$ and a p-value of 0.001. The fact that all p-values are below the critical level of 0.05 leads to rejecting the null hypothesis of normality; hence, it implies that the pretest and posttest data do not follow a normal distribution. Based on the findings from the normality test, a nonparametric test will be performed to gain further information. Before conducting the main nonparametric test, a randomness test was performed to ensure the data grouping was not accidentally occurring. Table 2 below shows the results of the Wald-Wolfowitz randomness test.

Table 2
The Wald-Wolfowitz Run Test

		Number of Runs	Z	Asymp. Sig. (1-tailed)
pretest	Minimum Possible	8	-5.990	.000
	Maximum Possible	44	3.385	1.000
posttest	Minimum Possible	6	-6.510	.000
	Maximum Possible	20	-2.865	.002

Table 2 shows the randomness of data groupings, which showed a violation in both pretest and posttest. For instance, where there is the least number of runs in the pretest, it yielded $Z = -5.990$ with $p < 0.001$, whereas the highest number of runs yielded $Z = 3.385$ with $p = 1.000$. In the posttest, the least number of runs yielded $Z = -6.510$ with $p < 0.001$, while the highest number yielded $Z = -2.865$ with $p = 0.002$. This means that both pretest and posttest data do not meet the

requirement of randomization or observation independence in data grouping. To gain detailed information on participants' performance in the pretest and posttest, a Man-Whitney U Test was run, and the results can be observed in Tables 3 and 4 below.

Table 3

The Descriptive Analysis of Both Groups in Pretest and Posttest

	groups	N	Mean Rank	Sum of Ranks
pretest	control	30	27.98	839.50
	experiment	30	33.02	990.50
	Total	60		
posttest	control	30	18.73	562.00
	experiment	30	42.27	1268.00
	Total	60		

Table 4

The Results of the Man-Whitney U Test in the Pretest and Posttest of Both Groups

	pretest	posttest
Mann-Whitney U	374.500	97.000
Wilcoxon W	839.500	562.000
Z	-1.143	-5.307
Asymp. Sig. (2-tailed)	.253	.000

Tables 3 and 4 include comprehensive descriptive and inferential assessments of the pretest and posttest results for the control and experimental groups. In the pretest, the experimental group had a marginally superior mean rank (33.02) relative to the control group (27.98), with sum rankings of 990.50 and 839.50, respectively. The Mann-Whitney U test findings for the pretest ($U = 374.500$, $Z = -1.143$, $p = 0.253$) demonstrate no statistically significant difference between the two groups. In the posttest, the experimental group exhibited a notably higher mean rank (42.27) than the control group (18.73), with sum rankings of 1268.00 and 562.00, respectively. The Mann-Whitney U test for the posttest ($U = 97.000$, $Z = -5.307$, $p < 0.001$) indicates a statistically significant difference between the groups. The data indicate that although there was no notable difference in performance between the groups during the pretest, the experimental group dramatically surpassed the control group in the posttest, presumably due to the intervention.

A comparison test was run between the groups to measure the effect of Pi AI on students' pronunciation. Tables 5 and 6 below show the statistical analysis for this variable.

Table 5*The Descriptive Analysis of Pronunciation in Pretest and Posttest*

	groups	N	Mean Rank	Sum of Ranks
pretest	control	30	30.50	915.00
	experiment	30	30.50	915.00
	Total	60		
posttest	control	30	18.00	540.00
	experiment	30	43.00	1290.00
	Total	60		

Table 6*The Man-Whitney U Test for the Pronunciation in Pretest and Posttest*

	pretest	posttest
Mann-Whitney U	450.000	75.000
Wilcoxon W	915.000	540.000
Z	.000	-5.926
Asymp. Sig. (2-tailed)	1.000	.000

Tables 5 and 6 comprehensively examine the pretest and posttest outcomes for the control and experimental groups. In the pretest, both groups exhibited equal mean rankings (30.50) and sum ranks (915.00 each), signifying no disparity in performance. The Mann-Whitney U test findings for the pretest ($U = 450.000$, $Z = 0.000$, $p = 1.000$) indicate no statistically significant difference between the control and experimental groups prior to the intervention. In the posttest, the experimental group exhibited a significantly higher mean rank (43.00) and sum rank (1290.00) than the control group, which recorded a mean rank of 18.00 and sum rank of 540.00. The Mann-Whitney U test for the posttest ($U = 75.000$, $Z = -5.926$, $p < 0.001$) reveals a highly significant difference between the two groups. The results indicate that although the groups were similar initially, the intervention administered to the experimental group resulted in substantial enhancements in their posttest performance, underscoring the treatment's efficacy.

Discussion

The primary objectives of the present paper were to measure the impact of using Pi AI as a learning facilitator within the language learning context, focusing on the speaking skills of EFL learners and pronunciation improvements. To achieve this goal, 60 Omani EFL learners with an intermediate English proficiency level participated in this study. They were randomly divided into two equal experimental and control groups, with 30 students in each group. During one month of treatment, both groups received regular in-class training and feedback from their teachers; however, the Pi AI was used within the experimental group as an extra tool for practicing speaking individually and in groups. The comprehensive data analysis of this study revealed that the experimental group outperformed the control group in the speaking posttest. In addition, the analysis of the pronunciation criterion showed similar results with significant progress of students in the experimental group from pretest to posttest and their outperformance compared to the control group.

The special benefits of Pi AI can explain the enhanced performance in the experimental group as a complementary pedagogical tool: Pi AI-enabled both individual and group speaking practices, allowing students to engage in language-related activities outside the scheduled class time. This is important for developing speaking skills, as students get many chances to practice, make mistakes, and receive immediate corrective feedback. All these characteristics are not seen in the traditional settings on which the control group relied exclusively.

The personalized feedback and adaptive exercise programs by Pi AI went a long way in bringing about notable improvements in pronunciation. Unlike traditional classroom feedback, Pi AI could focus on the specific phonetic difficulties encountered by each learner, thus allowing for targeted interventions that motivated steady and measurable progress, a notion in line with second language acquisition theories emphasizing the importance of constant and focused practice to achieve fluency and accuracy.

Moreover, the appealing and challenging features of Pi AI may have also raised the experimental group's motivation and confidence in verbal communication. As Pi AI likely reduced social anxieties related to presenting before a group of peers by offering a safe, low-anxiety environment for practice, it probably helped to overcome psychological barriers to performance, such as speaking apprehension. This individualized and assuring language practice gave the experimental group an advantage over the control group, resulting in better performance in the speaking posttest and improved pronunciation.

Several natural constraints of conventional language training settings explain the control group's lack of obvious improvement in speaking and pronunciation despite consistent classroom instruction. First, such environments usually provide little chances for ongoing and personalized speaking practice as classroom time is generally split among several students, depriving each student of the opportunity to participate in meaningful spoken contact. Face-to-face teaching also tends to deliver broad rather than specific comments, which might allow students to make the same pronunciation or fluency mistakes without knowing it. These tendencies might become fossilized over time without prompt remedial action. Moreover, conventional teaching often does not go outside the classroom, limiting the active language generation, which learners perform

independently. This limitation impedes the intensity and frequency of exposure required for significant progress. Students, especially those with speaking anxiety, may feel embarrassed in front of classmates, which might lower their desire to engage and practice freely in class. Students could lose interest or lack the drive to strive toward betterment if conventional classroom activities' often boring or monotonous character is considered. The control group, thus, while exposed to educational material, lacked the interactive, adaptive, and emotionally supportive setting needed for real improvements in spoken language and pronunciation accuracy.

The study results are consistent with several studies that have shown the positive effects of AI support tools on students' speaking (Qiao & Zhao, 2023; Safadi et al., 2022; El Shazly, 2021; Maknun, 2020; Makhoul, 2021). Qiao and Zhao's (2023) research examined how well artificial intelligence-based teaching may enhance second language (L2) speaking abilities and communication self-regulation in a real environment. These results imply that AI-based teaching improves L2 speaking skills and encourages language students to self-regulate. Another study that supports the beneficial effects of AI on speaking skills was carried out by El Shazly (2021) to examine how AI affected EFL students' speaking ability and anxiety. The findings showed that AI considerably enhanced the students' speaking abilities. Safadi et al. (2022) examined the impact of AI-based training on the speaking skills of female English students. The results showed that the experimental students outperformed the control students in speaking, indicating the significant benefits of AI-based training in improving the speaking abilities of female English language learners. In a similar vein, Maknun (2020) looked at how an AI program affected the speaking skills of ELL learners. The results showed that after the treatment, the experimental learners performed better while speaking than the control group, highlighting the important contribution of AI-based training to improving the speaking skills of EFL learners. These findings align with the research done by Makhoul (2021), who looked at how well AI training affected EFL learners' speaking abilities overall and accuracy, as well as fluency and speaking capacity subcomponents.

Multiple studies have obtained comparable outcomes to those found in the second study goal (Mohammadkarimi, 2024; Abimanto and Sumarsono, 2024; Al-Shallakh, 2024; Dennis, 2024; Zou et al., 2023), demonstrating that AI support tools improved learner pronunciation. Mohammadkarimi (2024) investigated the role of artificial intelligence (AI) in improving learners' English speech abilities. The research found that the experimental group improved significantly in their pronunciation accuracy. Abimanto and Sumarsono (2024) investigated the utilization of artificial intelligence in the Google Read Along app to improve English pronunciation, especially among learners who struggle with it. The research discovered that AI technology may assist students in enhancing their English pronunciation. Similarly, Al-Shallakh (2024) studied the use of Elsa Speak, an artificial intelligence tool, in higher education to improve the pronunciation abilities of EFL students at a Jordanian institution. The results add to the greater discussion of AI in education by emphasizing the practical effect of these kinds of apps on language acquisition, particularly pronunciation enhancement in higher education. These findings are congruent with Dennis' (2024) examination of the influence of AI-powered Speech Recognition Technology (AI-SRT) on enhancing English pronunciation and speaking abilities among EFL students. The outcomes of this research add to our knowledge of the influence of AI-powered voice recognition technologies on EFL learners' pronunciation and communication skills. The findings demonstrate the efficacy of this technology and provide useful insights into learners' perspectives and experiences. Zou et al. (2023) studied whether the varied automated feedback provided by AI

speech assessment tools may assist English as a foreign language (EFL) learners improve their speaking abilities. The findings revealed that almost all participants thought the AI speaking assessment program's input helped enhance their speaking abilities. The results also showed that their mean speaking ability ratings improved significantly.

Conclusion

The present paper focused on implementing AI tools, Pi, to monitor the students' speaking skills and pronunciation improvements in this study. After analyzing the 60 Omani EFL learners' performance in pre and post-treatment tests, it was revealed that the experimental group that employed Pi AI as the speaking facilitator performed significantly better than the control group in both variables. The results could be associated with using technological instruments, Pi AI.

The findings could be useful for students, teachers, and higher education institutions. The results confirm that AI technologies, especially Pi, greatly improve EFL learners' speaking and pronunciation. The customized approach, which enables students to work on their deficits to develop those skills at their pace, gives them immediate feedback and ample opportunity to practice, thus assuring better language ability and removing the fear of speaking, the most important ability for academic and professional success. Results show that AI technologies should be used in supporting language classes. Teachers can use pi AI to complement their teaching methodologies to ensure that learners receive additional support beyond the limits of school confinement. Its ability to monitor improvement and provide instant feedback will give teachers more time to fit their lesson plans more adequately to the needs of each learner and save precious time inside the classroom. Therefore, applying AI-driven tools like Pi in academic institutions comes with increasing emphasis on digital transformation across higher education. Institutions can help increase the quality of language programs by offering new tools to attract new students and further build the institution's reputation as a leader in adopting the latest state-of-the-art educational technology.

This study had some shortcomings, which are worth pointing out. First, the small sample size of 60 participants limits the generalization of results to larger populations, though this size is appropriate for an exploratory study. The experiment is conducted within a specific framework, targeting only Omani EFL learners from one place, hence narrowing to culturally or educationally different contexts. Whereas the Pi application does provide real opportunities for practicing languages, the outcome may be further influenced by several external factors relating to students' differing levels of technological expertise or their willingness to use the tool. Finally, the intervention length is rather short, lasting for a month, which is not enough to properly investigate the long-term effects on the development of speaking skills or to maintain the gain that has been reported.

Future studies can examine the longitudinal effect of AI-driven technologies like Pi on speaking proficiency and long-term retention of the acquired language. Such a treatment model will allow researchers to study how long the benefits are maintained and how learners eventually

accommodate the AI technologies. An investigation into the effectiveness of AI-supported language learning in different cultural and linguistic contexts can indicate the function of cultural variables in engagement and learning outcomes, thus allowing for a wider generalization of these tools. A more general design that incorporates the investigation of a range of different age groups, educational backgrounds, and technical abilities would have helped establish how learner profiles interact with the process of language acquisition driven by AI. Further research might be directed towards hybrid approaches that meld AI technology with more traditional face-to-face teaching to identify what works best for effective instruction. Looking at unique AI tool characteristics, such as voice synthesis, customizability, and accessibility, may define their specific effects on capabilities like fluency, pronunciation, and vocabulary building. The research into AI tools' effects on learner motivation and engagement, particularly because of such elements as gamification and interactive dialogues, will go a long way toward improving the understanding of how AI learning tools affect the learning process.

No Conflict of Study

We certify that there is no actual or potential conflict of interest or unfair advantage in providing the offer submission or performing the required services.

References

- Abimanto, D., & Sumarsono, W. (2024). Improving English pronunciation with AI speech-recognition technology. *Acitya: Journal of Teaching and Education*, 6(1), 146–156. <https://doi.org/10.30650/ajte.v6i1.3810>
- Adamopoulou, E., & Moussiades, L. (2020). Chatbots: History, technology, and applications. *Machine Learning with Applications*, 2, 100006. <https://doi.org/10.1016/j.mlwa.2020.100006>
- Afendi, A., Sholihah, N., Mutmainah, F., Ishak, K., & Lubis, A. (2022). Penggunaan Microsoft Office untuk meningkatkan motivasi dan hasil belajar siswa sekolah dasar [*The use of Microsoft Office to improve motivation and learning outcomes of elementary school students*]. *Jurnal PGSD*, 8(1), 28–32. <https://doi.org/10.32534/jps.v8i1.2949>
- Ahmad, N. A., Che, M. H., & Zainal, A. (2018). Review of chatbots design techniques. *International Journal of Computer Applications*, 18(8), 7–10. <https://doi.org/10.5120/ijca2018917606>
- Akhter, S., Haidov, R., Rana, A. M., & Qureshi, A. H. (2020). Exploring the significance of speaking skill for EFL learners. *PalArch's Journal of Archaeology of Egypt/Egyptology*, 17(9), 6019–6030.
- Al Balushi, M., & Al Siyabi, F. (2016). Spelling strategies of Omani EFL students. *English Linguistics Research*, 5(3), 1–14. <https://doi.org/10.5430/elr.v5n3p1>
- Aldosari, M. S. (2024). Another world with artificial intelligence in speaking classes: To delve into the influences on willingness to communicate, personal best goals, and academic enjoyment. *Computer Assisted Language Learning Electronic Journal (CALL-EJ)*, 25(4), 439–463.
- Al Mahrooqi, R. (2012). A student perspective on low English proficiency in Oman. *International Education Studies*, 5(6), 263–271. <https://doi.org/10.5539/ies.v5n6p263>
- Alsalihi, H. D. (2020). Main difficulties faced by EFL students in language learning. *Journal of College of Education for Women*, 31(2), 19–34. <https://doi.org/10.36231/coedw.v31i2.1359>
- Al-Shallakh, M. A. I. (2024). Embedding artificial intelligent applications in higher educational institutions to improve students' pronunciation performance. *Theory and Practice in Language Studies*, 14(6), 1897–1906. <https://doi.org/10.17507/tpls.1406.31>
- Al Yaqoobi, Z., Ali, F., & Sulan, N. (2016). An analysis of errors caused by Omani EFL learners in pronouncing certain consonant sounds. *International Journal of Languages, Education and Applied Linguistics*, 5, 59–71.
- Arbi, A. P. (2024). Optimizing the use of artificial intelligence in English language learning: A literature review. *Global Journal of Management and Innovation*, 2(2), 25–30. <https://doi.org/10.59435/gjmi.v2i2.278>

- Baek, J., & Lee, C. H. (2018). University students' perceptions and engagement in mobile-assisted blended learning in English speaking classes. *Multimedia-Assisted Language Learning*, 21(4). <https://doi.org/10.15702/mall.2018.21.4.11>
- Bower, J., & Kawaguchi, S. (2011). Negotiation of meaning and corrective feedback in Japanese/English eTandem. *Language, Learning and Technology*, 15(1), 41–71. <http://dx.doi.org/10125/44237>
- Brown, H. D., & Lee, H. (2015). *Teaching by principles: An interactive approach to language pedagogy* (4th ed.). Pearson Education.
- Bueno, A., Madrid, D., & McLaren, N. (2006). *TEFL in secondary education*. Editorial Universidad de Granada.
- Burston, J. (2015). Twenty years of MALL project implementation: A meta-analysis of learning outcomes. *ReCALL*, 27(1), 4–20. <https://doi.org/10.1017/S0958344014000159>
- Çakmak, F. (2022). Chatbot-human interaction and its effects on EFL students' L2 speaking performance and anxiety. *Novitas-ROYAL (Research on Youth and Language)*, 16(2), 113–131.
- Chen, M. R. A., & Hwang, G. J. (2019). Effects of a concept mapping-based flipped learning approach on EFL students' English-speaking performance, critical thinking awareness, and speaking anxiety. *British Journal of Educational Technology*, 51(3), 817–834. <https://doi.org/10.1111/bjet.12887>
- Colace, F., Santo, M. D., Lombardi, M., Pascale, F., Pietrosanto, A., & Lemma, S. (2018). Chatbot for e-learning: A case of study. *International Journal of Mechanical Engineering and Robotics Research*, 7(5), 528–533. <https://doi.org/10.18178/ijmerr.7.5.528-533>
- Dao, H. (2017). Identify factors that negatively influence non-English major students' speaking skills. *Higher Education Research*, 2(2), 35–43. <https://doi.org/10.11648/j.her.20170202.12>
- Davis, F. D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results* [Doctoral dissertation, MIT Sloan School of Management].
- Dennis, N. K. (2024). Using AI-powered speech recognition technology to improve English pronunciation and speaking skills. *IAFOR Journal of Education*, 12(2), 107–126.
- Duong, T., & Suppasetseree, S. (2024). The effects of an artificial intelligence voice chatbot on improving Vietnamese undergraduate students' English-speaking skills. *International Journal of Learning, Teaching and Educational Research*, 23(3), 293–321. <https://doi.org/10.26803/ijlter.23.3.15>
- El Shazly, R. (2021). Effects of artificial intelligence on English speaking anxiety and speaking performance: A case study. *Expert Systems*, 38(e12667). <https://doi.org/10.1111/exsy.12667>
- El Shorbagi, A., Al Kharusi, H., Al Kindi, F., Al Siyabi, A., & Al Abri, A. (2017). The effectiveness of phonemic and phonological awareness program to improve reading

- performance of first grade basic education students in Oman. *Journal of Educational and Psychological Studies*, 11(3), 666–676. <https://doi.org/10.24200/jeps.vol11iss3pp666-676>
- Fathi, J., Rahimi, M., & Derakhshan, A. (2024). Improving EFL learners' speaking skills and willingness to communicate via artificial intelligence-mediated interactions. *System*, 121, 103254. <https://doi.org/10.1016/j.system.2024.103254>
- Fryer, L., & Carpenter, R. (2006). Bots as language learning tools. *Language Learning & Technology*, 10(3), 8–14. <http://dx.doi.org/10.125/44068>
- Hamuddin, B. (2018). Blogs as powerful learning tools: The perception from EFL students in Riau main island, Indonesia. *IOP Conference Series: Earth and Environmental Science*, 156, 012060. <https://doi.org/10.1088/1755-1315/156/1/012060>
- Jabber, K. W., & Mahmood, A. A. (2020). Non-verbal communication between two non-native English speakers: Iraqi and Chinese. *Theory and Practice in Language Studies*, 10(2), 189–196. <https://doi.org/10.17507/tpls.1002.06>
- Heil, C. R., Wu, J. S., Lee, J. J., & Schmidt, T. (2016). A review of mobile language learning applications: Trends, challenges, and opportunities. *The EuroCALL Review*, 24(2), 32–50. <https://doi.org/10.4995/eurocall.2016.6402>
- Hill, J., Ford, W. R., & Farreras, I. G. (2015). Real conversations with artificial intelligence: A comparison between human–human online conversations and human–chatbot conversations. *Computers in Human Behavior*, 49, 245–250. <https://doi.org/10.1016/j.chb.2015.02.026>
- Huy, V., Nam, T., & Bon, N. (2024). The importance of speaking in English as a foreign language between skillful and thoughtful competencies: Studying sociolinguistics perspectives. *International Journal of English Language Studies*, 6(2), 153–159. <https://doi.org/10.32996/ijels.2024.6.2.22>
- Junaidi, J. (2020). Artificial intelligence in EFL context: Rising students' speaking performance with Lyra virtual assistance. *International Journal of Advanced Science and Technology Rehabilitations*, 29, 6735–6741.
- Kang, H. (2022). Effects of artificial intelligence and native speaker interlocutors on ESL learners' speaking ability and affective aspects. *Multimedia-Assisted Language Learning*, 25, 9–43. <https://doi.org/10.15702/mall.2022.25.2.09>
- Kaplan, J. (2016). *Artificial intelligence: What everyone needs to know*. Oxford University Press. <https://doi.org/10.1093/wentk/9780190602383.001.0001>
- Kim, N.-Y. (2017). Effects of types of voice-based chat on EFL students' negotiation of meaning according to proficiency levels. *English Teaching*, 72(1), 159–181. <https://doi.org/10.15858/engtea.72.1.201703.159>
- Kim, N.-Y. (2018). A study on chatbots for developing Korean college students' English listening and reading skills. *Journal of Digital Convergence*, 16(8), 19–26. <https://doi.org/10.14400/JDC.2018.16.8.019>

- Kim, H.-S., Cha, Y., & Kim, N. Y. (2021). Effects of AI voice chatbots on EFL students' communication skills. *Korean Journal of English Language and Linguistics*, 21, 712–734. <https://doi.org/10.15738/kjell.21..202108.712>
- Kohn, K., & Hoffstaedter, P. (2017). Learner agency and non-native speaker identity in pedagogical lingua franca conversations: Insights from intercultural telecollaboration in foreign language education. *Computer Assisted Language Learning*, 30(5), 351–367. <https://doi.org/10.1080/09588221.2017.1304966>
- Li, Q., & Chan, K. K. (2024). Test takers' attitudes of using exam-oriented mobile application as a tool to adapt in a high-stakes speaking test. *Education and Information Technologies*, 29(1), 219–237. <https://doi.org/10.1007/s10639-023-12297-0>
- Loewen, S., Crowther, D., Isbell, D. R., Kim, K. M., Maloney, J., Miller, Z. F., & Rawal, H. (2019). Mobile-assisted language learning: A Duolingo case study. *ReCALL*, 31(3), 293–311. <https://doi.org/10.1017/S0958344019000065>
- Loewen, S., Isbell, D. R., & Sporn, Z. (2020). The effectiveness of app-based language instruction for developing receptive linguistic knowledge and oral communicative ability. *Foreign Language Annals*, 53(2), 209–233. <https://doi.org/10.1111/flan.12454>
- Makhlouf, M. K. I. (2021). Effect of artificial intelligence-based application on Saudi preparatory-year students' EFL speaking skills at Albaha University. *International Journal of English Language Education*, 9(2), 36. <https://doi.org/10.5296/ijele.v9i2.18782>
- Maknun, L. L. (2020). The implementation of Orai as artificial intelligence for digital native students in English speaking learning. *Indonesian Technology Enhanced Language Learning*, 1, 131–138.
- Manurung, K. (2015). Improving the speaking skill using reading contextual internet-based instructional materials in an EFL class in Indonesia. *Procedia - Social and Behavioral Sciences*, 176, 44–51. <https://doi.org/10.1016/j.sbspro.2015.01.442>
- Mitchell, R., & Myles, F. (2004). *Second language learning theories* (2nd ed.). Hodder Arnold.
- Mohammadkarimi, E. (2024). Exploring the use of artificial intelligence in promoting English language pronunciation skills. *LLT Journal: A Journal on Language and Language Teaching*, 27(1), 98–115. <https://doi.org/10.24071/llt.v27i1.8151>
- Muslimah, M., Usman, B., & Iskandar, A. S. (2021). Teaching speaking report text through documentary video. *Research in English and Education*, 6(1), 42–48.
- Nazara, S. (2011). Students' perception on EFL speaking skill development. *JET (Journal of English Teaching)*, 1(1), 28–43.
- Paudel, P. (2024). Navigating linguistic diversity: Implementing English medium instruction in Nepal's community schools. *Issues in Educational Research*, 34(4), 1526–1547.
- Qiao, H., & Zhao, A. (2023). Artificial intelligence-based language learning: Illuminating the impact on speaking skills and self-regulation in Chinese EFL context. *Frontiers in Psychology*, 14, 1255594. <https://doi.org/10.3389/fpsyg.2023.1255594>

- Qiao, H., & Zhao, A. (2023). Artificial intelligence-based language learning: illuminating the impact on speaking skills and self-regulation in Chinese EFL context. *Frontiers in Psychology, 14*, 1255594. <https://doi.org/10.3389/fpsyg.2023.1255594>
- Rahimi, M., & Fathi, J. (2022). Employing e-tandem language learning method to enhance speaking skills and willingness to communicate: The case of EFL learners. *Computer Assisted Language Learning, 1*–37. <https://doi.org/10.1080/09588221.2022.2064512>
- Reiss, M. J. (2021). The use of AI in education: Practicalities and ethical considerations. *London Review of Education, 19*(1), 1–14. <https://doi.org/10.14324/LRE.19.1.05>
- Ronsumbre, S., Rukmawati, T., Sumarsono, A., & Warembra, R. S. (2023). Pembelajaran digital dengan kecerdasan buatan (AI): Korelasi AI terhadap motivasi belajar [*Digital learning with artificial intelligence (AI): The correlation of AI with learning motivation*]. *Educatio: Jurnal Pendidikan, 9*(3), 1464–1474. <https://doi.org/10.31949/educatio.v9i3.5761>
- Safadi, H. A., Shgair, M. S. A., & Qatawnih, K. S. (2022). The effectiveness of designing an e-learning environment based on mastery learning and artificial intelligence on developing English speaking skills among tenth graders in Palestine. *Journal of Educational and Psychological Sciences, 31*, 475–507. <https://doi.org/10.33976/IUGJEPS.31.1/2023/22>
- Shumin, K. (1997). Factors to consider: Developing adult EFL pupils' speaking abilities. *English Teaching Forum, 35*(3), 8–13. Retrieved January 5, 2025, from <http://dosfan.lib.uic.edu/usia/E-USIA/forum/vols/vol35/no3/p8.htm>
- Shumin, K. (2002). Factors to consider: Developing adult EFL student speaking abilities. In J. C. Richards & W. A. Renandya (Eds.), *Methodology in language teaching: An anthology of current practice* (pp. 204–211). Cambridge University Press.
<https://doi.org/10.1017/CBO9780511667190.028>
- Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research, 78*(1), 153–189. <https://doi.org/10.3102/0034654307313795>
- Soleimani, H., Mohammaddokht, F., & Fathi, J. (2022). Exploring the effect of assisted repeated reading on incidental vocabulary learning and vocabulary learning self-efficacy in an EFL context. *Frontiers in Psychology, 13*, 851812. <https://doi.org/10.3389/fpsyg.2022.851812>
- Tarisayi, K. S. (2024). A theoretical framework for interrogating the integration of artificial intelligence in education. *Research on Education and Media, 16*(1), 37–44. <https://doi.org/10.2478/rem-2024-0006>
- Thornbury, S., & Slade, D. (2006). *Conversation: From description to pedagogy*. Cambridge University Press.
- Toolify.ai. (2023, December 26). *Meet Pi, your personal AI companion*. <https://www.toolify.ai/ai-news/meet-pi-your-personal-ai-companion-25320>
- Wan, Y., & Moorhouse, B. L. (2024). Using Call Annie as a generative artificial intelligence speaking partner for language learners. *RELC Journal*. Advance Online Publication. <https://doi.org/10.1177/00336882231224813>

- Wekke, I. S., Yandra, A., & Hamuddin, B. (2017). Learning strategy in class management: A reflection from Manado case. *IOP Conference Series: Earth and Environmental Science*, 97(1), 012053. <https://doi.org/10.1088/1755-1315/97/1/012053>
- Yahya, M., Hidayat, & Wahyudi. (2023). Implementasi artificial intelligence (AI) di bidang pendidikan kejuruan pada era revolusi industri 4.0 [*Implementation of artificial intelligence (AI) in vocational education in the era of the industrial revolution 4.0*]. *Prosiding Seminar Nasional Dies Natalis ke-62*, 190–199. Retrieved from <https://journal.unm.ac.id/index.php/Semnasdies62/index>
- Zhang, R., & Zou, D. (2020). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. *Computer Assisted Language Learning*, 35(2), 1–47. <https://doi.org/10.1080/09588221.2020.1744666>
- Zhou, W. (2021). Sociocultural theory and its implications in college English teaching and learning in the age of artificial intelligence. *Journal of Physics: Conference Series*, 1646(1), 012142. <https://doi.org/10.1088/1742-6596/1646/1/012142>
- Zou, B., Du, Y., Wang, Z., Chen, J., & Zhang, W. (2023). An investigation into artificial intelligence speech evaluation programs with automatic feedback for developing EFL learners' speaking skills. *SAGE Open*, 13. <https://doi.org/10.1177/21582440231193818>
- Zou, B., Liviero, S., Hao, M., & Wei, C. (2020). Artificial intelligence technology for EAP speaking skills: Student perceptions of opportunities and challenges. In M. R. Freiermuth & N. Zarrinabadi (Eds.), *Technology and the psychology of second language learners and users* (pp. 433–463). https://doi.org/10.1007/978-3-030-34212-8_17

Generative AI in Project-Based 3D Modeling: Effects on Creativity, Critical Thinking, and Workflow

Shyu Wye Ee
UNDO Academy, Malaysia
ye@undo.edu.my

Zaidatun Tasir
(corresponding author)
Faculty of Educational Sciences & Technology,
Universiti Teknologi Malaysia
p-zaida@utm.my

Abstract

Generative Artificial Intelligence (Gen-AI) has sparked significant debate within creative industries and educational settings. This study examined the effect of integrating Gen-AI tools into project-based 3D Modeling on students' creativity, critical thinking, processes, and workflows. A mixed-method research design with a sequential explanatory approach was employed, involving 19 students from a Malaysian creative arts institution specializing in 3D design, selected through convenience sampling. Quantitative data were gathered from students' creative scores based on Amabile's Componential Model for Creativity and timeline worksheets documenting the time spent on artwork creation. Qualitative data were collected through interviews to assess critical thinking, and through self-reflection forms to evaluate processes and workflows. Insights were also gained from two industry experts regarding their use of Gen-AI tools. Findings indicated that Gen-AI tools enhanced creativity and accelerated the creative process, thereby improving workflow efficiency. However, mixed reactions were observed regarding the implementation of Gen-AI tools in education, highlighting concerns about academic integrity and ethical considerations. This study provides valuable insights into the opportunities and challenges associated with the use of Gen-AI tools in educational contexts.

Keywords: Generative AI, creativity, critical thinking, process and workflow, 3D modeling

Shyu, W.E. & Tasir, Z. (2026). Generative AI in project-based 3D modeling: Effects on creativity, critical thinking, and workflow. *Online Learning*, 30(1), pp. 531-555.
<https://doi.org/10.24059/olj.v30i1.4769>

Digital transformation has significantly reshaped the educational landscape by incorporating advanced technologies to support innovative teaching and learning environments (Bender, 2023; Hutson & Cotroneo, 2023). The rise of the internet and artificial intelligence (AI) has provided educators with access to a wide range of knowledge and tools, enabling the creation of engaging learning experiences that encourage independent and personalized exploration (Ouyang & Jiao, 2021).

AI in education can be categorized into three paradigms; AI-directed, where the learner acts as a recipient of information; AI-supported, where the learner collaborates with AI; and AI-empowered, where the learner takes on the leadership role of decision-making based on AI-driven insights (Ouyang & Jiao, 2021). These paradigms represent varying levels of learner engagement and autonomy in relation to AI. This study focuses on the AI-supported and AI-empowered paradigms, which use AI tools to enhance student learning through more collaborative and student-centered approaches.

Generative AI (Gen-AI), a branch of artificial intelligence, introduces new possibilities in content creation (Chiu, 2023; Tong et al., 2023). Gen-AI employs advanced algorithms to produce new content, such as text and images, based on data it has been trained on. Tools like ChatGPT and MidJourney are common examples of Gen-AI applications (Chiu, 2023). Within the context of 3D modeling, Gen-AI tools offer the potential to accelerate the creative ideation process by enabling rapid content generation and visual communication of ideas (Hutson & Cotroneo, 2023; Epstein et al., 2023; Shi et al., 2023).

Bhaduri et al. (2019) found that providing students with access to a variety of 3D modeling platforms increases their engagement and interest. In the current digital era, these platforms now include Gen-AI tools, which are transforming creative practices across multiple disciplines. The integration of Gen-AI in the 3D modeling process challenges traditional distinctions between human and machine creativity, offering new opportunities for innovation (Bender, 2023; Cheng, 2022). This may be particularly beneficial for students who struggle with generating ideas or visualizing design concepts (Tong et al., 2023; Bender, 2023).

Although previous research has demonstrated the potential benefits of Gen-AI (Hutson & Cotroneo, 2023; Grassini, 2023; Tahiru, 2021), its practical application within 3D modeling courses remains limited (Chiu et al., 2023; Grassini, 2023). This study aims to investigate the effects of project-based 3D modeling activities enhanced by Gen-AI on students' creativity, critical thinking, and workflow in the context of the 3D computer graphics industry.

To provide structure, this article begins with a review of relevant literature, followed by an explanation of the research methodology. The findings are then presented and critically discussed. The paper concludes with a summary of the key results, a discussion of the study's limitations, and suggestions for future research.

Literature Review

AI in Education

Definitions of artificial intelligence (AI) vary depending on the research context, but many compare it to human intelligence in terms of decision-making and problem-solving capabilities (Dobrev, 2005; Kong, 2020). In the field of education, AI plays a growing role in supporting and empowering learners by helping them become more digitally and technically literate. This literacy equips students with the ability to adapt, innovate, and create solutions in an increasingly digital world (Grassini, 2023). As AI technologies continue to evolve, their integration into educational settings has the potential to fundamentally transform how students learn and how educators teach.

Several studies (Baidoo-Anu & Owusu Ansah, 2023; Chiu, 2023; Grassini, 2023; Han & Cai, 2023) have investigated both the benefits and challenges of AI integration in education. For example, Baidoo-Anu and Owusu Ansah (2023) argue that incorporating generative AI tools, such as ChatGPT, can enhance learning by providing personalized tutoring experiences. The adaptive nature of AI makes learning more flexible and interactive (Chiu et al., 2023). AI is also widely used to create gamified educational activities that engage students and improve their learning outcomes.

Beyond student engagement, AI technologies support educators in developing more effective teaching strategies. For instance, AI systems can generate personalized learning content and provide real-time feedback, offering insights into student progress. This allows educators to focus on designing impactful and responsive learning experiences (Chiu et al., 2023). Grassini (2023) notes that AI can also automate routine tasks, enabling educators to allocate more time to developing creative and innovative lesson plans. These personalized environments, supported by AI, are made possible by data-driven algorithms that analyze student learning patterns to deliver tailored instruction (Chiu et al., 2023).

As AI continues to advance, its role in enhancing creativity has become an area of growing interest. Gen-AI, which is designed to support rather than replace human creativity, has opened new opportunities in education, particularly in creative and visual fields. This leads to a deeper discussion about Generative Adversarial Networks (GANs) and their relationship to creativity in educational contexts.

Generative Adversarial Network (GAN), Gen-AI, and Creativity

The development of Generative Adversarial Networks (GANs) and Gen-AI has led to major breakthroughs in AI, particularly in the domain of artistic creativity. GANs operate through two neural networks: a generator that creates output based on data samples, and a discriminator that evaluates and refines these outputs. Through iterative feedback, the system produces increasingly realistic content (Goodfellow et al., 2020). These tools are frequently used in text-to-image generation, where descriptive prompts yield highly detailed and lifelike visuals. This rapid advancement has generated concern within the creative arts community, as it challenges long-standing assumptions about creativity as a uniquely human trait (Shi et al., 2023).

Creativity, however, remains a deeply human cognitive function, essential for innovation, expression, and demonstrating mastery (Cheng, 2022; Esling & Devis, 2020). Gen-AI tools do not replace human creativity but instead support it by encouraging new ways of thinking and

visualizing ideas (Bender, 2023; Notaro, 2020). This collaborative dynamic between humans and machines is aligned with Conceptual Blending Theory, which posits that combining multiple sources of information leads to the generation of novel and original ideas (Tunmer & Fauconnier, 1995).

By generating content in response to text-based prompts, Gen-AI tools facilitate creativity, ideation, and collaboration (Hutson & Cotroneo, 2023). These tools act as partners in the creative process by supporting visual communication and expanding the boundaries of imagination (Esling & Devis, 2020). Although Gen-AI tools demonstrate impressive creative capabilities, they rely entirely on human input to function. Without the user's imaginative ideas and prompts, these tools remain passive. As noted by Hutson and Harper-Nichols (2023), AI cannot replace artists but can serve as a valuable collaborator in enhancing and extending human creative potential.

Gen-AI Applications in Creative Art Education

The integration of Gen-AI into creative arts education has been explored in recent studies, which highlight its potential to foster creativity and critical thinking while emphasizing ethical use and the maintenance of academic integrity (Dehouche & Dehouche, 2023; Hutson & Harper-Nichols, 2023; Hutson & Cotroneo, 2023). Scholars such as Betker et al. (2023), Hutson et al. (2023), and Tong et al. (2023) discuss how Gen-AI can enhance visual expression and help students represent ideas more effectively. Kong (2020) outlines three key strategies for incorporating AI into arts education: adapting AI for instructional use, improving intelligent teaching methodologies, and enriching student experiences through AI-enhanced creative tasks.

Similarly, Dehouche and Dehouche (2023) describe how AI can be used to recreate historical art pieces, enabling students to explore the stories behind artwork through interactive and immersive learning. Successful implementation of Gen-AI in this context encourages students to experiment with creative solutions and develop sustainable, innovative designs (Hutson & Lang, 2023; Anam & Fathoni, 2023). These tools also enhance students' visual communication abilities and support ideation and sketching processes, allowing learners to blend their own ideas with AI-generated suggestions (Betker et al., 2023; Hutson et al., 2023; Tong et al., 2023). This collaborative approach helps cultivate aesthetic literacy and creative thinking (Bender, 2023).

While concerns exist that Gen-AI tools might dominate the creative process, they are still highly dependent on human input, such as descriptive prompts and artistic intention (Hutson & Lang, 2023; Kong, 2020). Though these tools can support innovation and critical thinking, they do not replicate the depth and nuance of human creativity. Instead, many researchers advocate for a co-creative model in which Gen-AI complements human abilities (Dehouche & Dehouche, 2023; Shi et al., 2023; Tsai et al., 2023). This human-AI partnership offers opportunities to overcome creative limitations and explore ideas that might otherwise remain unrealized (Esling & Devis, 2020; Anam & Fathoni, 2023).

Pedagogical Challenges in 3D Modeling and Ethical Practices of AI

Teaching and learning 3D modeling present notable challenges for both educators and students. The complexity of 3D software and technical processes can be overwhelming for beginners, often leading to disengagement, especially among learners who lack spatial awareness or critical thinking skills (Bhaduri et al., 2019).

Achieving competence in 3D modeling requires not only technical skills but also creativity and cognitive flexibility. Studies show that instructional strategies such as cognitive apprenticeship can enhance metacognition and practical skill development (Huang et al., 2019). Similarly, goal-driven training approaches have been found to improve learners' cognitive abilities and problem-solving strategies (Benzer & Yildiz, 2019). When implemented effectively, Gen-AI tools can provide additional support by guiding students toward clear and achievable outcomes.

Project-Based Learning (PjBL) has proven to be an effective approach in promoting both creativity and critical thinking by immersing students in real-world challenges. According to Jeon et al. (2014), the PjBL cycle includes five stages: Orientation, Identifying and Defining, Planning, Implementing, and Reporting and Evaluating. This model supports self-directed learning, encouraging students to actively seek out solutions, often with the help of Gen-AI tools.

When aligned with PjBL and constructivist learning theories, Gen-AI tools offer personalized and collaborative learning experiences. These tools enhance active participation by supporting creative workflows, preventing stagnation during ideation, and promoting reflection through iterative design. In this setting, educators serve not only as facilitators but also as technological guides, helping students use AI ethically, uphold academic integrity, and stay engaged throughout the creative process.

Despite the potential of Gen-AI to support creativity, many students experience creative blocks when faced with the “blank slate” problem, uncertainty about how to begin or develop ideas without a clear concept. Gen-AI tools can help overcome these barriers by providing visual prompts and suggestions that stimulate the early stages of ideation.

However, the use of AI in education also raises ethical concerns. Chiu (2023) points out a lack of research on AI ethics in educational contexts, while Koubaa et al. (2023) highlight mixed perceptions of Gen-AI tools, particularly around issues such as plagiarism, misuse of copyrighted material, academic dishonesty, and dependence on unreliable content. These concerns emphasize the importance of developing ethical guidelines for AI integration in educational settings (Grassini, 2023; Zhai, 2022).

Educators' perspectives are essential in determining how AI tools are implemented. As the education sector increasingly adopts a skills-based approach in line with industrial demands, AI tools are seen as valuable assets in course design, collaboration, and innovation (Bender, 2023). In creative arts education, in particular, AI holds promise for enhancing student engagement, creativity, and learning outcomes.

Despite a growing body of literature on AI in education, there remains a noticeable gap in research on its integration into 3D modeling courses (Chiu et al., 2023; Grassini, 2023). This study addresses that gap by investigating the impact of project-based 3D modeling activities enhanced by Gen-AI on students' creativity, critical thinking, and workflow. Specifically, it examines how AI influences students' creative processes, time management, and problem-solving strategies in the context of 3D computer graphics education.

Creativity and Critical Thinking Theories

As the definition of creativity continues to evolve, it is increasingly understood as a multifaceted concept involving both cognitive and developmental dimensions. This study focuses on *developmental creativity* and *cognitive creativity*, both of which are shaped by internal factors—such as individual motivation and thinking strategies—and external influences, including tools and environmental conditions (Kozbelt et al., 2010). One of the foundational models used in this study is Amabile’s Componential Model of Creativity (Amabile & Pratt, 2016), which defines creativity as the result of producing novel and useful ideas that lead to successful implementation. The model highlights three key components that influence creativity: domain-relevant skills (knowledge), creativity-relevant processes (thinking strategies), and task motivation.

Creativity is not limited to artistic or visual expression but also encompasses the ability to develop innovative and resourceful solutions to problems (Sternberg et al., 2019). The theory of conceptual combination further supports this view by proposing that synthesizing different sets of information can stimulate creative ideation (Kozbelt et al., 2010). In this context, Gen-AI acts as a collaborative tool that facilitates idea generation and exploration by expanding the user’s cognitive reach.

As AI becomes more deeply embedded in creative processes, its influence can also be interpreted through the Four C Model of Creativity, developed by Kaufman and Beghetto (2007). This model identifies four levels of creativity: Mini-c (personal insight), Little-c (everyday problem-solving), Pro-c (professional-level creativity), and Big-C (eminent, domain-transforming creativity). While Gen-AI tools are particularly effective in supporting Mini-c and Little-c creativity, their capabilities also contribute to the development of higher-level creative outcomes (Pro-c and Big-C), especially when integrated with structured learning and mentorship (Markauskaite et al., 2022).

Critical thinking is another essential cognitive skill that is often acquired through real-world experiences rather than formal instruction (Ellerton, 2022). This study draws on Facione’s Critical Thinking Model (2015), which emphasizes the development of six core cognitive skills: interpretation, analysis, inference, evaluation, explanation, and self-regulation. These skills enable individuals to make reasoned judgments and solve problems effectively. Facione (2015) further argues that the cultivation of these abilities enhances not only academic performance but also quality of life.

The relevance of this model to the current research lies in its alignment with the objective of enhancing critical thinking through the use of Gen-AI tools. For example, as students interact with AI-generated content, they must evaluate, revise, and apply this content critically within their projects, activities that mirror Facione’s framework.

Both creativity and critical thinking are also deeply rooted in constructivist learning theory, which posits that learners actively construct knowledge through engagement and interaction with their environment. Gen-AI tools support this theory by enabling students to access, remix, and reframe information in ways that promote deeper understanding. For instance, students can experiment with image generation tools to visualize ideas, combine different concepts, and reflect on their outcomes. These actions not only reinforce creative thinking but also foster self-directed learning (Baidoo-Anu & Owusu Ansah, 2023).

Research Questions

This study aims to explore the impact of generative AI in project-based 3D modeling through the following research questions:

1. What is the effect of project-based 3D modeling activities integrated with Generative AI on students' creativity?
2. How much time do students spend on creating 3D modeling artwork when using Generative AI tools?
3. In what ways do project-based 3D modeling activities, enhanced by Generative AI, influence students' critical thinking skills?
4. What are the overall processes and workflows students follow when creating 3D modeling artwork with the aid of Generative AI tools?

Methodology

Research Design

This study employed a mixed-methods design with a sequential explanatory approach (Creswell & Clark, 2007), integrating both quantitative and qualitative data to provide a comprehensive understanding of the research problem. This approach enhances the validity of findings by enabling qualitative insights to explain quantitative results (Creswell, 2012).

One challenge associated with this design is obtaining ethical approval, particularly when participants for the qualitative phase are not identified in advance. However, in this study, ethical approval was not required, as all participants had provided prior informed consent to take part in the research.

Research Setting and Participants

The research was conducted at a private college in Petaling Jaya, Malaysia, selected for its qualified educators and well-equipped facilities that support 3D modeling and animation software. Participants were selected through convenience sampling, with voluntary participation. The selection criteria were:

- Enrolment in a 3D Animation course that included a 3D Modeling subject, ensuring foundational knowledge relevant to the study.
- Prior experience or interest in using digital tools for creative projects, enabling meaningful engagement with Gen-AI applications.

Out of 27 eligible students, 19 consented to participate in the study, which took place over the course of one semester (14 weeks). The remaining eight students declined, expressing strong opposition to the use of Gen-AI tools in their creative processes.

The convenience sampling method was appropriate as the study targeted students who were both willing and available to participate, consistent with Creswell's (2012) justification for using convenience sampling. Additionally, participants needed to be genuinely interested in and open to using Gen-AI tools in their 3D Modeling projects.

To minimize bias, sample variability was controlled by selecting students from the same course, thereby ensuring a comparable level of prior knowledge. As this study is exploratory in nature, its findings are not intended for generalization.

Two industry experts were also interviewed to enrich the qualitative data. They were selected purposefully based on their expertise. Expert 1 (E1) had over 15 years of experience in the creative industry, transitioning from traditional to digital methods and using Gen-AI tools to innovate creative workflows. Expert 2 (E2) had 9 years of experience in the Games and Animation industry and 5 years of teaching experience, offering valuable insights from both industry and academia.

Data Collection

Data collection occurred in two phases: Initially, quantitative data were gathered, followed by the collection of qualitative data to further elucidate the results. In the quantitative phase, participants completed Pre-Post Projects. Prior to the study, students were provided with informed consent forms to confirm voluntary participation. A total of 19 students participated, while 8 opted out. The project-based learning (PjBL) activity, based on Jeon et al. (2014), involved a Pre-Post Project task under the theme “Stylized Diorama Building.” This activity was selected due to its alignment with industry practices and suitability for integrating Gen-AI tools.

The Pre-Post Project was divided into two parts: Part 1 focused on the pre-production phase, where students designed conceptual art, and Part 2 involved the production phase, including modeling, UV mapping, texturing, and rendering. Students’ creativity levels were measured using Susan Brookhart’s Creativity Rubric (Brookhart, 2010) and they tracked their time using a Timeline worksheet to monitor progress and optimize their creative process.

In the qualitative phase, participants were interviewed using questions based on Facione’s Holistic Critical Thinking Rubrics (Facione & Facione, 1994) and completed a self-reflective form inspired by Kleon’s “Steal Like an Artist” rubrics (Kleon, 2012) to gain insights into their critical thinking and overall process. Qualitative data were collected through interviews and a self-reflection form. Interviews followed open-ended, flexible questions to gather in-depth insights (Maguire & Delahunt, 2017; Ruslin et al., 2022). A self-reflection form encouraged students to articulate their experiences and self-assess their learning, helping to foster constructive discussion (Martinez-Villagrasa et al., 2020).

All rubrics used in the study were selected based on Dawson’s (2017) rubric design criteria, which include specificity, scoring strategy, evaluative criteria, quality levels, quality definitions, quality processes, and presentation.

Data Analysis

The demographic data of the participants were analyzed descriptively using percentages. Quantitative data collected from Susan Brookhart’s Creativity Rubric were analyzed descriptively using mean and standard deviation to identify students’ creativity scores before and after using Gen-AI. To examine differences in scores, Wilcoxon’s Signed-Rank Test and Effect Size r were employed.

Data from the timeline worksheet were also analyzed descriptively using mean and standard deviation to determine the average time spent and efficiency in the creative process. The

Wilcoxon's Signed-Rank Test and Effect Size r were again used to analyze significant differences in the time taken to complete projects before and after using Gen-AI.

For the qualitative data collected from interviews and self-reflection forms, thematic analysis was employed (Williamson et al., 2018). This approach helped identify recurring patterns and relationships within the data, offering deeper insights into students' critical thinking and creative processes. Data from both sources were triangulated to strengthen findings. The frequency and percentage of theme occurrences were also recorded to support interpretation.

Ethical Considerations

Given ongoing concerns in the creative community surrounding the use of Gen-AI tools, this study adhered to strict ethical guidelines. Participation was voluntary, with students given the option to consent or decline without any academic consequences.

All student data remained anonymous, and analysis was conducted collectively using overall means and themes. The study was conducted outside regular class hours and was not associated with any graded coursework or specific subject, ensuring it did not affect students' academic performance. As such, formal ethical approval was not required, since informed consent was obtained, and no identifiable or sensitive data were used.

Results

Background of the Participants

Table 1 presents the demographic characteristics of the participating students in this research, suggesting a diverse sample in terms of age, gender, and educational background. The variety among students in this sample enhanced the generalization of the findings to a broader population.

Table 1

Analysis of Participating Students' Demographic Background

		Frequency	Percentage
Gender	Male	10	52.6%
	Female	9	47.4%
Age Gap	20 – 21 years	8	42.1%
	22 – 23 years	7	36.8%
	24 – 25 years	2	10.5%
	26 – 27 years	1	5.3%
	28 years and above	1	5.3%
Education Level	High School Graduates	15	78.9%
	Diploma	2	10.5%
	Degree	1	5.3%
	Masters	1	5.3%

Effects of Gen-AI on Student's Creativity

The assessment of the effectiveness of Project-Based 3D Modeling Learning Activities embedded with generative AI verified that most of the students displayed significant improvements in their scores (see Table 2), as measured by the Creative Rubrics (Brookhart, 2017). This indicated the success of the project activities.

Table 2

Student's Pre-Post Creativity Scores

	Project Creativity Part 1		Project Creativity Part 2	
	Pre	Post	Pre	Post
<i>Mean</i>	9.79	13.16	56.89	73.68
<i>Standard Deviation</i>	2.59	1.57	12.49	9.18
<i>Median</i>	10.0	13.0	57.0	73.0
<i>n (Total)</i>	19		19	

Based on Table 2, the students' average scores in Project Part 1 improved from 9.79 to 13.16, while in Part 2, the results increased from 56.89 to 73.68. The statistical findings revealed a decrease in standard deviations from 2.59 to 1.57 for Part 1 and from 12.49 to 9.18 for Part 2. The decrease indicated stronger consistency in scores, with data clustering more closely around the mean after the project activities. The increased median scores reflected a general improvement in student creativity, with half of the students scoring from 10 to 13 marks or higher in Part 1 and from 57 to 73 marks or higher in Part 2. This substantial improvement demonstrated a positive impact of the project intervention on students. These findings not only illustrate the improvements in student scores but also highlight the statistical significance of the results, as shown in the subsequent analysis.

According to Table 3, the Wilcoxon signed-rank test revealed significant increases in creativity scores for both Part 1 and Part 2. The analysis indicated large effect sizes of 0.747 for Part 1 and 0.877 for Part 2. Furthermore, the asymptotic significance (2-tailed) value was less than 0.001, which is below the threshold of 0.05, confirming a significant improvement following the implementation of generative AI tools in the learning activities.

Table 3

Wilcoxon Signed-Rank Test for Creativity

	Mean	Z	Sig.	Effect size r
Pre-Project Part 1	9.79	-3.258	0.001	0.747
Post-Project Part 1	13.16			
Pre-Project Part 2	56.89	-3.826	0.001	0.877
Post-Project Part 2	73.68			

Time Used by Students by Implementing Gen-AI Tools

During the overall process of the study, students recorded their timelines in the provided worksheets to determine the number of days used to produce their artwork. The variation in pre-project time suggested differences in the complexity of the artwork created by each student, as well as individual learning curves. It was also expected that students would perform faster in the post-project phase after their prior experience in the pre-project.

Table 4 details the results from the Wilcoxon signed-rank Test. The significant decrease in time from 10 days to 1.84 days during Part 1 and from 44.89 days to 20.26 days indicates the efficiency and effectiveness of the project intervention, including the utilization of Gen-AI tools, in optimizing the artwork creation process. Participating students likely benefited from the experience gained during the pre-project phase, as well as the guidance and training provided as part of the project activities.

Table 4

Wilcoxon Signed-Rank Test for Time Used

	Mean	Z	Sig.	Effect size r
Pre-Project Part 1	10.00	-3.831	0.001	0.878
Post-Project Part 1	1.84			
Pre-Project Part 2	44.89	-3.829	0.001	0.878
Post-Project Part 2	20.26			

t

According to the results from the Wilcoxon signed-rank test, there is a significant difference in the time spent, with the effect size for both parts at 0.878 indicating large effects and a significant reduction in time spent. The average time spent on both parts of the activity decreased significantly in the post-project phase, indicating improved workflow and productivity among students. This suggests that the intervention utilizing Gen-AI tools not only facilitated the ideation process in pre-production but also optimized time and resource management during the production stage.

Influence of Gen-AI tools towards Student's Critical Thinking

The data in Table 5 reveals varied perceptions among students regarding the use of generative AI tools in their 3D modeling projects. A significant portion of the participants, 84.6%, reported having used Gen-AI tools, indicating a strong engagement with this technology. However, opinions on its practicality were mixed: while 38.5% found the tools useful, a notable 46.2% remained undecided, and 15.4% viewed them as unethical. This uncertainty suggests a need for further education on the ethical implications and practical applications of Gen-AI in creative work.

Regarding the impact of Gen-AI on critical thinking, opinions were nearly evenly split. While 53.9% of students believed that Gen-AI positively influenced their critical thinking skills, 46.1% disagreed. This dichotomy reflects a complex relationship between technology use and the development of critical thinking abilities, highlighting the necessity for careful integration of Gen-AI in educational practices to maximize its benefits.

Additionally, the influence of Gen-AI on motivation was generally positive, with 61.5% of students affirming that it enhanced their motivation to engage with their projects. This indicates that the integration of Gen-AI tools may lead to greater student engagement in learning activities.

When asked about problem-solving strategies, students utilized a variety of resources, with 30.8% relying on online resources, followed closely by seeking help from friends and lecturers (both at 23.3%). This shows that while Gen-AI tools were utilized, students still turned to traditional methods and peer support for problem-solving.

In summary, the findings suggest that while students are generally receptive to using Gen-AI tools, there are mixed feelings about their ethical implications and their specific impact on critical thinking. This highlights the importance of fostering discussions around ethical use and providing support to enhance students' critical thinking skills in conjunction with new technologies.

Table 5

Perception of Participating Students Towards Gen-AI Tools

		Frequency	Percentage
<i>Practicality</i>	Useful	5	38.5 %
	Undecided	6	46.2 %
	Unethical	2	15.4 %
<i>Used Gen AI</i>	Yes	11	84.6 %
	No	2	15.4 %
<i>Impact Towards Critical Thinking</i>	Yes	7	53.9 %
	No	6	46.1 %
<i>Gen AI on Motivation</i>	Yes	8	61.5 %
	No	5	38.5 %
<i>How Students Solve Problems Initially</i>	Online Resources	4	30.8 %
	Friends	3	23.3 %
	Lecturers	3	23.3 %
	AI Tools	2	15.4 %
	Misc	1	7.7 %
<i>Total</i>		13	100%

The qualitative data gathered from interviews revealed mixed reactions from students regarding their use of Gen-AI tools, despite the positive quantitative findings. The thematic analysis indicated that most students drew inspiration from themes related to food and culture. They reported using Gen-AI tools to further develop these initial ideas, particularly when facing challenges like creative blocks in traditional artistic expression. For instance, S16 stated,

“Conveying the ideas and expectations from my imagination into words commands,” while S17 noted, “When I am stuck, I ask AI to generate images to know what details to model.”

In addressing their creative challenges, students frequently utilized online resources alongside Gen-AI tools to generate references that supported their projects. They encountered some technical issues, such as modeling with nGon (polygonal faces with more than four edges), UV projections, and texturing outcomes. Overall, students utilized Gen-AI tools to stimulate ideation, facilitate referencing, and accelerate project timelines. For example, S11 highlighted this efficiency:

It helped me model out my ideas without me thinking of them first. It saved me a lot of time... without AI, I would take long hours thinking of different ideas, but with AI, I can see what it generates and sketch it out.

While many students found that Gen-AI tools allowed them to bypass difficulties in sketching their thoughts, which led to improved productivity, they also acknowledged the risk of complacency through over-reliance on technology. This suggests a dual impact on critical thinking: Gen-AI tools can enhance efficiency and idea generation but may also hinder deeper engagement in the creative process.

Students re-stated that Gen-AI played a vital role in ideation during the pre-production phase, helping them generate innovative ideas from initial text prompts by combining multiple elements. This process enabled them to view their projects from different perspectives and expand their creative horizons. S16 remarked, “AI can generate a lot of art, so I can use them as references and combine the elements I like from there.” Similarly, S10 noted, “It gives me freedom from lecturer comments,” indicating a desire for autonomy in their creative work.

Despite the array of Gen-AI tools available, students maintained a sense of independence by integrating their prior knowledge and techniques into their projects. They acknowledged that while Gen-AI was enjoyable and interesting, they still valued the personal touch in their designs. S03 stated, “AI is a fun and interesting way to approach designing, but I still prefer to come up with the design myself; it doesn’t hurt to have some references.”

In conclusion, the students exhibited mixed perceptions of Gen-AI tools. While they found these tools useful in overcoming creativity blocks and time constraints, they expressed caution regarding their overuse. Students anticipated that future developments in Gen-AI would introduce more features, although they recognised that the technology is not yet mature enough to fully replace traditional creative processes. Throughout the interviews, students demonstrated awareness of the ethical and legal challenges posed by Gen-AI, as well as ongoing debates within the creative community regarding its use. This indicates their recognition of the complexities surrounding this transformative technology.

Overall Process and Workflow with the Implementation of Gen-AI Tools

Table 6 provides insights into students’ experiences with Gen-AI tools in their creative workflows. A majority (53.8%) indicated that they utilized these tools for ideation in concept art, while a significant portion (46.2%) expressed uncertainty about their overall effectiveness. Additionally, 61.5% of students recognised changes in their workflows due to Gen-AI tools, suggesting that these tools have a meaningful impact on their creative processes. However,

nearly 39% felt that there were no notable changes, highlighting a divide in acceptance and integration of these technologies.

Regarding critical thinking, 53.9% of students believed that Gen-AI tools positively influenced their analytical skills, although 46.1% did not see a significant impact. The practical use of Gen-AI was predominantly focused on ideation and concept art, with 76.9% of students employing these tools in this phase, while applications in modeling, UV texturing, and lighting and rendering were minimal (7.7% each). This indicates that while students find Gen-AI tools valuable for generating ideas, their effectiveness in technical stages of the creative process is limited. Overall, the findings suggest a generally positive yet cautious view of Gen-AI tools, emphasizing their primary role in the early phases of artistic development.

Table 6

Students' Overall Process and Workflow with Gen-AI Tools

		Frequency	Percentage
<i>Usability</i>	Ideation for Concept Art	7	53.8 %
	Undecided / Maybe	6	46.2 %
<i>Changes with Gen AI</i>	Yes	8	61.5 %
	No	5	38.5 %
<i>Impact towards Critical Thinking</i>	Yes	7	53.9 %
	No	6	46.1 %
<i>Practical use On Gen AI</i>	Ideation & Concept Art	10	76.9 %
	Modeling	1	7.7 %
	UV Texturing	1	7.7 %
	Lighting & Rendering	1	7.7 %
	Composition	0	0.0 %

The thematic analysis revealed that most students completed their projects using traditional production methods, even while incorporating Gen-AI tools into their workflows. This integration did not significantly alter their established processes, which typically progressed from ideation to concept art, model blocking, UV unwrapping, texturing, and finalizing materials, lighting, and rendering. While some students utilized platforms like Sketchfab for online 3D viewing, the overall workflow remained consistent with conventional practices.

Students effectively employed Gen-AI tools during the planning stages, where these tools aided in artistic decision-making and influenced the final outcomes. By blending elements from cultural references, such as food and anime, students crafted detailed prompts that guided the generation of images. This approach enabled them to think creatively and explore innovative ideas, as illustrated by S03's statement: "Taking parts of the images I like the most and merge

them into one design,” and S06’s imaginative concept description: “Describe a concept I want with ideas like a huge bao on a roof with keywords like diorama, miniature, cute.”

Despite the advantages of Gen-AI tools, students encountered several challenges, such as finding the right tools for their specific needs. While Gen-AI could produce images quickly, the outputs often had issues like pixelation and structural flaws, complicating their translation into 3D models. The inconsistency in generated images posed difficulties, particularly for beginners, leading students to rely on traditional methods and tutorials to address these shortcomings. Statements like S02’s critique—“Sometimes their generation doesn’t make the structure rationalization, and some small detail isn’t clear enough”—and S03’s concerns—“Some images created are not very stable if in real life it would not be able to support its own weight; it makes it hard to try changing the idea into something more realistic/stable”—highlight these obstacles.

However, students acknowledged the utility of Gen-AI in accelerating the ideation process and facilitating smoother workflows. Many expressed a cautious optimism regarding the ethical use of Gen-AI tools, recognizing their potential to assist primarily in the early phases of pre-production. Overall, while Gen-AI tools were valuable for generating ideas, the students’ reliance on traditional methods underscores their limited impact during the later stages of production.

The insights gathered from conversations with industry experts highlighted a cautious perspective on the use of generative AI tools in creative processes. Both experts agreed that Gen-AI allows for an expression of freedom to visually communicate ideas, but most of these applications are limited to internal experiments. The rapid production of sketches for ideation is not advisable when dealing with clients due to the randomization of generated images, which lacks user control over the outcome. In developing and brainstorming ideas, the experts noted that they use Gen-AI tools to cross-reference and mix elements from prompted images with other resources. However, they also pointed out that the repetition of styles from generated images lacks originality and contributes to market saturation, leading users to lose focus on their original ideas and creativity. Expert 1 stated, “It is very easy to lose your focus with Gen AI tools. It is important to pull back to your original ideas and creativity,” while Expert 2 emphasized the need for ethical use, mentioning that they would only engage with Gen-AI after conducting extensive studies on how the tool operates.

Leveraging Gen-AI tools has proven efficient for certain artistic projects, but the experts indicated that these tools may not assist effectively in more controlled processes within the games and animation industries. The time saved in the pre-production phases can become counterproductive, as the destructive nature of generated images can complicate modifications. Expert 1 pointed out, “Time saved at the beginning is spent on the later parts of production. Challenges in consistency and specific details. The more detailed it is, the harder for Gen-AI tools to produce.” They observed that the most time-consuming aspect of projects is often the detailing and finishing phases, particularly when clients have specific requirements. Both experts recognised that Gen-AI tools have not yet matured sufficiently, often confusing beginners who lack foundational skills in art and design. Expert 1 noted, “The current Gen-AI tools are not matured enough; it is still difficult to control for young students,” while Expert 2 added, “I think Gen-AI tools will confuse the students more than helping them, without understanding the key elements of what should be extracted by Gen-AI.”

Furthermore, ethical practices surrounding Gen-AI tools remain contentious; the experts acknowledged these concerns and agreed that current tools are only suitable for ideation and inspiration but should never be used as final outcomes. Expert 1 commented, “I also educate my clients on ethical and copyright issues from the beginning to make sure that we’re on the same page,” and Expert 2 reiterated, “I will never use Gen-AI generated work as a final image.” Overall, they argued that developing foundational skills and understanding design principles should take precedence over quick solutions that lack context, warning against an over-reliance on Gen-AI tools in educational settings.

Discussion

The quantitative data reveals a significant improvement in students’ creativity scores, suggesting that project-based 3D modeling activities integrated with Gen-AI enhance both creativity and critical thinking. This aligns with constructivist principles and Amabile’s model of creativity (Amabile & Pratt, 2016). Similar findings by Tong et al. (2023) show how students using Gen-AI tools to visually communicate ideas and generate images rapidly improve design quality. This supports the ideation process, fostering creativity, as also confirmed by other studies (Kong, 2020; Zhai, 2022). Gen-AI tools offer multiple perspectives that help students overcome creative barriers and stimulate innovation (Anam & Fathoni, 2023). In particular, research by Dehouche and Dehouche (2023) indicates that integrating Gen-AI into artistic education could revolutionize how creativity is nurtured, addressing the theoretical gap regarding the role of AI technologies in creative education. This study contributes to this gap by providing concrete evidence of the effects of Gen-AI on creativity, especially in project-based learning contexts.

Although Gen-AI tools showed clear benefits during the pre-production phase, where they supported ideation and conceptual art (Amabile & Pratt, 2016), their utility declined beyond this stage. Similar studies, such as Cheng (2022), also suggest that while Gen-AI aids average students during pre-production, its impact in later creative stages remains limited (Hutson & Lang, 2023). This research concurs, acknowledging Gen-AI’s current limitations in advanced stages of the creative workflow, though future developments may address these shortcomings.

Utilizing Gen-AI tools may churn out unlimited outcomes, but this could be counterproductive. During the study, having that many options and choices delivered, potentially divert from the original rationale. Gen-AI may spark countless ideas, but it could also be difficult for users to make the final selection. Experts interviewed for this study expressed mixed opinions on Gen-AI tools in the creative process. One expert praised the creative freedom afforded by these tools, while another took a more cautious stance, voicing concerns about the market saturation of AI-generated works diminishing originality (Dehouche & Dehouche, 2023).

Both experts agreed that although Gen-AI offers exciting opportunities for inspiration, there is a risk of over-reliance, which could lead to a loss of students’ creative direction. This echoes findings by Hutson and Cotroneo (2023), who stress the importance of students retaining control over their artistic processes while using AI tools to expand their creative horizons. These expert perspectives fill the theoretical gap by highlighting the need to balance AI use with creative independence, reinforcing Amabile’s model, which emphasizes originality as central to creativity.

Despite the concerns highlighted by the experts, the research demonstrated that students using Gen-AI tools were able to reduce time spent on pre-production and increase efficiency

during production (Grassini, 2023; Kong, 2020). Students reported that Gen-AI facilitated their projects by providing references and sparking creativity, a finding consistent with constructivist learning theories (Mota-Valtierra et al., 2019). However, experts pointed out that the time-saving benefits of Gen-AI were not consistent across different projects, especially beyond the pre-production phase. AI-generated outputs, often compressed into single layers, restrict flexibility in later stages, such as production and post-production, complicating the creative workflow.

The study revealed mixed results regarding the influence of Gen-AI tools on critical thinking. While some students benefited from the tools' ability to break through creative blocks and inspire innovative solutions (Bender, 2023; Facione, 2015; Anam & Fathoni, 2023), others tended to rely more on their prior knowledge and technical skills when confronted with challenges. This suggests that Gen-AI may not uniformly impact critical thinking across all contexts, as many students adopted a self-directed approach, turning instead to real-world simulations and online tutorials for guidance (Jeon et al., 2014). This aligns with constructivist theory, which emphasizes the ability of students to think critically and adapt independently when faced with challenges (Ouyang & Jiao, 2021). These findings contribute to addressing the research gap by providing empirical evidence that, although limited in scope, Gen-AI tools can foster self-directed learning and enhance creativity.

Experts also noted the difficulty in measuring Gen-AI's impact on critical thinking, as its effectiveness depends heavily on how individuals engage with the tools. This observation adds to the research gap regarding AI's role in fostering critical thinking, a topic that has not been deeply explored in prior studies. The advantage of the randomization in Gen-AI tools is also an adversity for the creative process. One expert highlighted that the more specific the creative requirement, the harder it is for Gen-AI to provide satisfactory results, often requiring users to experiment extensively. Both experts concluded that Gen-AI may not be ideal for promoting critical thinking in the creative process, as the tools often lack the depth required for complex problem-solving.

From a Project-Based Learning (PjBL) perspective, the use of Gen-AI tools aligns well with PjBL principles, helping students better define their design requirements and facilitating smoother project planning (Han & Cai, 2023). Gen-AI tools enabled students to research references, develop rationales, and avoid stagnation in the creative process. As a result, students were able to complete their final artworks more efficiently and with higher quality (Han & Cai, 2023). These findings support PjBL theories by demonstrating how real-world tools like Gen-AI enhance active learning and planning, thus addressing a theoretical gap in the understanding of AI's role in PjBL practices in creative fields.

Generated content from Gen-AI tools provides amazing images for references and inspiration, however participating students encountered discrepancies in the actual perspectives and structures of the design, thus, making it difficult to model in the actual 3D space. Certain realistic details were not convincing to support the idea that is being generated. An example observed during the study indicated that some participating students experienced difficulty aligning a circular top with an angular bottom, which led to a lack of functional coherence in the design. Students acknowledged Gen-AI tools—despite their limitations—as useful for sparking creativity and overcoming creative blocks (Tong et al., 2023) by accelerating the ideation stage to engage the artist with a direction to move forward within an allocated timeframe. The complex nature of producing 3D artworks, which requires both artistic and technical solutions, pushed

students to develop their metacognitive skills and critical thinking (Bhaduri et al., 2019; Huang et al., 2019).

At the time of the study, Gen-AI tools are limited to the pre-production conceptual art and ideation stage. This is because the produced outcome from Gen-AI tools is due to its' destructive nature of its workflow, making it difficult to make customized detailed adjustments when the layers are all collapsed into one. During this study, participating students expressed their interest in Gen-AI tools to assist in complex technical and automated tasks in other parts of the creative process. As the development of Gen-AI tools is still in its infancy, assimilating as supportive tools into the 3D software to be part of the process rather than the final outcome would be more productive.

Experts cautioned against over-reliance on Gen-AI tools, advising students to focus on strengthening their creative foundations and design principles. It is essential to understand that Gen-AI tools could only be replicated from existing data. This reminds us of the fact that Gen-AI is not here to replace but to assist in the production of creativity and expand our imagination. They emphasized that creative works should go beyond aesthetics to reflect deeper meanings, values, and personal expression, encouraging originality. This highlights the importance of students balancing technology with the development of their unique artistic voices.

Conclusion

This research conclusively demonstrated the impact of Gen-AI tools on students' creativity, time spent, critical thinking, processes, and workflow within Project-Based 3D Modeling. Statistical findings indicated positive results in enhancing creativity development and reducing the time spent on projects. Students drew inspiration from images generated by Gen-AI tools, which effectively sparked ideation for their designs. The support provided by Gen-AI accelerated project progress, particularly during the pre-production stage of conceptual art development, enabling students to allocate more time to tackle technical challenges in later phases.

However, the study also revealed mixed reactions concerning the development of critical thinking skills and the overall influence of Gen-AI on the creative process. While Gen-AI tools were effective in supporting the early stages of the creative workflow, their influence appeared to diminish in the later phases of production. Students nonetheless demonstrated resourcefulness, often relying on their prior knowledge and problem-solving abilities to overcome challenges. Furthermore, the study highlighted ethical concerns related to the potential over-reliance on Gen-AI tools, raising important questions about their long-term implications for creative education and industry practices.

These findings align with the theories underpinning this study. Amabile's Componential Model (Amabile & Pratt, 2016) and the Four C Model (Kaufman, 2007) highlight external influences in fostering creativity, reflected in students' use of Gen-AI during ideation. Conceptual combination theory (Kozbelt et al., 2010) supports how students synthesized AI-generated images with cultural references, reinforcing cognitive creativity. However, inconsistencies in AI outputs emphasized the importance of Facione's Critical Thinking Model (2015), particularly in analysis and self-regulation. The students' problem-solving approaches

also align with constructivist learning theory, which emphasizes active learning, and Project-Based Learning (PjBL) (Jeon et al., 2014), which promotes adaptive problem-solving. While Gen-AI enhanced ideation, its limitations reinforce the need for foundational skills and critical engagement, as emphasized by these models.

Recommendations

As Gen-AI continues to play a growing role in creative processes, this study suggests that 3D modeling education should embrace Gen-AI through activities specifically tailored to fit the course's objectives. Rather than treating Gen-AI as a replacement for traditional methods, educators should use it as a collaborative tool to support students in brainstorming ideas, solving problems, and improving workflow efficiency. By designing structured activities that combine AI-assisted creativity with hands-on technical skill development, students can benefit from AI while still building a strong foundation in essential skills.

Educators and university administrators are also encouraged to explore how Gen-AI can enhance learning outcomes. By integrating AI-driven approaches, they can create learning experiences that inspire creativity and critical thinking, helping students develop both technical expertise and flexible problem-solving abilities. Looking ahead, future research should focus on identifying the best ways to incorporate Gen-AI into education while upholding academic integrity and addressing ethical concerns.

Limitations and Future Research

This study faced limitations due to a small sample size, influenced in part by anti-AI sentiments within the current creative community. The limited number of participants was the result of a low response rate from students willing to be involved in the study. While it is commendable that students upheld ethical practices to protect their artistic and academic integrity, the findings are based solely on data from one institution and a limited demographic (Hutson & Lang, 2023). Furthermore, the study observed limited diversity within the sample, particularly in terms of age range, as participants were exclusively college students aged between 20 and 30 years.

Future research should aim to increase the sample size, broaden participant demographics, and extend the study duration to explore the long-term effects of Gen-AI tools. At the time of this study, the availability of AI tools aligned with the 3D production process was still limited. As noted by Chiu et al. (2023) and Hutson et al. (2023), further research and development of these tools is needed to address this gap and enhance their practical integration into creative workflows.

Given the current divide between the anti-AI movement and artists who embrace Gen-AI tools, it would be valuable to revisit this topic once the landscape has stabilized (Tong et al., 2023). Future studies are encouraged to explore the perceptions and perspectives of students, educators, and the wider community to promote constructive dialogue and address misunderstandings about Gen-AI tools (Shi et al., 2023; Chiu et al., 2023).

Declarations**Conflict of Interest**

All authors declare that they have no conflict of interest.

Acknowledgement

This work was supported/funded by the Ministry of Higher Education (MOHE) Malaysia under Fundamental Research Grant Scheme [FRGS/1/2023/SSI07/UTM/01/2].

References

- Anam, A. F. C., & Fathoni. (2023). Leveraging generative AI solutions in art and design education: Bridging sustainable creativity and fostering academic integrity for innovative society. *E3S Web of Conferences*, 426, Article 01102. <https://doi.org/10.1051/e3sconf/202342601102>
- Amabile, T. M., & Pratt, M. G. (2016). The dynamic componential model of creativity and innovation in organizations: Making progress, making meaning. *Research in Organizational Behavior*, 36, 157-183. <https://doi.org/10.1016/j.riob.2016.10.001>
- Baidoo-Anu, D., & Owusu Ansah, L. (2023). *Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning*. SSRN. <https://doi.org/10.2139/ssrn.4337484>
- Bender, S. M. (2023). Coexistence and creativity: screen media education in the age of artificial intelligence content generators. *Media Practice and Education*, 24(4), 351–366. <https://doi.org/10.1080/25741136.2023.2204203>
- Betker, J., Goh, G., Jing, L., Brooks, T., Wang, J., Li, L., Ouyang, L., Zhuang, J., Lee, J., Guo, Y., Manassra, W., Dhariwal, P., Chu, C., Jiao, Y., & Ramesh, A. (2023). Improving image generation with better captions. *OpenAI*. <https://cdn.openai.com/papers/dall-e-3.pdf>
- Bhaduri S., Van Horne, K., & Sumner, T. (2019). Designing an Informal Learning Curriculum to develop 3D modeling knowledge and improve spatial thinking skills. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, 1-8. <https://doi.org/10.1145/3290607.3299039>
- Brookhart, S. M. (2010). How to assess higher-order thinking skills in your classroom. ASCD.
- Cheng, M. (2022). The creativity of artificial intelligence in art. *Proceedings*, 81(1), Article 110. <https://doi.org/10.3390/proceedings2022081110>
- Chiu, T. K. F. (2023). The impact of Generative AI (GenAI) on practices, policies and research direction in education: A case of ChatGPT and Midjourney. *Interactive Learning Environments*, 1–17. <https://doi.org/10.1080/10494820.2023.2253861>
- Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 4, Article 100118. <https://doi.org/10.1016/j.caeai.2022.100118>
- Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research*. Sage Publications.
- Dawson, P. (2017). Assessment rubrics: towards clearer and more replicable design, research and practice. *Assess. Eval. High. Educ.* 42, 347–360. <https://doi.org/10.1080/02602938.2015.1111294>
- Dehouche, N., & Dehouche, K. (2023). What's in a text-to-image prompt? The potential of stable diffusion in visual arts education. *Heliyon*, 9(6), Article e16757. <https://doi.org/10.1016/j.heliyon.2023.e16757>

- Dobrev, D. (2005). *Formal definition of AI. International Journal "Information Theories & Applications, 12(3), 277–285.* <https://doi.org/10.48550/arXiv.1209.4838>
- Double, K., El Masri, Y., McGrane, J., & Hopfenbeck, T. (2023). Do IB students have higher critical thinking? A comparison of IB with national education programs. *Thinking Skills and Creativity, 50*, Article 101416. <https://doi.org/10.1016/j.tsc.2023.101416>
- Ellerton, P. (2022). On critical thinking and content knowledge: A critique of the assumptions of cognitive load theory. *Thinking Skills and Creativity, 43*, Article 100975. <https://doi.org/10.1016/j.tsc.2021.100975>
- Epstein, Z., Hertzmann, A., Akten, M., Farid, H., Fjeld, J., Frank, M. R., Groh, M., Herman, L., Leach, N., Mahari, R., Pentland, A. S., Russakovsky, O., Schroeder, H., & Smith, A. (2023). Art and the science of generative AI: Understanding shifts in creative work will help guide AI's impact on the media ecosystem. *Science, 380(6650), 1110–1111.* <https://doi.org/10.1126/science.adh4451>
- Esling, P., & Devis, N. (2020). *Creativity in the era of artificial intelligence* [Keynote paper]. JIM Conference. <https://doi.org/10.48550/arXiv.2008.05959>
- Facione, P. A. (2015). *Critical thinking: What it is and why it counts* (6th ed.). Insight Assessment. https://www.researchgate.net/publication/251303244_Critical_Thinking_What_It_Is_and_Why_It_Counts
- Facione, P. A., Facione, N. C., & The California Academic Press. (1994). *Holistic critical thinking scoring rubric* (Version 2.0). The Critical Thinking Community. <https://teaching.temple.edu/sites/teaching/files/resource/pdf/Holistic%20Critical%20Thinking%20Scoring%20Rubric.v2%20%5BAccessible%5D.pdf>
- Grassini, S. (2023). Shaping the future of education: Exploring the potential and consequences of AI and ChatGPT in educational settings. *Education Sciences, 13(7), Article 692.* <https://doi.org/10.3390/educsci13070692>
- Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., Courville, A., & Bengio, Y. (2014). Generative adversarial networks. In *Advances in Neural Information Processing Systems* (Vol. 3). Communications of the ACM, 63(11), 139–144. <https://doi.org/10.1145/3422622>
- Han, A., & Cai, Z. (2023). Design implications of generative AI systems for visual storytelling for young learners. In *IDC '23: Proceedings of the 22nd Annual ACM Interaction Design and Children Conference* (pp. 470–474). <https://doi.org/10.1145/3585088.3593867>
- Huang, T.-C., Chen, M.-Y., & Lin, C.-Y. (2019). Exploring the behavioral patterns transformation of learners in different 3D modeling teaching strategies. *Computers in Human Behavior, 92*, 670–678. <https://doi.org/10.1016/j.chb.2017.08.028>
- Hutson, J., & Cotroneo, P. (2023). Generative AI tools in art education: Exploring prompt engineering and iterative processes for enhanced creativity. *Metaverse: Exploring Arts, Humanities, and Sciences, 4(1) Article 2164.* <https://doi.org/10.54517/m.v4i1.2164>

- Hutson, J., & Harper-Nichols, M. (2023). Generative AI and algorithmic art: Disrupting the framing of meaning and rethinking the subject-object dilemma. *Global Journal of Computer Science and Technology*, 23(D1), 55–61. <https://doi.org/10.34257/GJCSTDVOL23IS1PG55>
- Hutson, J., & Lang, M. (2023). Content creation or interpolation: AI generative digital art in the classroom. *Metaverse: Exploring Arts, Humanities, and Sciences*, 4(1), Article 2158. <https://doi.org/10.54517/m.v4i1.2158>
- Hutson, J., & Robertson, B. (2023). Exploring the educational potential of AI generative art in 3D design fundamentals: A case study on prompt engineering and creative workflows. *Global Journal of Human-Social Science: Arts & Humanities*, 23(A2), 1–11. <https://socialscienceresearch.org/index.php/GJHSS/article/view/103669>
- Jeon, K., Jarrett, O., & Ghim, H. (2014). Project-based learning in engineering education: Is it motivational? *International Journal of Engineering Education*, 30(2), 438–446. https://www.researchgate.net/publication/285579124_Project-Based_Learning_in_Engineering_Education_Is_it_motivational
- Kaufman, S. B. (2007). Review of *Explaining creativity: The science of human innovation*, by R. K. Sawyer. *Psychology of Aesthetics, Creativity, and the Arts*, 1(1), 47–48. <https://doi.org/10.1037/1931-3896.1.1.47>
- Kleon, A. (2012). *Steal like an artist: 10 things nobody told you about being creative*. Workman Publishing. <https://austinkleon.com/steal/>
- Kong, F. (2020). Application of artificial intelligence in modern art teaching. *International Journal of Emerging Technologies in Learning (iJET)*, 15(13), 238–251. <https://doi.org/10.3991/ijet.v15i13.15351>
- Kozbelt, A., Beghetto, R. A., & Runco, M. A. (2010). Theories of creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 20–47). Cambridge University Press. <https://doi.org/10.1017/CBO9780511763205.004>
- Ma, Y. (2023). Exploration of flipped classroom approach to enhance critical thinking skills. *Heliyon*, 9(11), Article e20895. <https://doi.org/10.1016/j.heliyon.2023.e20895>
- Maguire, M., & Delahunt, B. (2017). *Doing a thematic analysis: A practical, step-by-step guide for learning and teaching scholars*. Dundalk Institute of Technology. https://www.researchgate.net/publication/349506918_Doing_a_Thematic_Analysis_A_Practical_Step-by-Step_Guide
- Markauskaite, L., Marrone, R., Poquet, O., Knight, S., Martinez-Maldonado, R., Howard, S., Tondeur, J., De Laat, M., Buckingham Shum, S., Gašević, D., & Siemens, G. (2022). Rethinking the entwinement between artificial intelligence and human learning: What capabilities do learners need for a world with AI? *Computers and Education: Artificial Intelligence*, 3, Article 100056. <https://doi.org/10.1016/j.caeai.2022.100056>
- Martínez-Villagrasa, B., Esparza, D., Llacer, T., & Cortiñas, S. (2020). Methodology for the analysis and self-reflection of design students about their competences. In L. Buck, E. Bohemia, & H. Grierson (Eds.), *DS 104: Proceedings of the 22nd International*

- Conference on Engineering and Product Design Education (E&PDE 2020)* (pp. 1-9). VIA Design, VIA University. <https://doi.org/10.35199/EPDE.2020.63>
- Mota-Valtierra, G., Rodríguez-Reséndiz, J., & Herrera-Ruiz, G. (2019). Constructivism-based methodology for teaching artificial intelligence topics focused on sustainable development. *Sustainability*, 11(17), Article 4642. <https://doi.org/10.3390/su11174642>
- Notaro, A. (2020). State of the art: A.I. through the (artificial) artist's eye. In *Proceedings of EVA London 2020: Electronic Visualisation and the Arts* (pp. 322-328). British Computer Society. <https://doi.org/10.14236/ewic/EVA2020.58>
- Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, 2, Article 100020. <https://doi.org/10.1016/j.caeai.2021.100020>
- Ruslin, R., Mashuri, S., Sarib, M., Alhabsyi, F., & Syam, H. (2022). Semi-structured interview: A methodological reflection on the development of a qualitative research instrument in educational studies. *International Journal of Scientific & Technology Research*, 12(1), 22-29. <https://www.iosrjournals.org/iosr-jrme/papers/Vol-12%20Issue-1/Ser-5/E1201052229.pdf>
- Shi, J., Jain, R., Duan, R., & Ramani, K. (2023). Understanding generative AI in art: An interview study with artists on G-AI from an HCI perspective. *arXiv*. <https://doi.org/10.48550/arXiv.2310.13149>
- Sternberg, R. J., Kaufman, J. C., & Roberts, A. M. (2019). The relation of creativity to intelligence and wisdom. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (2nd ed., pp. 237–353). Cambridge University Press.
- Supianto. (2025). Do rubrics kill creativity? Rethinking assessment practices in college teaching. *College Teaching*, 1–3. <https://doi.org/10.1080/87567555.2025.2479144>
- Tahiru, F. (2021). AI in education: A systematic literature review. *Journal of Cases on Information Technology*, 23(1), 1–20. <https://doi.org/10.4018/JCIT.2021010101>
- Tong, H., Türel, A., Şenkal, H., Yagci Ergun, S. F., Güzelci, O. Z., & Alaçam, S. (2023). Can AI function as a new mode of sketching: A teaching experiment with freshman. *International Journal of Emerging Technologies in Learning (iJET)*, 18(18), 234–248. <https://doi.org/10.3991/ijet.v18i18.42603>
- Tsai, C.-A., Song, M.-Y. W., Lo, Y.-F., & Lo, C.-C. (2023). Design thinking with constructivist learning increases the learning motivation and wicked problem-solving capability: An empirical research in Taiwan. *Thinking Skills and Creativity*, 50, Article 101385. <https://doi.org/10.1016/j.tsc.2023.101385>
- Tunner, M., & Fauconnier, G. (1995). Conceptual integration and formal expression. *Metaphor and Symbolic Activity*, 10(3), 183–204. https://doi.org/10.1207/s15327868ms1003_3
- Williamson, K., Given, L. M., & Scifleet, P. (2018). Qualitative data analysis. In K. Williamson & G. Johanson (Eds.), *Research methods: Information, systems, and contexts* (2nd ed., pp. 453–476). Chandos Publishing. <https://doi.org/10.1016/B978-0-08-102220-7.00019-4>

Zhai, X. (2022). *ChatGPT user experience: Implications for education*. SSRN.
<https://doi.org/10.2139/ssrn.4312418>