Online Learning

OLJ • THE OFFICIAL JOURNAL OF OLC

Volume 29, Issue 3

Section I
2025 OLC Accelerate Conference Special Issue

Introduction to the Special Issue: Select Papers Presented at Recent OLC Conferences

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Each year, the September issue of the Online Learning Journal (OLJ) highlights select articles showcasing research presented at one of the past year's Online Learning Consortium (OLC) conferences, OLC Accelerate or OLC Innovate. This special issue continues this tradition by presenting seven studies that demonstrate the breadth and depth of current scholarship in online and digital learning. The selected papers address critical areas including leadership competencies, mobile-assisted language learning, student success factors, instructional design effectiveness, faculty motivation and support, and innovative pedagogical approaches using generative artificial intelligence. These studies offer valuable insights into the evolving landscape of online education and provide evidence-based practices for educators, administrators, and researchers working to enhance the quality and effectiveness of digital learning environments.

This year, however, we tried a new approach. The first 3 papers were recruited from presenters at the 2024 OLC Accelerate conference, held in Orlando, Florida in November, which has traditionally been how we identified research to showcase in the special issue. This year, we flipped our approach, and the last 4 papers were first submitted to *Online Learning* and then will be presented at this year’s 2025 OLC Accelerate conference, to be held November 7-20, 2025, in Orlando, Florida.

COLO Profiles & Competencies 2024: A National Research Project about Chief Online Learning Officers by Eric E. Fredericksen (University of Rochester), Bethany Simunich (Quality Matters), and Julie Uranis (University Professional and Continuing Education Association) presents the latest findings from an ongoing comprehensive national study of Chief Online Learning Officers (COLOs). Building on previous research from 2017 and 2018, this study gathered data from more than 500 online learning leaders during summer 2024, examining their backgrounds, experiences, and leadership roles in driving online learning initiatives. A significant contribution of this research is the introduction of the UPCEA COLO Competencies framework, which assesses the relevance of various competencies to institutional contexts alongside leaders' self-evaluations of their skills. The study provides valuable organizational context and comparative insights that illuminate the evolving role of COLOs in post-pandemic higher education, offering guidance for professional development and strategic planning in online education leadership.

Applying the TAM Framework to Inform Faculty Participation in Course Quality Reviews by Efren de la Mora Velasco, Roslyn Miller, Florence Williams, and Aimee deNoyelles (University of Central Florida) addresses the critical challenge of faculty engagement in course quality review (CQR) processes. Using the Technology Acceptance Model (TAM) as a theoretical framework, the researchers developed and administered a context-specific survey instrument to 119 eligible faculty members. Through Partial Least Squares Structural Equation Modeling (PLS-SEM), the study revealed that perceived usefulness was the strongest predictor of participation intention, followed by subjective norm, which also significantly influenced perceived usefulness. The findings provide valuable insights into the motivational and social factors that shape faculty engagement in quality assurance processes, offering practical implications for institutional strategies aimed at improving participation rates.

Utilizing Generative AI to Counter Learner Groupthink by Introducing Controversy in Collaborative Problem Based Learning Settings by Andrew Wiss (George Washington University), Mary Showstark (Yale University), Kyle Dobbeck (Montclair State University), Jennifer Pattershall-Geide (George Washington University), Elke Zschaebitz (Georgetown University), Dawn Joosten-Hagye (University of Southern California), Kirsten Potter (Tufts University), and Erin Embry (New York University) explores innovative applications of artificial intelligence in educational settings. This mixed-methods study addresses the challenge of groupthink in newly formed interprofessional student teams by introducing a generative AI-based agent into collaborative problem-based learning activities. The research demonstrates how this novel pedagogical technique can positively influence group dynamics and limit groupthink potential by providing catalysts for engaged discussion through the introduction of diverse and potentially controversial perspectives. The findings offer insights into the strategic use of AI tools to enhance collaborative learning experiences and promote critical thinking in team-based educational environments.

In **Using a Mobile Vocabulary Application to Enhance L2 Learners' Vocabulary Acquisition: Possibilities and Challenges,** Qian Xu (Purdue University), Jennifer C. Richardson (Purdue University), Zhuo Zhang (Towson University), Zui Cheng (Shenzhen University), and Fengping Guo (Southeast University) examined the effectiveness of mobile-assisted language learning (MALL) applications for English vocabulary acquisition. Using a quasi-experimental design with 70 Chinese undergraduate L2 learners, the researchers compared outcomes between students using the Shanbay Dan-Ci (SBDC) mobile application and those using traditional wordlists. Through a mixed methods approach, the study revealed that while MALL users showed performance advantages, the differences were not statistically significant. However, qualitative findings highlighted the impact of key learning features such as personalized learning, rich content, and collaboration opportunities. The research provides important insights into the challenges of mobile learning environments and offers directions for future research in technology-enhanced language education.

Competing hypotheses about online versus face-to-face course outcomes: Analysis leveraging the unique circumstances of the COVID-19 pandemic by Claire Wladis (Borough of Manhattan Community College and the Graduate Center at CUNY), Alyse C. Hachey (The University of Texas at El Paso), Catherine A. Manly (Fairleigh Dickinson University), and Katherine M. Conway (Borough of Manhattan Community College at CUNY) capitalizes on the unprecedented natural experiment created by the COVID-19 pandemic. Using a comprehensive dataset from the City University of New York (CUNY) system, the researchers employed a quasi-experimental fixed effects approach to examine course completion rates across different delivery modalities. The findings challenge common assumptions about online learning effectiveness, revealing that students' original choice of medium was more predictive of success than the actual delivery format. The study also uncovered important differences in course selection patterns, with students more likely to choose elective courses online and major requirements in-person, providing nuanced insights into student behavior and course completion factors.

In **Insights at the Nexus of Instructional Design and Student Success: An Institutional Analysis Using LMS Accessibility Metrics,** Jeff Freels (Southwestern Michigan College) and Rajagopal Sankaranarayanan (The University of Texas at Austin) investigated the relationship between Learning Management System (LMS) course design and student outcomes. Through multiple linear regression analysis of 925 course sections, the researchers examined interactions between course-level failure and withdrawal rates (DFW), enrollment, student satisfaction, and instructor-embedded content within LMS course sites. The study demonstrates that optimal LMS course design supports improved student success rates, with findings contextualized within the Community of Inquiry (CoI) Framework. The research provides evidence that certain types of instructor-embedded content can serve as measurable proxies for teaching presence, offering actionable insights for designing student-centered digital learning environments.

In **From Burnout to Belonging: A Sequential Mixed Methods Study of Comprehensive Support Structures for Online Adjunct Faculty,** Rheanna Reed, Jennifer Carriere, Laura Pipoly, and Anthony M. Bennett (University of Phoenix, Center for Educational and Instructional Technology Research) present findings that challenge conventional wisdom about online adjunct faculty experiences. Phase 1 of this sequential explanatory mixed methods study (n=101) revealed outcomes that contradicted established literature patterns, including high personal accomplishment scores, low emotional exhaustion, minimal depersonalization, and reduced organizational cynicism. Grounded in Communities of Practice theory, Phase 2 employed case study methodology with participants across all institutional colleges to understand the mechanisms behind these positive results. The research identified four key themes explaining the outcomes: strategic leadership implementation, systematic support infrastructure, structural policy commitment, and genuine community building. The study provides a replicable framework for institutions seeking to improve online adjunct faculty experiences through systematic organizational commitment.

These seven studies collectively demonstrate the field's commitment to evidence-based practice and continuous improvement in digital learning environments. From leadership development and mobile learning technologies to AI-enhanced pedagogy and faculty support systems, this collection addresses fundamental challenges facing online education today. The research presented here offers valuable contributions to our understanding of effective practices in online learning and provides actionable insights for practitioners working to enhance educational outcomes in digital environments. We invite you to consider OLC conferences and *Online Learning* as outlets for your original future research.

We extend our gratitude to the OLC community, conference organizers, and the contributors who present and publish in the field who make these valuable research exchanges possible. We also thank the peer reviewers whose expertise ensures the quality and rigor of the scholarship presented in this journal. To our readers, we encourage you to engage with these findings and consider how they might inform your own practice and research in the evolving landscape of online and digital learning.

COLO Profiles & Competencies 2024
A National Research Project about Chief Online Learning Officers

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Abstract

In the wake of the COVID-19 pandemic, online learning has become a central component of higher education in the United States, elevating the importance of the Chief Online Learning Officer (COLO) role in implementation, leadership, and strategic development. This national study builds on previous COLO research conducted in 2017 and 2018, as well as insights from the Changing Landscape of Online Education (CHLOE) reports. During the summer of 2024, data was gathered from more than 500 online learning leaders, exploring their backgrounds and experiences as they drive online learning initiatives at their institutions. The study provides organizational context and comparative insights. A notable addition to this research is the introduction of the University Professional and Continuing Education Association COLO Competency and Attribute Statements for Professional, Continuing, and Online Practitioners (UPCEA COLO Competencies), which assess the relevance of various competencies to their colleges and universities, alongside a self-evaluation of their skills. This comprehensive analysis aims to illuminate the evolving role of COLOs and inform best practices in online education leadership.

Keywords: online learning, leadership, higher education, UPCEA COLO Competencies

Fredericksen, E. E., Simunich, B., & Uranis, J. (2025). COLO profiles & competencies 2024: A national research project about chief online learning officers. *Online Learning, 29*(3), 1-38. https://doi.org.10.24059/olj.v29i3.5017

Introduction

With online learning in U.S. higher education now achieving mainstream status, there is great value in examining the leadership for this essential academic activity and the individuals who guide those programs and initiatives. This can be beneficial to the individual COLOs as they consider their own professional development and career planning. This can also help institutions and their executives with organizational planning and strategies for this critical area.

We believe that it is also very important to do this research now. We are only a few years past the COVID-19 global pandemic, an unprecedented catalyst for the advancement of online education and the realization of the essential role it can play in academic offerings. In addition, higher education is facing enrollment challenges, and online education has the potential to enhance access and provide an attractive option for students. Lastly, institutional leaders are facing a unique technological innovation with the rapid development of AI. They are trying to leverage the opportunities it presents while mitigating the challenges for all instruction, both traditional, in-person, as well as online.

The goals of this study were:

- Revisit and build on the national studies of online learning leadership.
- Collect institutional data for context.
- Gather information about the position and professional experience of the leader.
- Gain the COLO perspective on the importance of the UPCEA COLO Competencies at their institution and their own self-assessment of those skills and aptitudes.
- Investigate the potential relationships among these factors and dimensions.

Research Questions

Our research questions are directly connected to the goals of this study:

1. What is the current state of online education at responding institutions?
2. What are the background skills and experiences of current leaders of online learning?
3. What is the importance of the COLO Competencies at their institution, and what is their self-assessment with these competencies?

These research questions guided the study and informed our methodology and survey instrument. For example, to explore the current state of online education at responding institutions, it is essential to ask about the scope of online learning associated with the position, reporting relationships, and organizational structure. Regarding background and experiences, we inquired about a variety of skills, potential roles as a faculty member or student, and prior, current, and future titles. To better understand the significance of the COLO Competencies, we asked about their importance at the institution and the COLO's self-assessment regarding these competencies.

Literature Review

Prior studies highlighted organizational theories in higher education that are relevant to understanding how colleges and universities work. Rather than repeat a discussion of the concepts of *Organized Anarchy* (Cohen & March, 1986), *Loosely Coupled Systems* (Weick, 1976), and *Professional Bureaucracy* (Mintzberg, 1979), we encourage readers to revisit the *OLJ* article “A national study of online learning leaders in US higher education” (Fredericksen, 2017). Beyond those core organizational and cultural concepts, the research literature about leadership in higher education offers additional insight for COLOs.

A review of the literature highlights key issues and strategies of successful higher education leaders. In the 2015 article, “Qualities of effective leadership in higher education,” Black emphasizes some of the organizational concerns and unique aspects of the higher education sector noted above. Not only is this context relevant and important, but it also helps us reflect on some leadership models that are more appropriate in higher education. Various leadership models were discussed, with hierarchical and individualistic models being discouraged and others, such as collegial, collaborative, and transformative, being emphasized as more likely to be effective in higher education institutions (Black, 2015). The author goes on to highlight leadership competency frameworks as being helpful guides but urges caution. There can be a significant difference between knowing what one needs to do and how one does it.

The American Council on Education, through its Center for Policy Research and Strategy, published *Shared Leadership in Higher Education* by Kezar and Holcombe in 2017. The authors advocated that new forms of leadership are needed in higher education, given the notable challenges colleges and universities are facing. They present a model of shared leadership—not to be confused with shared governance. “Shared leadership, by contrast, is more flexible and identifies various individuals on a campus with relevant experience” (Kezar & Holcombe, 2017). The idea of the requirement for new forms of collaborative leadership was underscored as a way to help institutions be nimble and respond to these challenges. The role of online learning and how it may strategically support the institution is an excellent example of one of these areas that demands change.

Laker (2023) wrote about the approach of multidirectional leadership. Rather than a hierarchical, top-down process, higher education leaders need to function in a matrix or web-style environment, connecting to various groups and promoting shared objectives. Leaders need to look in all directions—up, down, and sideways—and recognize that knowledge and expertise reside at different levels and areas of the institution. We believe this makes sense as higher education does not typically work in a militaristic command and control structure. There is more of an emphasis on engagement and consensus-building when it comes to decision-making. Laker suggests that this collaborative leadership style is more resilient and innovative, and even argues that the inherent feedback loops can lead to faster decision-making.

The Academic Leadership Group (2023) provides higher education leaders with advice about effective leadership styles. They wrote about important aspects of higher education institutions that leaders need to navigate. A few worth noting include shared governance, academic freedom, institutional tradition, and creating a positive and collaborative culture. With that context, they suggest that certain leadership styles are more effective. These include transformative leadership (where leaders inspire followers by communicating a compelling vision of the future and empower them to embrace innovation and change), servant leadership (where serving the needs of others is prioritized above the self-interest of the leader and trust and respect are emphasized), and spiritual leadership (an approach that integrates values and ethics and a sense of higher purpose). In contrast, certain leadership styles are acknowledged to be less effective. These include transactional leadership (where everything is based on exchanges between leaders and followers) and passive leadership (where leaders take a hands-off approach and provide little direction and guidance to followers) (Academic Leadership Group, 2023).

Another relevant article by Ufomata (2024) promotes the key traits of successful higher education leaders. While twelve characteristics are presented, a few that we would highlight for COLOs include: successful leaders recognize that they cannot do their jobs alone, they acknowledge the complex environment in which they serve, they embrace the mission and values of their university, they understand that there are different centers of power and they need to guide a coalition, the importance of trust in the community, and effective leaders understand the value of a process to make decisions (Ufomata, 2024). An article by Joubert (2020) complements and reinforces the essential qualities of higher education leaders. The eight key skills are financial acumen, collaboration, building new leaders, communication, strategic planning, change management, commitment to diversity, and intellectual curiosity.

One last concept worth noting is institutional isomorphism. The idea refers to the phenomenon of one organization going through a similar transformation as another organization in that same environment (Sakib, 2020). This tendency to mimic other institutions is common in higher education. A frequent activity in colleges and universities that are faced with decisions is to benchmark their peers. We would suggest that the development, proliferation, and positioning of COLOs across the vast majority of colleges and universities in the U.S. aligns with this concept. We believe senior institutional leaders review and consume research articles (such as this one) as a means to inform their local approaches and validate them with the broader higher education community.

UPCEA Competency and Attribute Statements

UPCEA, the professional association for those in professional, continuing, and online (PCO) postsecondary education, developed a competency set for leaders at two- and four-year institutions in the U.S. The competency and attribute statements serve as the foundation for professional development opportunities and other activities within the association.

This was no small task, as the portfolios of professional and online education units are unique to each institution. As such, there are many different roles and organizational attributes for leaders in the field. For this reason, UPCEA identified seventy-five postsecondary associations and other competency sources relevant to specific job tasks and roles found in many professional and online education units. Of the 75 sources reviewed, 19 sources had competency sets available via their organization's website.

After identifying over five hundred multidimensional items from these competency sets, UPCEA team members engaged in a thematic analysis. Eight initial themes emerged throughout the competency sets:

- Critical thinking and decision-making
- Human resource management/higher education leadership
- Information and digital technology
- Integrity and ethics
- Program planning
- Supporting and advocating for constituencies
- Marketing, research, and evaluation
- Partnerships and relationship-building

These themes were validated by the UPCEA network vice-chairs for professional development and the then-titled NCOE professional development subcommittee (later to be known as the Council for Chief Online Learning Officers or C-COLO), various UPCEA members, as well as UPCEA staff members with knowledge of PCO operations.

Once the thematic analysis was completed and validated, the UPCEA team began the content analysis of the 550 items and coded them based on those themes. During the item coding process, three more themes emerged:

- Entrepreneurship/business orientation
- Goal-setting and results-driven
- Administrative tasks.

This yielded eleven themes with over 60 sub-themes and topics. Once coding was complete, the UPCEA team summarized and constructed competency statements. During this process, specific topics were identified as subsets of each statement.

The competency and attribution statements were grouped under headings that aligned with UPCEA’s Hallmarks of Excellence in Online Leadership and the Hallmarks of Excellence in Professional and Continuing Education to reflect an alignment between the enterprise-focused and aspirational Hallmarks and the individually focused, specific competency statements. This arrangement of statements does not suggest magnitude or priority but rather an attempt to show the alignment between PCO enterprises and the individuals charged with PCO initiatives.

The UPCEA competency areas and statements were reviewed and validated by various groups within UPCEA (network vice-chairs for professional development, NCOE/C-COLO professional development subcommittee, NCOE/C-COLO advisory board members, select UPCEA members, UPCEA board members, and UPCEA staff members). Four additional sources were suggested by UPCEA’s review teams and included during the final competency area and statement reconciliation process. This resulted in 23 sources included in the competency analysis.

The competency areas and statements were last reviewed by the 2022-2023 C-COLO leadership team, composed of Chief Online Learning Officers at leading U.S. postsecondary institutions.

Methods

Data was collected during the summer of 2024. The study reached out to 3,648 individuals, and 521 of them responded to this web-based survey, resulting in a 14% response rate. The survey consisted of 25 multiple-choice questions that used a Likert-type scale and six open-ended questions.

The first section of the survey instrument collected information about the context and current state of online education at the institution. The questions included:

What is the basic Carnegie classification of your institution?
What is your institutional sector?
How do you and your institution define the scope of online learning for your position specifically, what modalities of online learning are within your responsibility?
How many years ago did your institution create a leadership position for online learning?
Whom do you report to?
Is your position a member of the following? President's Cabinet / Council, Provost's Cabinet / Council, Dean's Cabinet / Council, Online Learning Committee
Has your institution used your online learning efforts as a catalyst for organizational changes?
How would you describe the organizational approach to online learning administration and management at your institution?
What groups/functions at your institution have been unified/centralized within your organization as a result of institutional efforts with online initiatives?

The second section of the survey instrument collected information about the background, experience, and skills of the online learning leader. The questions included:

What is your current title?
Were you promoted from within the institution or externally recruited and hired?
What was the title of the position you held prior to your current role as Chief Online Learning Officer?
What do you envision as your next role or position?
How many years have you held this position of leadership for online learning?
How many years have you served at your current institution?
How many years of experience do you have in higher education?
In addition to your leadership role for online learning, do you also hold a faculty appointment?
What is the highest degree have you received?
Which of the following are field(s) in which you earned a degree?
Have you been an online student in a credit-bearing course?
How many years of traditional in-person classroom teaching experience do you have?
How many years of online teaching experience do you have?
How many years of management/leadership experience do you have?
How many years of instructional design/curriculum development experience do you have?

How many years of educational research experience do you have?
How many years of IT (Information Technology) experience do you have?

The third section of the survey instrument collected information about the importance of the COLO Competencies at their institution and their self-assessment relative to those competencies. There are 25 individual items across the following eight categories:

Entrepreneurship, Partnerships and Relationship-Building
Resource Management
Supporting and Advocating for Faculty and Students
Program Planning
Marketing, Research, & Evaluation
Information and Digital Technology
Critical Thinking and Decision Making
Integrity, Ethics, and Professionalism

The fourth and final section of the survey instrument collected information about professional development and networking needs, activities, and challenges.

Which of the following organizations or associations do you or your institution belong to?
How do you stay informed about the state of online learning? (peers, articles, events, research, technologies, vendors, etc.)
Thinking about your own professional development needs, what are the top two topics that you feel would most help you in your current online leadership position?
What is your biggest challenge or barrier with moving online learning initiatives forward at your institution?

Results

The presentation of the results is organized and aligned with the goals and research questions of the study. As noted earlier, this included collecting institutional data for context, gathering information about the professional experience of the leader, and responses regarding the COLO Competencies.

Institutional Context

The initial question in this section captured which sector was associated with the COLO's institution. The results show a good representation of responses across these three sectors. It also enabled deeper analysis, which uncovered potential differences in responses associated with these sectors.

Table 1

Institutional Sector

What is your institutional sector?	%
Public 2-year	26%
Public 4-year	43%
Private 4-year	30%
Private for-Profit	1%

A foundational question for this study related to how institutions defined the scope of online learning for this leadership position. Basically, where are the boundaries for the responsibilities of the COLO for the academic offerings of the institution? Consistent with prior studies, the responses defy perceptions about a narrow association with distance education. The majority of responses indicated that the responsibilities of the COLO included web-based learning activities and resources integrated into face-to-face courses at the institution.

Table 2

Scope for Online Learning (check all that apply)

How do you and your institution define the scope of online learning for your position?	%
Fully online courses and programs	90%
Hybrid/blended online courses and programs	81%
Web-based learning activities and resources integrated into face-to-face courses	55%
Other	9%

The study was also interested in the reporting relationship for online learning leaders. More than two-thirds of the respondents stated that they reported to the Provost/Chief Academic Officer or Other Senior Academic Leader of the institution. Consistent with prior studies, it should be noted that only 2% of the leaders reported to the CIO. Once again, this might validate the view that online learning is not an IT function, even if it is reliant on a robust IT platform.

Table 3

Reporting Relationship

Whom do you report to?	%
President	6%
Provost (Chief Academic Officer)	41%
Other Senior Academic Leader in the Office of the Provost/Academic Affairs	27%
Vice President/Senior Vice President (Outside of Academic Affairs)	7%
CIO (Chief Information Officer)	2%
Dean of a School	9%
Other	7%

In addition to reporting relationships, the study inquired about membership in organizational committees. These types of structures are common to the operations and functions of higher education institutions. The role and visibility of the COLO might also suggest the potential influence of the position at the institution. The results highlight this with over three-fourths of COLOs serving on their Online Learning Committee, about half serving in the Provost's Cabinet, and even one out of five in the President's Cabinet. In hindsight, the authors acknowledge that a "No" response might also include that the committee does not exist at their institution. Adding that as another option might have been more informative.

Table 4

Organizational Committees

Is your position a member of the following?	Yes	No
President's Cabinet	19%	81%
Provost's Cabinet	49%	51%
Dean's Cabinet	42%	58%
Online Learning Committee	77%	23%

Table 5 captures an important institutional phenomenon: whether COLOs used their online learning efforts as a catalyst for organizational changes. Approximately 60% of COLOs reported they did, which is a lower percentage than seen in previous studies. Analyzing this item by institutional sector did not suggest statistically significant differences.

Table 5

Catalyst for Organizational Change

Has your institution used your online learning efforts as a catalyst for organizational changes?	%
Yes	61%
No	39%

We also asked COLOs about the general institutional approach to online learning at their institution—basically a centralization or decentralization question. The responses approximated a normal distribution curve, with an even balance as the most cited answer. Analyzing this item by institutional sector revealed that private four-year institutions are slightly more centralized than public four-year institutions.

Table 6

Organizational Approach

How would you describe the organizational approach to online learning at your institution?	%
Completely Centralized	10%
Most functions are centralized	28%
An even balance of centralization and decentralization	31%
Most functions are decentralized	25%
Completely Decentralized	7%

The last item the study explored was associated with organizational change. If this happened at their institution, the study asked what groups had been unified with the COLO. Certain units were noted more frequently than others. More than half of the respondents identified Instructional Design, Learning Management Systems, Online Learning Policy Development, Academic/Educational Technology, and Faculty Development and Training as being unified under their leadership. This is consistent with prior studies, with the exception that Course Design and Multimedia Development were only noted by 43% of COLOs in 2024. Breaking this down by the institutional sector revealed one very slight difference—only 49% of COLOs at public 4-year schools had responsibility for Faculty Development.

Table 7

What Groups Were Unified?

What groups at your institution have been unified within your organization?	%
Instructional Design	74%
Learning Management Systems	68%
Online Learning Policy Development	60%
Academic/Educational Technology	56%
Faculty Development and Training	52%
Course Design and Multimedia Development	43%
Center for Teaching and Learning	36%
Faculty IT Support	34%
Library Support for Faculty	21%
Marketing	21%
Student Services	20%
Advising	14%
Not applicable—there have been no changes to our organization	8%
Educational Research	7%

The Personal Background, Experience, and Skills of COLOs

To start this section, we asked respondents whether they were promoted from within the institution or externally recruited. Approximately 60% of COLOs indicated that they were promoted from within their institution. This result was consistent across institutional sectors.

Table 8

Internal or External

Were you promoted from within the institution or externally recruited and hired?	%
Promoted from within the same institution	59%
Externally recruited and hired	41%

The next area of inquiry related to COLO titles was solicited as open-ended questions that were coded into several title categories. The first question asked the COLO about their current title, and the top response was “Director,” and the second response was “Associate/Assistant Vice President/Provost.”

Breaking this down by institutional sector revealed some modest differences. Public and private four-year institutions cited “Associate/Assistant Vice President/Provost” as the number two response, more than their public 2-year counterparts, who noted “Dean” as their second choice.

Table 9

Current Title

What is your current title?	%
Director	30%
Associate/Assistant Vice President/Provost	16%
Dean	12%
Vice President/Provost	11%
Senior/Executive Director	10%
Coordinator	5%
Other	5%
Associate/Assistant Dean	4%
Associate/Assistant Director	3%
COLO	3%
Faculty	2%
Manager	1%
President/Provost	1%

COLOs were then asked about their previous role. “Director” was the title most COLOs referenced for their position before their current role, and a faculty title was the second most cited response.

Breaking this down by the institutional sector again yielded some insightful differences. Private 4-year institutions cited Associate/Assistant Vice President/Provost as their number two response, more than their public four-year and two-year counterparts, who noted a faculty title as their second choice.

Table 10

Prior Title

What was the title of the position you held prior to your current role as Chief Online Learning Officer?	%
Director	26%
Faculty	14%
Instructional Design	10%
Associate/Assistant Vice President/Provost	9%
Dean	9%
Associate/Assistant Dean	6%
Associate/Assistant Director	6%
Senior/Executive Director	6%
Other	5%
Coordinator	4%
Manager	3%
IT	3%
Vice President/Provost	2%
COLO	1%
President/Provost	1%

The third open-ended question in this area asked COLOs about their next role or position. “Vice President/Provost” was most referenced by COLOs as the title of the position they held before their current role. The second most noted role by COLOs, perhaps initially surprising, was “Retirement.” The third choice, “Dean,” was followed by the fourth, “Associate/Assistant Vice President/Provost.” We want to highlight that the fifth response was coded as “happy.” The responses aligned to this choice spoke about their contentment and happiness with their current position and a desire to remain. The tenth response, “a new institution,” should also be noted.

Institutional presidents and provosts should recognize that the retirement (14%) and new institution (4%) replies may mean that almost one out of five COLOs will soon be leaving their current position, and institutions would do well to consider retention, recruitment, or internal development and succession strategies.

Breaking this down by the institutional sector yielded some differences. Private four-year institutions cited “happy” as their number two response, more than their public four-year and two-year counterparts, who noted “retirement” as their second choice.

Table 11

Next Position

What do you envision as your next role or position?	%
Vice President/Provost	17%
Retirement	14%
Dean	14%
Associate/Assistant Vice President/Provost	11%
Happy	10%
President/Provost	9%
Director	8%
COLO	6%
Other	5%
New Institution	4%
Senior/Executive Director	4%
Faculty	3%
Associate/Assistant Dean	2%
IT	1%

The study captured the length of service in higher education. More than half of COLOs have worked in higher education for at least 16 years, and 40% have worked in higher education for more than 20 years.

Table 12

Time in Higher Education

How many years of experience do you have in higher education?	%
Less than 1	13%
1–5	11%
6–10	9%
11–15	11%
16–20	15%
20+	40%

Given the importance of relatable experience and the value of peer relationships, the study asked whether the COLO also held a faculty appointment. More than 40% of COLOs said yes (16% tenure or tenure track and 25% non-tenure track), and 59% said no. We investigated this item by institutional sector, and some differences were statistically significant. Private four-year COLOs were much more likely (51%) to hold a faculty appointment than their public four-year (42%) and public two-year (19%) peers. Mintzberg (1979) emphasized the importance of this issue: "Full-time administrators who wish to have any power at all in these structures must be certified members of the profession, and preferably be elected by the professional operators or at least appointed with their blessing." This breakdown by institutional sector was consistent with prior studies. We should note that we did not ask if the COLO held a faculty appointment prior to becoming COLO.

Table 13

Faculty Appointment

In addition to your leadership role for online learning, do you also hold a faculty appointment?	%
Yes—Tenure or tenure track professor	16%
Yes—Non-tenure track professor	25%
No	59%

We also asked about the academic credentials of the COLO. Most (56%) COLOs have earned a doctoral degree, with 35% with PhDs and 21% with EdDs. This result was consistent with prior studies.

Table 14

Academic Credentials

What is the highest degree you have received?	%
PhD	35%
EdD	21%
Other	10%
MBA	9%
MA/MS	3%
MPA	1%
BA/BS	1%
JD	1%
MD	0%

The question about academic credentials was followed by a query about the fields of those degrees. While this was a "check all that apply" question, by far, the most cited discipline was education, with 60% of COLOs. This result was consistent with prior studies.

Table 15

Academic Disciplines

Which of the following are field(s) in which you earned a degree? (check all that apply)	%
Education	60%
Social Sciences	23%
Humanities	22%
Business	19%
Other	17%
Computer Science/IT	12%
Natural Science	5%

Healthcare	4%
Engineering	3%

The authors have long believed that direct, first-hand experience as an online student can be very valuable. The vast majority (79%) of COLOs have been online students, with one out of three earning a complete online degree. When analyzed by the institutional sector, we did see that public two-year COLOs were slightly more likely (85%) to have experience as an online student as compared to their four-year counterparts (76%).

Table 16

Online Student

Have you been an online student? (credit-bearing)	%
Yes—I have taken one online course as a student	14%
Yes—I have taken multiple courses as a student	33%
Yes—I have earned a completely online degree program as a student	32%
No	21%

In prior studies, we found that COLOs often have a rich blend of a variety of professional experiences. We believe this is very valuable in their ability to collaborate and work with various constituent groups across their campuses, so we investigated these areas again. This also aligns with the work of Nworie (2012), who acknowledged the differences in leadership in the field of online distance education.

The first area centered on management and leadership experience. Responses showed that 65% of COLOs have eleven or more years of management and leadership experience (see Table 17, below).

Table 17

Leadership Experience

How many years of management/leadership experience do you have?	%
I do not have any	1%
Less than 1	1%
1–5	14%

6–10	21%
11–15	23%
16–20	16%
20+	26%

The second area inquired about experience with instructional design and curriculum development. The response was that most respondents had more than 11 or more years of instructional design and curriculum development experience.

Table 18

Instructional Design Experience

How many years of Instructional Design / Curriculum Development experience do you have?	%
I do not have any	7%
Less than 1	2%
1–5	14%
6–10	24%
11–15	19%
16–20	18%
20+	17%

The third area concerns online teaching. The response was that 70% of COLOs have taught online for at least six years.

Table 19

Online Teaching Experience

How many years of online teaching experience do you have?	%
I do not have any	6%
Less than 1	5%
1–5	19%

6–10	27%
11–15	17%
16–20	15%
20+	11%

The fourth area was traditional face-to-face classroom teaching. Table 20 below shows that two out of three COLOs have six or more years of traditional face-to-face teaching experience.

Table 20

Face-to-face Teaching Experience

How many years of traditional face-to-face classroom teaching experience do you have?	%
I do not have any	8%
Less than 1	5%
1–5	19%
6–10	21%
11–15	13%
16–20	11%
20+	22%

The fifth area asked about educational research experience. The response was that most leaders had six or more years of educational research experience.

Table 21

Educational Research Experience

How many years of Educational Research experience do you have?	%
I do not have any	15%
Less than 1	5%
1–5	23%

6–10	22%
11–15	14%
16–20	8%
20+	12%

The final question in this section asked about Information Technology experience. It should be noted that 35% of the leaders did not have any IT experience, and only 30% had more than 10 years. This result is consistent with prior studies and might again indicate that online learning is not an IT function, even if it clearly relies on our IT colleagues for a robust and stable platform.

Table 22

IT Experience

How many years of IT (Information Technology) experience do you have?	%
I do not have any	35%
Less than 1	4%
1–5	16%
6–10	14%
11–15	10%
16–20	7%
20+	13%

COLO Competencies

The survey included questions focused on the competencies necessary to do the work of COLOs. The researchers sought to establish the importance of specific competencies and attributes to the role of COLO, potentially further validating UPCEA's competency and attribute statements. Additionally, the researchers wanted to determine the degree to which COLOs believed they possessed these competencies and attributes. As this study also addresses the professional development of COLOs, any discussion of self-identified professional development must begin with a needs self-assessment.

For the purposes of this research study, the competency and attributes items were clustered into eleven areas, arranged by their importance and the level of skill respondents possess.

- Guiding the Online Enterprise (four survey items)

- Relationships (two items)
- Integrity and Professionalism (two items)
- Governance and Compliance (two items)
- Organizational and Operational Considerations (two items)
- Inclusive Environments (two items)
- Curriculum and Faculty/SMEs (two items)
- Financial Models and Entrepreneurship (two items)
- Marshalling Resources (three items)
- Attracting Learners (three items)
- Facilities (one item)

Guiding the Online Enterprise

With regard to the competencies and attributes focused on the leadership of the online enterprise, respondents indicated these items were both very important, and they possessed these competencies and attributes.

Table 23

Guiding the Online Enterprise—Four Items

Thinks strategically with flexibility and creativity (n = 368, 359)			
Very Important	86%	Very Skilled	83%
Somewhat Important	11%	Somewhat Skilled	16%
Not Important	3%	Needs Improvement	1%
Engages in evidence-based decision-making, which often requires collaboration and consensus building (n = 367, 359)			
Very Important	84%	Very Skilled	76%
Somewhat Important	14%	Somewhat Skilled	23%
Not Important	2%	Needs Improvement	1%
Engages in analytical & critical thinking for the purposes of evaluation, reflection, and analysis (n = 368, 359)			
Very Important	85%	Very Skilled	81%
Somewhat Important	13%	Somewhat Skilled	19%
Not Important	2%	Needs Improvement	0%

Models effective leadership and demonstrates a willingness to provide direction and communicate a vision for your enterprise (n = 358, 347)			
Very Important	84%	Very Skilled	78%
Somewhat Important	14%	Somewhat Skilled	20%
Not Important	2%	Needs Improvement	2%

Relationships

Similarly, respondents felt that building relationships, both within the online enterprise team and outside the team with internal and external institutional constituencies, was important to the role of a COLO. Most respondents felt they were very skilled in both efforts, yet for the item focused on building internal and external constituency relationships as well as representing their perspectives to these constituencies, around a third of the respondents indicated they were only "somewhat skilled."

Table 24

Relationships—Two Items

Motivates and develops team members for the purposes of creating trust as well as building and retaining a dynamic team of professionals (n = 371, 362)			
Very Important	83%	Very Skilled	76%
Somewhat Important	14%	Somewhat Skilled	23%
Not Important	3%	Needs Improvement	1%
Builds internal and external relationships that support your initiatives and the institution, representing your perspectives to internal and external constituencies. (n = 374, 360)			
Very Important	80%	Very Skilled	65%
Somewhat Important	16%	Somewhat Skilled	32%
Not Important	4%	Needs Improvement	3%

Integrity and Professionalism

Once again, we see that respondents felt these items were of greatest importance to COLOs, and likewise, respondents felt they possessed these competencies and attributes.

Table 25

Integrity and Professionalism—Two Items

Adheres to professional and personal standards and/or demonstrates conduct reflective of the ethics and theories in your enterprise and higher education in general (n = 359, 346)			
Very Important	84%	Very Skilled	88%
Somewhat Important	16%	Somewhat Skilled	12%
Not Important	0%	Needs Improvement	0%
Demonstrates broadly accepted personal and professional attributes, often described as soft skills, found in good team members regardless of position or role in your enterprise (n = 357, 346)			
Very Important	82%	Very Skilled	81%
Somewhat Important	16%	Somewhat Skilled	19%
Not Important	2%	Needs Improvement	0%

Governance and Compliance

Again, respondents indicated the two items focused on governance and compliance were very important to the role of COLOs. Interestingly, for the item, "understands the laws, regulations, policies, governance, and institutional contexts relevant to your position and experience," respondents were less sure of their skills in this area, with nearly half indicating they were only "somewhat skilled." Given the fact that this survey was in the field during a period when the Biden Administration's Education Department was in the midst of negotiated rulemaking, the anticipated changes, when paired with the possibility of change in the administration in January 2025, could have fed some of the lack of confidence the 53% "somewhat skilled"/"needs improvement" responses indicate.

Table 26

Governance and Compliance—Two Items

Understands the laws, regulations, policies, governance, and institutional contexts relevant to your position and experience (n = 373, 364)			
Very Important	78%	Very Skilled	48%
Somewhat Important	20%	Somewhat Skilled	46%

Not Important	2%	Needs Improvement	6%
Engages in inductive and deductive reasoning for the purposes of forming rules, policies, or conclusions or apply existing rules or policies to arrive at conclusions (n = 367, 356)			
Very Important	72%	Very Skilled	72%
Somewhat Important	24%	Somewhat Skilled	27%
Not Important	4%	Needs Improvement	1%

Organizational and Operational Considerations

Again, we see that respondents felt the two competencies and attributes aligned with their organization and operations were important to COLOs, and most indicated they were very skilled in these areas.

Table 27

Organizational and Operational Considerations—Two Items

Manages overall operational resources for the purpose of achieving optimal organizational performance (n = 373, 362)			
Very Important	77%	Very Skilled	63%
Somewhat Important	18%	Somewhat Skilled	36%
Not Important	5%	Needs Improvement	1%
Engages in active learning to stay current with trends, stakeholder needs, and operational improvements (n = 356, 348)			
Very Important	78%	Very Skilled	75%
Somewhat Important	19%	Somewhat Skilled	23%
Not Important	3%	Needs Improvement	2%

Inclusive Environments

With regard to navigating complex and sensitive situations, respondents felt both were important and that they possessed these skills. While the importance of the second item, focused on their ability to facilitate diverse, inclusive, and culturally sensitive working and learning environments, was of similar importance, a large percentage of respondents questioned their own skill level by responding “somewhat skilled” and “need improvement” (42%).

Table 28

Inclusive Environments—Two items

Navigates and/or resolves complex and sensitive situations (n = 368, 358)			
Very Important	79%	Very Skilled	71%
Somewhat Important	19%	Somewhat Skilled	27%
Not Important	2%	Needs Improvement	2%
Possesses social perceptiveness and orientation to facilitate diverse, inclusive, and culturally sensitive working and learning environments to serve global audiences (n = 357, 344)			
Very Important	73%	Very Skilled	58%
Somewhat Important	24%	Somewhat Skilled	39%
Not Important	3%	Needs Improvement	3%

Curriculum and Faculty/Subject Matter Experts (SMEs)

Most respondents recognized the importance of curriculum design and theories in their work as chief online learning officers. While most (69%) felt this knowledge was important to their roles, they were more confident in their abilities, with 73% indicating they were very skilled in these areas. Recruiting, retaining, and developing subject matter experts had more modest results in that just over half of the respondents indicated this was important to their role, and less than half (42%) felt they were very skilled in this area. This notable deviation from previous items might be indicative of the varying degrees to which COLOs have the opportunity to select SMEs and provide those experts with professional development. As noted in UPCEA’s 2024 *Benchmarking Online Enterprises Survey (BOnES)*, 53% of respondents indicated their online unit was academically decentralized, “defined as faculty, programs, and courses emanating from multiple academic departments or units for online programs” (Uranis, Ives, Etter, & Sullberg, 2024).

Table 29

Curriculum and Faculty/Subject Matter Experts (SMEs)—Two Items

Understands curriculum design, sourcing, and revisions inclusive of learning strategies and theories for the purposes of delivering instruction and supporting programmatic outcomes and objectives for your programs (n = 370, 362)			

Very Important	69%	Very Skilled	73%
Somewhat Important	27%	Somewhat Skilled	24%
Not Important	4%	Needs Improvement	3%
Marshal necessary support to identify, recruit, retain, and develop subject matter experts/faculty for your programs (n = 370, 356)			
Very Important	50%	Very Skilled	42%
Somewhat Important	27%	Somewhat Skilled	49%
Not Important	23%	Needs Improvement	9%

Financial Models & Entrepreneurship

Like recruiting and retaining SMEs, respondents may have varying amounts of influence on the financial models and entrepreneurial activities of their online units. As can be inferred by UPCEA's 2024 BOnES items focused on the online enterprise's financial conditions, respondents in this study may not have the need to explore the implications of financial models, revenue sources, and budgeting simply because that opportunity is not open to them. For this reason, the lack of skill in these areas, only 43% and 44%, respectively, seem reasonable and more indicative of individual COLO circumstances and experience than professional deficiencies.

Table 30

Financial Models and Entrepreneurship—Two Items

Understands the implications of financial models, revenue sources, and higher education budgeting processes relevant to the fiscal management of your unit (n = 372, 362)			
Very Important	66%	Very Skilled	43%
Somewhat Important	28%	Somewhat Skilled	45%
Not Important	6%	Needs Improvement	12%
Uses an entrepreneurial mindset and business acumen to guide your initiatives (n = 373, 353)			
Very Important	55%	Very Skilled	44%
Somewhat Important	38%	Somewhat Skilled	47%

Not Important	7%	Needs Improvement	9%

Marshalling Resources

Similar to the financial models and entrepreneurship items, planning, executing, and evaluating programs as well as information management/digital technology may be outside the portfolios of respondents, noting the researchers' earlier assertions that each online unit's portfolio is unique. The online leader may not be involved in academic programming and faculty development. Likewise, the institution's centralized IT department may be charged with supporting the technology needs of the online enterprise. These nuances in organizational structure and responsibilities likely influenced the respondents' survey answers.

Table 31

Marshalling Resources—Three Items

Plans, executes, and evaluates programs relevant to your enterprise and initiatives (n = 371, 361)			
Very Important	64%	Very Skilled	62%
Somewhat Important	31%	Somewhat Skilled	34%
Not Important	5%	Needs Improvement	4%
Possesses functional and operational knowledge of information management and digital technology in the support of your enterprise (n = 371, 359)			
Very Important	61%	Very Skilled	56%
Somewhat Important	35%	Somewhat Skilled	38%
Not Important	4%	Needs Improvement	6%
Manages human resources for the purposes of hiring and employing staff to create a productive workplace. (n = 370, 356)			
Very Important	56%	Very Skilled	56%
Somewhat Important	30%	Somewhat Skilled	39%
Not Important	14%	Needs Improvement	5%

Attracting Learners

While Table 10 details respondents' previous title, it does not distinguish specific areas, such as marketing. Rather, it does suggest some specific areas, such as instructional design (online unit) and faculty (academic affairs). Lacking insights into the specific areas and acknowledging the anecdotal information acquired through years of working in online education, the researchers can only surmise that most online leaders lack skills in recruitment, retention, and marketing efforts because their previous roles did not require that of them. Further, once they ascend to the role of COLO, they have a team of professionals skilled in these areas. Additional research in this area may be warranted.

Table 32

Attracting Learners—Three Items

Facilitate necessary support to identify, recruit, and retain students/participants in your programs (n = 370, 356)			
Very Important	53%	Very Skilled	37%
Somewhat Important	27%	Somewhat Skilled	50%
Not Important	20%	Needs Improvement	13%
Uses market research and prospective student/participant needs to guide marketing activities and aspects of program delivery (n = 371, 358)			
Very Important	41%	Very Skilled	25%
Somewhat Important	37%	Somewhat Skilled	55%
Not Important	22%	Needs Improvement	20%
Possesses an understanding of the marketing strategies and principles appropriate for your programming and consistent with the professional's role in your enterprise (n = 367, 355)			
Very Important	41%	Very Skilled	25%
Somewhat Important	40%	Somewhat Skilled	52%
Not Important	19%	Needs Improvement	23%

Facilities

The lack of importance and lack of skill in the area of facilities management seems valid at its face, since online learning is a digital environment, often lacking the same brick and mortar obligations that may exist in other areas of professional and continuing education. The researchers can only guess that these numbers would be impacted if the definition of facilities were to include the digital spaces and learning management systems used by online enterprises to deliver educational opportunities. Yet in being that liberal with the definition, the researchers could have ultimately confused respondents. As with the previous area, attracting learners, more research may be needed.

Table 33

Facilities—One Item

Manages facilities for the purposes of recruiting and delivering educational opportunities. (n = 370, 257)			
Very Important	26%	Very Skilled	4%
Somewhat Important	42%	Somewhat Skilled	82%
Not Important	32%	Needs Improvement	14%

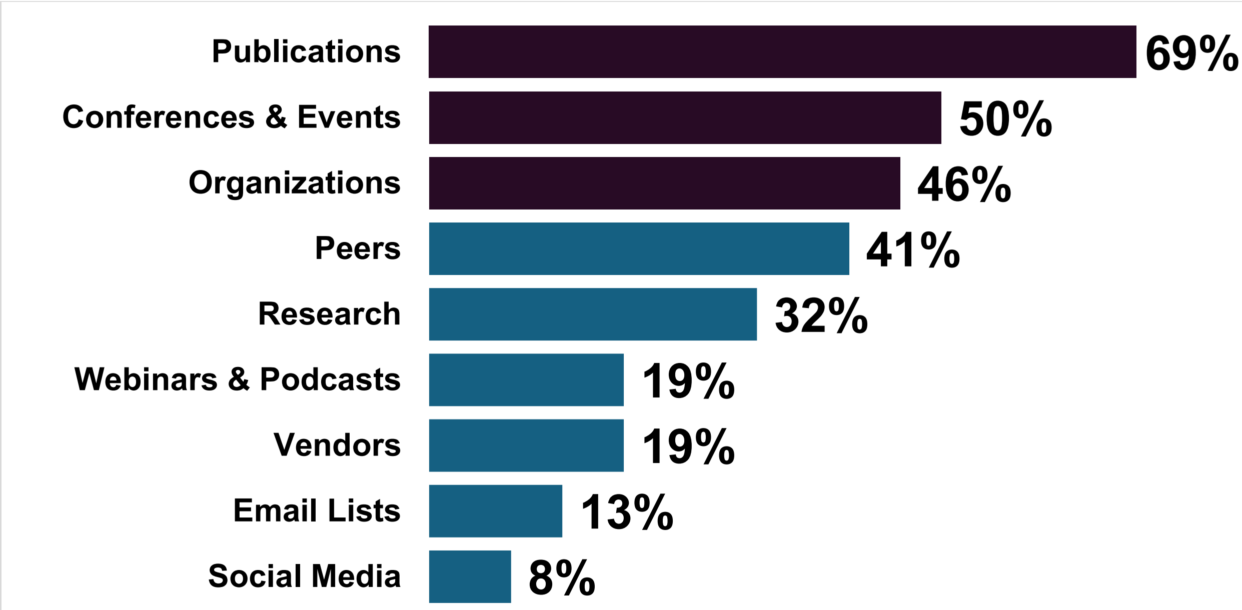
Staying Informed as the Chief Online Learning Officer

The last section of the study examined ways that COLOs stay up-to-date with online learning practices and policies, from engaging with professional development to staying connected to organizations and resources that inform online strategies and practices.

First, we asked COLOs how they stay informed about online learning. Nearly 70% cited relevant publications as a major way of staying informed, while half of the respondents also highlighted engaging with online conferences and events (see Figure 1 below).

Figure 1

How COLOs Stay Informed About Online-related Topics (n = 308)



Breaking it down by institutional type did reveal some differences. Both public and private four-year institutions prioritized publications (73% of respondents in both these sectors indicated they used publications to stay informed), while only 57% of COLOs at public two-year institutions said the same. Public community college COLOs had a near-equal investment in conferences and events (58%) and online-related organizations (59%), with the latter showing a deeper connection to organizations than either public four-year institutions (44%) or private four-year institutions (39%).

Next, we did a deeper dive into online-related organizations, asking COLOs which organizations they currently belonged to or might join in the future. The top five organizations that COLOs or their institutions belonged to were: Quality Matters (QM) (67%), EDUCAUSE (64%), the Online Learning Consortium (OLC) (58%), UPCEA (44%), and WCET (41%). COLOs had the opportunity to also indicate if they were currently a member but might drop the membership, as well as if they had no intention of joining the organization in the near future (see Table 34).

Table 34

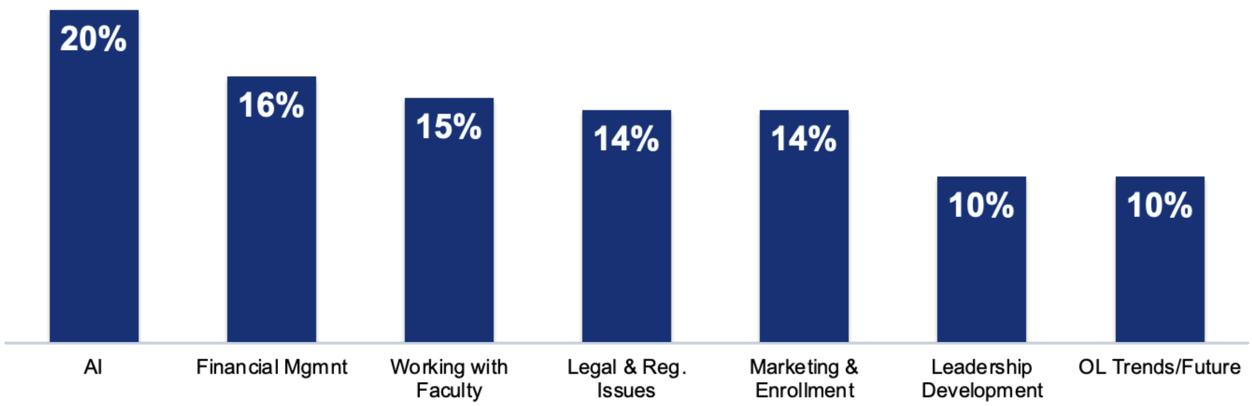
Associations

Which of the following organizations or associations do you or your institution belong? (check all that apply)	Yes	Yes—but might drop	No—but might join	No
QM	67%	3%	8%	21%
EDUCAUSE	64%	4%	8%	24%
OLC	58%	5%	12%	25%
UPCEA	44%	1%	9%	47%
WCET	41%	2%	18%	39%
USDLA	15%	3%	16%	66%
ISTE	10%	1%	11%	77%
AECT	9%	2%	12%	76%
League for Innovation	9%	1%	7%	83%

In terms of most-needed topics for their own professional development, COLOs indicated that information on AI would be the most helpful (20%), followed by financial management (16%), and working well with faculty (15%) (see Figure 2).

Figure 2

Most Helpful Professional Development Topics Identified by COLOs (n = 308)



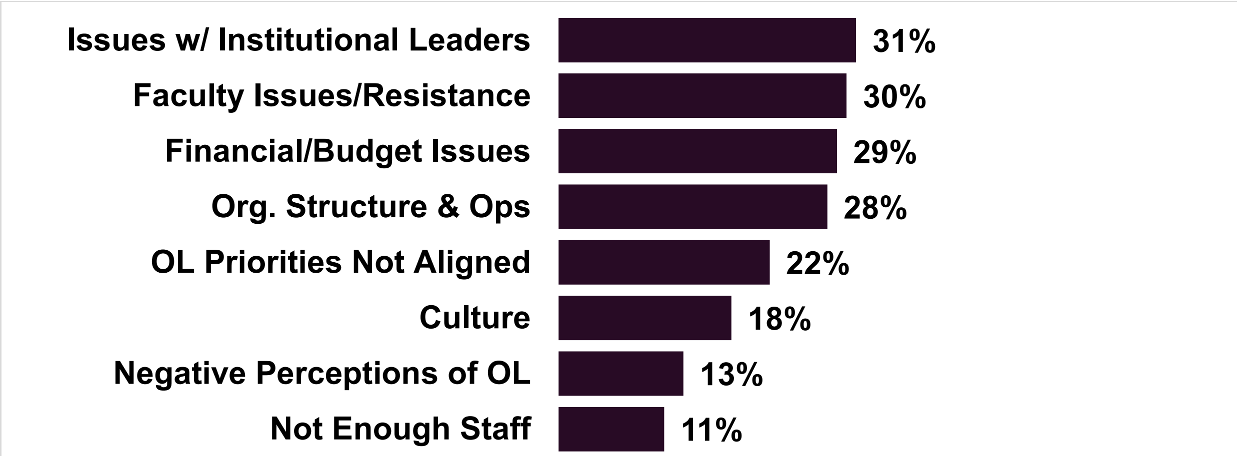
Open-ended comments for this question highlighted the need for continuing education on emerging issues and challenges, especially at the intersection of academics and policy. AI is one such topic, but change management was also frequently mentioned, especially in the complex context of the COLO role, which often must bridge the gap between online learning staff and senior administration who may lack specific knowledge about online strategies and scaling.

Institutional Barriers to Online Initiatives

As a final topic, COLOs were asked about common challenges and barriers encountered when trying to advance or scale online initiatives. Several challenges were experienced by COLOs to a relatively equal degree—approximately 30% of respondents identified issues with institutional leadership, issues with faculty, financial issues, and an organizational structure or operations that were not well-aligned with moving online projects forward (see Figure 3).

Figure 3

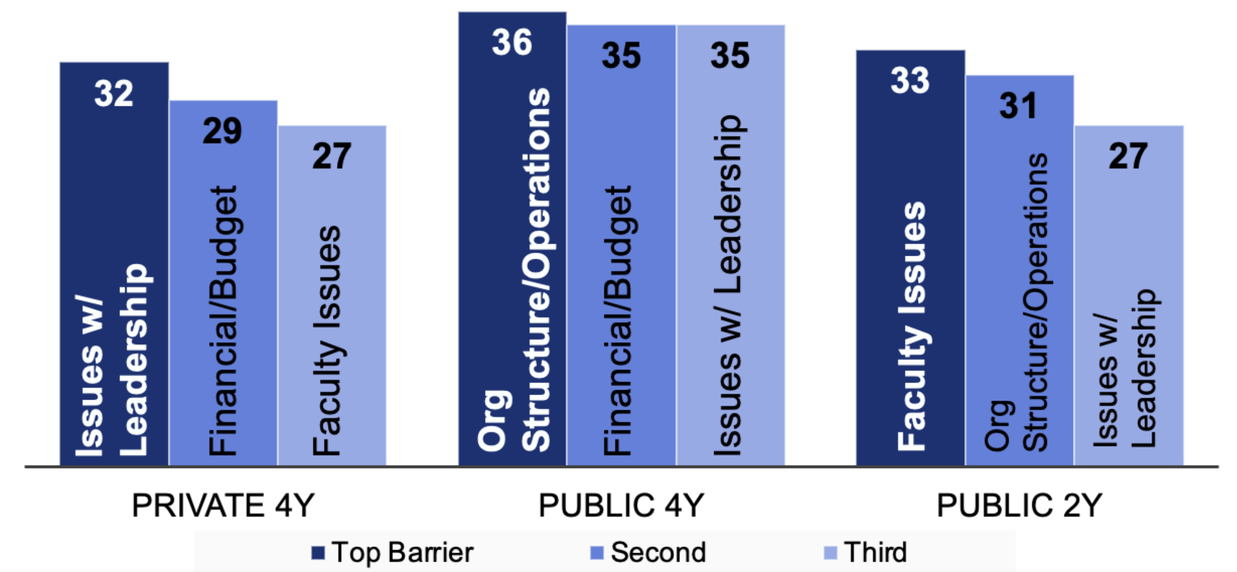
Challenges and Barriers to Moving Online Initiatives Forward (n = 319)



Similar to the variety of ways that COLOs stay informed, data revealed differences by institutional type when looking at the top three identified issues. While all sectors included "issues with institutional leaders," their placement varied (see Figure 4).

Figure 4

Top Challenges/barriers Vary by Institutional Type (n = 319)



Open-ended comments for this question revealed the unique impact of institutional culture and context. For example, issues around centralized support and faculty autonomy received several comments, including how the interaction of these aspects often caused campus tensions. Institutional culture was identified as an issue in terms of serving on-ground "versus" online learners, a lack of prioritization for online staffing or support even with online initiatives, and undermining leadership efforts due to reporting lines not extending to senior leadership.

Key Findings

The bulleted list below provides two summarized lists of the key findings of this study broken down by those associated with the individual COLO and those with the institution.

Summary of findings related to the individual COLO:

- The majority of COLOs have more than 16 years of HE experience
- More than 40% of COLOs have a faculty appointment
- The majority of COLOs have doctoral degrees
- Approximately 3/5 COLOs were promoted from within their institution
- 1 out of 7 COLOs indicated that their next step will be retirement
- Almost 80% of COLOs have been online students—with 1/3 completing a fully online degree
- Most COLOs indicated that they are very skilled in the UPCEA COLO Competencies that they say are important to their school
- Publications, Events, Organizations, and Peers are most cited by COLOs for staying informed about Online Learning
- The topics most mentioned by COLOs for their professional development include AI, Financial Management, Working with Faculty, Legal and Regulatory Issues, and Marketing/Enrollment.

Summary of findings related to the COLO’s institution:

- Director/Exec Director and VP/AVP are the most common titles
- More than 2/3 report to the Provost or other senior academic leader
- The vast majority have responsibility for fully online, hybrid online, and web-enhanced online courses
- ID, LMS, OL Policy Development, Academic Tech, and Faculty Development are the functions most likely to be unified with the COLO
- Online learning at most institutions has been a catalyst for organizational changes
- QM, EDUCAUSE, OLC, UPCEA, and WCET are the associations most noted by COLOs as having institutional memberships
- The biggest challenges identified by COLOs at their institution are Issues with Institutional Leaders, Faculty Issues, Financial and Budgeting Issues, Organizational Structure & Operations, and OL Priorities not aligned.

Discussion

This study provided a much-needed update to the profile and role of the chief online learning officer at U.S. higher education institutions and highlighted specific areas for COLOs to lead campus conversations relative to online learning leadership and strategy.

Impact on the Institution

For decades, many higher education institutions have understood the value of online learning to enhance access. During the pandemic, virtually all institutions embraced online learning as a means for academic continuity. Now, with the experience of the past five years, most colleges and universities are assessing the ongoing role of this modality to pursue opportunities for new markets and revenue growth. They understand the dynamic environment in which they operate and the challenges they are facing. One key factor related to institutions navigating these choppy waters is what happens to student enrollment. We believe that online learning will play a key role in retention and growth, and that is why this research is so valuable to higher education executives. It is vital to the future of their college or university to be organized for success, strategically embrace online learning initiatives, and identify and support a leader to guide these endeavors. They must have someone who has the right skills and experience and knows what they are doing.

One example for institutional leaders to consider relates to COLO positioning. This research recognizes that senior online learning leaders span a wide spectrum, with the majority reporting to the Provost or Chief Academic Officer or another Senior Academic leader. However, this area received some attention in the open comments, with several COLOs sharing difficulties in moving initiatives forward when they did not have communication lines with senior leadership. Although 61% of respondents reported that online learning efforts served as a catalyst for institutional change, only 19% reported membership in the President's Cabinet, and slightly less than half (49%) reported membership in the Provost's Cabinet. Additionally, the most common title reported was "Director" (30%) followed by "Associated/Assistant VP/Provost" (16%), showing a stark difference in terms of institutional "power"—directors of online, for example, must master "leading from the middle" and can be disconnected from senior leadership, often limiting their impact, scope, and autonomy. Institutions would be well served to examine who the senior-most online leader is at the institutional level and whether the position is elevated (or supported) enough to provide strategic leadership.

Impact on the Individual COLO

Regardless of the title, the COLO role is a portrait of deep knowledge and experience with both higher education in general and online learning specifically. A plurality (40%) had more than 20 years of higher education experience, and more than half had either a PhD or EdD. Most COLOs (79%) had taken at least one online course as a student, and most have both online and face-to-face teaching experience. While years of leadership experience varied widely, this data point may be revealing the different "levels" of leadership/titles as discussed above. We hope this study will help impact COLOs through self-assessment of the variety of skills and experience needed to be successful. They can benchmark with their peers through this research and identify the professional development required for their personal career plans. Higher education associations like QM, OLC, UPCEA, and EDUCAUSE might consider this research as they plan and offer professional development opportunities for our COLO colleagues.

This research was the first national study that considered the UPCEA COLO Competencies. In terms of those competencies, skills around leadership, strategic thinking, relationship-building, operational management, and institutional governance emerged as very important to the COLO role, while some areas that are equally vital to leading online, such as fiscal management, business acumen, enterprise solutions, information management, and growing enrollment, varied in terms of importance (and self-assessed skill). COLOs might use this data to do a deeper assessment of what competencies and skills should be valued at the institution to empower the COLO role and move online initiatives forward, as well as professional development opportunities that would help grow their acumen in these areas. The landscape of US higher education in general, and online learning specifically, is increasingly complex and competitive, and those who are leading online efforts may need to be their own visionaries.

The data also revealed that COLOs recognize the complex challenges of their role and make it a point to stay informed and connected in a variety of ways. Even as they expand their own knowledge and skill set, however, limitations are often imposed on their effectiveness due to a lack of appropriate staff and budget, a lack of a direct connection to senior leadership, or tensions around institutional mission and culture—all of which can impact their ability to lead effectively. COLOs who are in higher leadership positions might seize the opportunity to create a unified strategy that encompasses, rather than divides, on-ground and online students, while those leading from the middle may do well to form and lead collaborative committees that can better connect them with senior leadership and strategy discussions around online initiatives.

Limitations

The authors acknowledge that this research is limited by participants who provided data about themselves and their institutions. While we are extremely grateful that more than 500 COLOs contributed to this study, it does represent a modest 14% of the individuals who were invited to participate. Even though the findings might be of interest in other countries, another consideration is that this research was focused on higher education in the United States.

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Utilizing Generative AI to Counter Learner Groupthink by Introducing Controversy in Collaborative Problem Based Learning Settings

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Abstract

This article highlights the foundational challenge of rapid interprofessional student team formation and the potential challenges that groupthink poses for newly formed teams participating in collaborative problem based learning activities. This article describes a mixed-methods study that addresses groupthink by introducing a generative artificial intelligence-based agent (genAI agent) into the small group processes of student teams engaging in a session of a well-established virtual interprofessional education methodology. The integration of this novel genAI tool into each student team was an intentional pedagogical technique, introduced in response to the challenges that newly formed student teams may encounter as they rapidly come together and potentially contend with the many factors that may contribute to a state of groupthink. The research team observed that the introduction of the genAI agent positively influenced the dynamics of student groups and limited their potential for groupthink, providing a catalyst for engaged discussion through the introduction of novel and potentially controversial perspectives into their discussion.

Keywords: Generative AI agents (genAI), artificial intelligence in education, Groupthink, controversy, Interprofessional Education (IPE), Virtual Interprofessional Education (VIPE)

Wiss, A., Showstark, M., Dobbeck, K., Pattershall-Geide, J., Zschaebitz, E., Joosten-Hagye, D., Potter, K., & Embry, E. (2025). Utilizing generative AI to counter learner groupthink by introducing controversy in collaborative problem based learning settings. *Online Learning, 29*(3), 39-65. https://doi.org.10.24059/olj.v29i3.5096

Introduction

The landscape of interprofessional education (IPE) offerings for health professions students is populated with a highly varied set of pedagogical approaches with the goal of bringing students from various professions together in some form to explore professional roles, responsibilities, and areas where mutual support and collaboration might be found in collaborative workforce settings (Oudbier et al., 2024). IPE activities aim to bring vocationally disparate groups of learners together to practice team building and collaboration with members of different professions. In many cases, IPE is a short-term team experiential learning activity, with small groups of students being asked to rapidly engage in the well-established cycle of group: “forming, storming, norming, performing, and adjourning” (Hansen, 2006; Tuckman, 1977). These students are often new to one another yet have been given the task of rapidly moving into a state of successful team collaboration and performance.

One of the well-documented challenges for groups that have not worked through the early phases of small group formation is a potential for the phenomenon of *groupthink* (Janis, 1982, 1972). Groupthink refers to a psychological phenomenon that occurs when a group of well-intentioned people make irrational or non-optimal decisions due to social pressures that lead to conformity (Janis, 1982, 1972). Members of a team suffering from groupthink tend to minimize conflict and reach consensus without critically testing, analyzing, or evaluating ideas, and can occur in educational settings and student teams (Fong, 2010). This state of agreement for its own sake, with either the first or most strongly presented ideas emerging from the group’s collaborative process (Robinson & Held, 2024), does not allow a safe space to raise contrary or confounding points, may impede the collaborative process, and can negatively influence the group’s conclusions and work product.

These challenges of rapid student team formation and the potential for groupthink in newly formed teams are a common occurrence in both physical and virtual classrooms (McGowan-Kirsch & Lohiser, 2021; Soboleva et al., 2021) and is a phenomenon difficult for both faculty and students to identify as it emerges and even more difficult to address.

In this study, we introduced an experiment to counter groupthink by introducing a generative artificial intelligent agent (genAI agent) into small virtual teams of students from varying disciplines engaging in a problem based experiential learning case study activity. This session was conducted using the well-established VIPE instructional methodology for delivering virtual interprofessional education experiences (Showstark et al., 2023).

The essential feature of the genAI agent was its regular introduction of potentially controversial responses to discussion questions being posed to student teams. These generated controversial responses aimed to stimulate individual thinking and introduce divergent viewpoints surrounding complex issues. The desired effect was to move student group discussion to a more productive state where differentiated thought could be more comfortably introduced and explored, reducing groupthink. Furthermore, it was hypothesized that these small student groups would be influenced by their small group faculty facilitator's behaviors and any potential bias, positive or negative, they may possess when integrating the genAI agent into the session.

Literature Review

Setting: Collaborative Training for Health Professions Programs Students

IPE is a required curricular component of United States-based clinical health, allied health professions, and public health academic programs (Grbic et al., 2014). The specific requirements for what constitutes IPE varies between the different professional program competency models (Havyer et al., 2016), meaning that students training for two different roles (e.g., Doctor of Medicine and Master of Public Health) may have differing IPE requirements. Regardless of specific differences between academic programs, all U.S.-based health programs utilize the same shared core interprofessional education competencies developed by the Interprofessional Education Collaborative (IPEC), informed by expert representatives from over 15 core academic degree program associations. This model emphasizes the core competencies for collaborative practice required for successful teaming and collaboration with members of other health sector disciplines represented by four domains: (a) values and ethics; (b) roles and responsibilities for collaborative practice; (c) interprofessional communication; and (d) teamwork and team-based care (Interprofessional Education Collaborative, 2023).

Competencies for AI Use and Collaboration

Against the backdrop of this essential collaborative training requirement for health professions students, there is the emerging reality that artificial intelligence systems and services will continue to proliferate within healthcare settings and the work taking place across the health sector (Alowais et al., 2023; Ray, 2023; Sallam, 2023). The rapid growth and dissemination of AI tools and enhancements to existing educational systems has led to a response within academia to craft competency models for students to help provide training needed for future roles inside and outside the health sector. The new models bring focus to domains such as: (a) basic knowledge of AI, (b) social and ethical implications of AI, (c) AI-enhanced clinical encounters, (d) evidence-based evaluation of AI-based tools, (e) workflow analysis for AI-based tools, and (f) practice-based learning and improvement regarding AI-based tools (Russell et al., 2023).

It is thought that genAI tools may have a specific role in facilitating teamwork, collaboration, and formative assessment (Masters et al., 2025). For example, AI tools may enable students to create and critique each other's work with AI-enhanced guidance, fostering deeper understanding and critical thinking. Russell (2023) underscores the intersection of clinical competencies, AI competencies and collaborative competencies, highlighting AI's potential influence on various clinician roles and responsibilities, the nature of the clinical encounter, and the "impact on team dynamics and workflow" (pp. 350–352). These competencies received strong support during a recent convening of healthcare and AI experts by the National Academies (Forstag & Cuff, 2023). A recent study of interprofessional student teams and their acceptance of generative AI agents as a part of their team process (Wiss et al., 2025) point to areas of concern for students including ethics and clarity of roles and responsibilities, with direct implications for teaming and collaboration. In summary, there is a dearth of scholarly work at this time providing an exploration between the intersection of collaborative competencies outlined in models such as IPEC (2023) and the workforce and AI competencies put forward by Russell et al. (2023).

Groupthink in Academic Settings

The phenomenon of groupthink has been studied extensively in organizational settings (Hällgren, 2010; Mullen et al., 1994), yet its presence in the academic realm has lacked the same attention from researchers. Packer's study of undergraduate teams and groupthink (2009) indicates that the strength of a student's identity as a part of the community is predictive of their willingness to challenge ideas within their group. Kaba et al.'s (2016) work regarding interprofessional education and groupthink note a direct relationship between factors such as trust, team focus, and team unity, as potentially resulting in unintended levels of conformity, reticence to challenge commonly held positions with divergent thinking, and ultimately leading to the phenomenon of groupthink. Heldal (2023) suggests that coaching on design thinking can improve student team process in this regard, focusing the collaboration on the essential needs and goals of the project, taking emphasis away from interpersonal and affective dimensions of team interaction and conflict when it may arise.

Role of Psychological Safety and Controversy in Team Learning

Closely tied to the challenges related to groupthink are underlying issues of psychological safety, controversy in group process, and its impacts on team learning. A study of short-term teaming assignments with nursing students found that there were improved attitudes towards teaming activities after a two-hour collaborative activity, yet when that teaming assignment was extended across multiple days, no further significant improvement in attitudes was found (Brown & Benson, 2020). These findings align with previous research on the IPE model utilized in this particular study regarding positive student attitudes post-activity (Showstark et al., 2023).

While reported improvements in attitudes from short-term engagement in IPE experiences are often viewed as an instructional success, studies of team performance also indicate that the desire to maintain surface-level positive group dynamics may block difficult conversations (Edmondson, 1999, 2023). Along these same lines, Sanner and Bunderson's (2015) study of team learning found positive correlations between: willingness to engage in challenging discussions, admitting errors, and seeking help, leading to a reduction in team member anxiety and an increase in consideration of dissenting opinions. The question for instructors designing collaborative experiential learning activities then becomes: *How do we make space for dissenting views and controversy to enhance student team processes?*

Methods

Purpose

This study assessed the perceptions of graduate level health professions learners after their participation in a collaborative case study IPE activity that integrated a GenAI agent known as CALIE (the Collaborative Agent for Learning and Interprofessional Exploration) into student discussion groups. More specifically, the authors wished to know how students within varying graduate training and backgrounds would perceive the AI agent in their collaborative discussion groups, not knowing that the AI was intentionally placed as a disruptor of potential groupthink and its underlying causes. Further, we wished to understand the influence that the faculty facilitator tasked with leading the collaborative discussion within each small group might have on students' perceptions of the genAI agent, including any potential bias, positive or negative, towards the genAI agent. To gain a more robust understanding of these areas of interest a mixed methods approach was adopted for the study, which was conducted under Yale IRB #2000024050.

Participants

One hundred and sixty-five learners participated in this virtual case study activity. Of that number, 158 participants opted into the study, which was administered using an online survey after the experiential interprofessional education activity described below. Students were divided evenly across twelve small groups, each led by a faculty facilitator from one of the participating academic programs. The CALIE agent's output was used in every group and students were evenly distributed across groups based on their academic program. Students were informed that the activity was part of a research study twice—during the case study activity itself and once again with the waiver of consent presented prior to their participation in the online survey. These volunteer participants were current students in one of seven different graduate programs preparing students for a role in clinical health, allied health professions, or public health. These degree programs included: Master of Public Health (MPH); Family Nurse Practitioner (FNP); Acute Care Nurse Practitioner - Adult Gerontology Acute Care Nurse Practitioner (AGACNP); Doctor of Physical Therapy (DPT); Doctor of Pharmacy (PharmD); Doctor of Dentistry (DDS); and Physician Associate (PA). Participant demographics are presented in Table 2. To simplify data analysis, all nursing degrees previously reported were collapsed into a single "nursing" degree category.

Learning Design and Research Context

This activity used the previously mentioned Virtual Interprofessional Education (VIPE) pedagogical method (Showstark et al., 2023), an efficacious model used for virtual interprofessional education learning activities that demonstrate IPEC competency (2023) attainment in domains such as collaboration, communication, and ethics. The VIPE method aligns well with and uses many recommendations from a recent meta-analysis of best IPE experience design practices (Oudbier et al., 2024). Findings from this analysis suggest that features such as development of knowledge about professional roles and responsibilities, utilization of active learning and student-centered activities including problem based learning, integration of technological support, reflection, and pre-briefing and debriefing activities can lead to successful learning outcomes.

Students were provided with asynchronous preparatory case materials to review in advance of a synchronous 180-minute problem based learning (PBL) session focused on a specific patient and her family within a fictional community's response to the opioid crisis. Preparatory materials included: a text-based medical case involving an individual who had recently suffered an overdose; a companion video to the case involving the mother of the patient and a physician associate (PA) discussing the patient's history and next steps in her treatment and recovery; a community snapshot document containing details on the local population, its health, related social determinants of health; and a companion video to the community snapshot featuring a planning call between the county's Public Health Director and the Chief Medical Officer of that county's primary addiction and rehabilitation facility. Along with these for required components, optional materials were also provided so that students could familiarize themselves with the roles and responsibilities of the other health professions students they would be collaborating with during this activity.

The 165 student participants joined a synchronous meeting platform for the PBL session, and after introductory remarks from the faculty, moved to small groups of 15 students facilitated by a faculty member from one of the academic programs involved. All faculty facilitators from varying professions were provided with a Facilitator's Guide that contained a set of approximately 50 open-ended questions to help guide their group's discussion, as is standard using the previously described VIPE model for virtual interprofessional education. During the opening portion of the small group session, faculty facilitators use the same script to announce the addition of the genAI agent CALIE, stating:

> Welcome to our small group discussion session. As noted in the main session, we will engage in an interprofessional exploration of this case study together, driven by all of you and your developing professional expertise. This case activity is also an opportunity for us to explore the value AI may or may not bring to interprofessional teams and their collaboration. At three points over the next hour, I will "voice" for a generative artificial intelligence named CALIE (which stands for Collaborative Agent for Live Interprofessional Exploration). CALIE has reviewed the case materials just as you have and was posed the same questions we are considering in this session. We will integrate CALIE's output into our group discussion.

Constructing CALIE—Technical Overview

The Collaborative Agent for Live Interprofessional Exploration (CALIE) was developed by the faculty leading this activity using ChatGPT 4.0. A new session was created in ChatGPT, with introductory prompting that outlined the following parameters: (a) In this session we would be creating and then interacting with a new AI agent named CALIE; (b) CALIE was being created to ingest a set of robust case study materials in order to respond to complex open-ended questions; (c) CALIE was asked to respond to all questions as if it were a health services delivery expert, with knowledge of the opioid crisis; (d) CALIE was informed that its responses would be shared with students training for health professions roles, as a part of a class discussion activity, and to shape its responses accordingly. After this initial prompting, the previously described case study materials were uploaded into the ChatGPT session. The rudimentary CALIE agent was then considered ready for prompting using the same PBL questions located in the faculty facilitator guide.

The faculty designers of this activity found CALIE's initial responses to sample PBL questions to be factually accurate yet lacking the same levels of sophistication and creativity that would be expected of the graduate students who would be participating in the activity. It was through this initial faculty exploration of CALIE's abilities that the instructional strategy of prompting for potentially controversial responses arose. To help standardize the student experience across multiple small group sessions, and ensure that all students received the same output from CALIE when responding to the PBL questions from the facilitator guide, CALIE was prompted with questions prior to this activity. This allowed the faculty to select the most instructionally appropriate and valuable responses. Those responses were then inserted into the Faculty Facilitator Guide for each facilitator to read aloud as the "voice" of CALIE during the VIPE session.

Use of CALIE in the VIPE Session

During each small group session, faculty facilitators led their students through a discussion of no more than 10–15 of the larger set of 50 questions located in the facilitator guide. At natural breaks in the discussion identified by the facilitator, a new question would be introduced, and when that facilitator deemed appropriate, voice aloud the previously generated output as CALIE. Students then had an opportunity to respond to CALIE's response, evaluate it as needed, and build it into their larger discussion of the question being considered. After the 60-minute small group session, all students and facilitators were brought back to the main virtual meeting room to debrief their experiences in their small groups, share their findings related to the case study, the questions provided, and conclude with an open-ended discussion regarding their experiences interacting with the output from CALIE.

Table 1

PBL Questions and CALIE Responses

PBL Question	CALIE Response—GenAI Agent
Are there gaps at the community health services level that you would recommend local leaders consider? Think about the call you watched and also the "Community Health Snapshot" pre-reading.	Local leaders should consider outsourcing certain health services to private companies. While controversial due to potential profit motives, this could bring efficiency and innovation lacking in public systems. It might bridge gaps highlighted in the "Community Health Snapshot" by leveraging specialized expertise and resources, albeit at the risk of privatizing essential services.

Who are the other stakeholders relating to this issue, in this community, and what do you imagine their roles would be?	Other stakeholders could also include local law enforcement agencies. They might serve a dual role: enforcing drug laws while also assisting in harm reduction efforts, such as providing safe spaces for drug use and facilitating access to treatment instead of punitive measures. This could involve training officers in overdose response and diversion programs, challenging traditional approaches to drug enforcement.
What are the resources (community or otherwise) that the: Patient would benefit from? Family would benefit from?	The patient could benefit from controversial resources such as safe injection sites, where they can use drugs under supervision, and harm reduction programs providing clean needles and overdose prevention kits. The family might benefit from controversial interventions like tough love strategies, where they cut off support until the individual seeks treatment, and involuntary commitment laws allowing them to force the patient into rehab against their will.

Quantitative Data Analysis Procedures

Responses were analyzed using a combination of repeated measures ANOVA, multivariate ANOVA, and correlation analysis. Repeated measures ANOVA was used to compare responses to the questions related to perceptions of AI. Multivariate ANOVA was used to examine AI perceptions by whether or not the facilitator influenced participants perceptions of AI. Finally, a correlation analysis was used to examine the relationship between perceptions of AI.

Qualitative Data Analysis Procedures

The single source of qualitative data collected was derived from a survey instrument that captured participant comments. In total, 158 sets of participant comments were analyzed. These comments were analyzed using categorical coding (Maxwell, 2005). This less structured approach to analysis was chosen to foreground internal validity and contextual understanding (Miles & Huberman, 1994), allowing the researchers to bound results based on the socio-contextual factors emerging from this specific IPE event. To this end, comments were coded using an open coding approach to assign meaningful categories to grouping of participant comments (Charmaz, 2006). These comments were coded in related groupings before a categorical cluster was assigned to identify similar patterns in the data (Saldaña, 2016). Beyond this systematic review of comments, the researchers benefited from their experience with similar IPE events to understand the setting, context, and participant experience and identify emergent patterns (Janesick, 2011). From these clusters coalesced patterns that linked to the study design and purpose noted above (Richards & Morse, 2013). The results of this analysis are detailed in the qualitative results section below.

Results

Quantitative Results

Quantitative analysis began with an analysis of participant perceptions of AI as useful, helpful, and as part of their team. A repeated measures ANOVA revealed that levels of agreement differed between all three items, $F(2, 156) = 26.01$, $p < .001$. Participants showed the greatest agreement with believing AI can be a useful tool ($M = 3.49$), followed by finding the AI's feedback to be helpful ($M = 3.21$), and finally perceiving AI as part of the team ($M = 2.88$). Pairwise comparisons between each item revealed all three to be significantly different from each other (all *p*s < .001).

We then examined whether specific facilitators had an impact on participant perceptions of AI. A multivariate ANOVA revealed that participants who reported that the facilitator influenced how they responded to and integrated the AI into their group's work indicated more positive sentiments toward AI on all three questions. In the context of leader influence, we then examined perceptions of *input from AI as if it were part of the team*. Participants reported greater agreement when they reported that the facilitator influenced the group response ($M = 3.08$) than when they said there was no facilitator influence ($M = 2.64$), $F(1, 156) = 5.96$, $p = .02$. Participants also reported greater agreement with the statement that *AI can be a useful tool in health sector work* when they also reported facilitator influence ($M = 3.67$) than when they reported no facilitator influence ($M = 3.26$), $F(1, 156) = 5.70$, $p = .02$. Finally, for the statement regarding *usefulness of AIs feedback in supporting the group's work*, when participants reported facilitator influence there was greater agreement ($M = 3.44$) than when they reported there was no facilitator influence ($M = 2.93$), $F(1, 156) = 10.26$, $p = .002$.

While there were clear differences on these three items regarding perceptions of AI, it was also found that they were all positively correlated with each other (all *p*s < .001; correlation coefficients are displayed in Table 4). This suggests that positive perceptions of AI in one dimension will result in a greater likelihood of finding AI valuable in other dimensions as well.

Table 2

Participant Demographics

		N
Age	18–24	30
	25–34	99
	35–44	18
	45–54	8
	55 or older	3
Gender	Female	119
	Male	35
	Non-binary/third gender	1
	Other	2

	Not disclosed	1
Professional Program	Public Health	65
	Nursing	36
	Pharmacy	28
	Dental	16
	Physician Assistant	8
	Physical Therapy	1
	Not disclosed	4

Table 3

Overall Item Means, and Means by Response to Facilitator Influence

	Overall	Facilitator Influence—Yes	Facilitator Influence—No
I perceived the input from artificial intelligence as if it were part of the interprofessional team.	2.88	3.08	2.64
Going into this activity, I believed that AI can be a useful tool to support health sector work and collaboration.	3.49	3.67	3.26
Artificial intelligence's feedback was helpful in supporting my group's work on the case.	3.21	3.44	2.93

Table 4

Inter-item Correlations

	I perceived the input from artificial intelligence as if it were part of the interprofessional team.	Going into this activity, I believed that AI can be a useful tool to support health sector work and collaboration.
Going into this activity, I believed that AI can be a useful tool to support health sector work and collaboration.	.56	-
Artificial intelligence's feedback was helpful in supporting my group's work on the case.	.51	.58

Note. $p < .001$

Qualitative Results

Participants expressed perspectives on the AI team member in three affective categories: (a) the AI's qualities as a teammate, (b) the AI's enhancements to the group, and (c) the challenges presented by AI's inclusion in the group. Within each category, participants' perspectives coalesced into three more broadly shared perspectives regarding characteristics of the AI and its function within the group dynamic. Table 4 below presents these results accompanied by relevant participant quotes drawn from the survey data.

Table 5

Categories of Shared Participant Perspectives

Affective Category	Shared Perspectives	Participant Quotes
AI as a teammate	genAI outputs are not aligned with typical human interaction or human connection.	"While the input from AI clearly showed a wealth of knowledge on the topic, its response lacked consideration of what other team members had already said because it wasn't directly part of the discussion and had essentially come up with their answers in a vacuum (ie CALIE wasn't listening to other's responses and responding accordingly, as the rest of us were)." "I am not sure how AI would work in relation to interprofessional teamwork and collaboration. I believe with AI there could be potential for error or miscommunication." "I don't feel I would trust the responses from AI based on answers it gave our group today." "The AI wasn't actively participating in the discussion (ie we weren't continuing to type in questions to the AI bot), I didn't necessarily perceive it to be a member of the team." "There is no discourse [from the AI]." "There is no human connection to AI so it is more challenging to get a humane response that consists of empathy." "It was a little out of the blue and didn't fit in context." "We did not ask the AI what it thought of the group's ideas."

AI as a teammate	The genAI's contributions perceived as a part of the team process.	"It was another team member giving their opinion and expertise." "I viewed it as a resource." "AI can contribute the same as data from a team member." "I did see AI as part of the team, but it is also a mental block that it is AI and not a human being responding to the questions." "I treated it like another group member." "It was interesting to see the perspective that the AI had…I obviously knew it was AI, but it still informed conversation."
AI as a teammate	genAI's inability to draw from lived experience limited its team contributions.	"I think team members not only bring knowledge but professional and personal experience which makes their input invaluable." "There is no human aspect that makes an interprofessional team work well." "AI does not have its own ideas, it would be the same as a team member searching through the literature for ideas and bringing them to the table. I think it is more useful in keeping people building on ideas." "It's difficult for the AI to see human error or add the unexpected nature of human actions. We, as healthcare providers, have human and patient interaction experience which is valuable in our discussion of the opioid crisis and possible solutions to our current problem."
Group Enhancement from AI	genAI responses prompted group ideation.	"The responses from AI definitely made our group think more about our answers." "It helped to stimulate diverse conversations." "AI's feedback allowed different perspectives and thinking to emerge and challenge the current ideas that we have in place." "I think AI's response to the questions help elicit critical thinking from our group."

		"CALI provided quite an outside-the-box suggestion that no one suggested within our group." "It provided another viewpoint to discuss." "The AI responses more-so helped to serve as discussion prompts for the group…it more served as a resource for discussion prompts for our group." "I think that it can help provide an alternative thought process that may not be contributed by other members."
Group Enhancement from AI	AI agent's prompting helped to initiate group discussion	"The generative AI prompts gave us different discussion topics. I think this is useful to change the dynamics and give other people a chance to speak." "It allowed and facilitated a good flow within our discussion." "I think it helped initiate some conversations between group members from different disciplines." "AI was helpful in that it helped create conversation. However, it was not helpful in providing concrete direction." "I think it was beneficial in creating group discussion."
Group Enhancement from AI	AI agent's contrarian viewpoints provided discussion material for the group	"We disagreed as a group with most of the AI responses and that consensus was helpful in solidifying our own responses and thoughts." "We didn't really agree with any of her answers. I guess it opened the conversation as to why we disagreed." "AI generated some great ideas but also some that were unpopular with the group. However, this presentation of ideas, however unpopular, is an important aspect of effective problem-solving and definitely added value to the conversation." "We didn't necessarily agree with its ideas, but at least it got us thinking." "While we didn't really agree what the AI feedback said, it allowed us to talk through the points that were said. We were able to talk about how we agree/disagree about what the AI said in our own disciplines, so it allows us to think more critically."

Challenges with the AI	AI's lack of humanity was apparent.	"I think it lacks the component of human emotion and experiences." "I think the challenges are that AI lacks the human empathy and human emotion when responding to questions. this could also be seen as a good thing because sometimes we need to take emotion out of the answers to our questions." "AI took a lot of empathy away from responses." "It's easy for AI technology to make sweeping generalizations, but does not have the ability to understand patient care with human emotions (like care, empathy, understanding)." "The answers lacked a human aspect." "Sometimes AI does not show the empathetic side of a situation and lists only the facts and figures which may be an issue within the healthcare field." "I felt that AI lacks empathy and it felt very capitalistic in its response." "AI wasn't able to grasp the human factor into their answers and that is one of the reasons why it is not accurate." "The AI answers through finding pure data without the humanistic nature of policies, actions, or locations." "AI offered objectified insight. Lacked humanism."

Challenges with the AI	AI's lack of lived experience was most apparent when situational context was needed.	"It was like hearing from a politician. Thanks for sharing, but I'm over here in the real world." "It seems the AI gave responses applicable to 'in an ideal world,' and missed some of the nuances of real-life issues/barriers/challenges to caring for people with addiction issues." "AI cannot represent every unique/specific situation. Each state, each setting, and each individual may have a different situation. It only provides suggestions from a general perspective." "AI answers are sometimes not applicable to real life situation…AI generates response from a larger scale rather than concentric around a specific or small pool." "Not able to bring in personal experiences." "AI is unable to see patients as individuals. The comments were too broad and not relevant." "Some of the issues were that the AI didn't incorporate a lot of the nuances of the questions of considering the holistic situation." "The answers sometimes did not put into consideration of the dynamics of certain areas or populations." "I didn't perceive the AI response as a human response because it hasn't had the same experiences as we have." "AI was very '1-dimensional.' It was not capable of providing or using the specific contexts of the case."
Challenges with the AI	Biases perpetuated from, with, and about AI clouded participant perceptions.	"I have realized that one of the challenges with using AI is that I can be biased when interpreting the answers. It's important to understand that AI doesn't have emotions and doesn't answer questions based on personal beliefs or opinions. Instead, its responses are based on the data that has been fed into it." "It will only worsen and perpetuate racist biases in medicine and has no place in healthcare." "I think the AI made some excellent points. While AI can help generate ideas, those ideas can sometimes be unreasonable or biased. One must research to understand the cause and effect

	of various health issues. AI can be used to create a study guide or a daily plan to maintain good health.”
	“Knowing it’s a machine creates bias.”
	“I think AI is not always accurate.”
	“There seems to always be a slight bias based on how AI has been designed to lean one way or another. I believe that is the greatest drawback and it was evident that there were some areas that this bot didn’t venture into.”
	“I am biased against it—my husband works in data and he and I talk a little too regularly about AI hallucinating things and the inaccuracy.”
	“AI has some bias, so some of the answers weren’t the best way to navigate a situation.”
	“Maybe it’s AI bias on my part. Knowing that AI is a computer and not a human, I have a difficult time acknowledging the AI’s input as credible or accurate.”

AI as a Teammate

Participants’ perceptions of the AI’s capacity and function as a teammate were centered around human-related factors. In some cases, the AI was perceived as a member of the interprofessional team, and learners “treated it like any other group member” and “viewed it as a resource.” However, the AI was not seen as a substitute for peer learners in dialogue, as several participants noted that AI’s responses were not connected to the typical flow of human conversation. One participant described how AI responses were disconnected from the group’s discussion, “its response lacked consideration of what other team members had already said because it wasn’t directly part of the discussion and had essentially come up with their answers in a vacuum.” Other participants agreed, suggesting “It was a little out of the blue and didn’t fit in the context” and “It was not interactive.” Thus, the AI agent functioned as a resource or initiator of discussion, rather than an active participant in the ongoing development of interactive team processes. Participants also highlighted that it was evident that the AI was not drawing upon lived or professional experience, which influenced its capacity to contribute to team processes. One participant wrote, “I think team members not only bring knowledge but professional and personal experience which makes their input invaluable.” While the artificiality of AI was apparent to participants in its capacity and function as a teammate, participants did emphasize several enhancements that the AI provided to the group discussion.

Group Enhancements from AI

The AI provided several dialogical enhancements for small groups. The AI’s prompts and responses elicited group ideation. Participants noted that the AI responses helped to “elicit critical thinking from our group" and "helped to stimulate diverse conversation." One participant noted that this catalyzing effect worked across disciplines: "It helped initiate some conversations between group members from different disciplines." While the responses were not perceived as natural or human, the resulting group discussion appeared to develop naturally. According to one participant, the AI "facilitated a good flow within our discussion." The most striking and controversial AI responses appeared to cause the greatest effect in this regard. Participants suggested that the group coalesced its thinking in opposition to the AI in these cases, with one noting how "we disagreed as a group with most of the AI responses and that consensus helped solidify our responses and thoughts." Another participant agreed that "we didn't agree with any of her answers. I guess it opened the conversation as to why we disagreed."

Challenges with AI

Several challenges were foregrounded by participants in terms of working with the AI. The primary challenges described by participants were the AI's lack of lived experience and subject matter expertise, factors that presented mixed effects. The AI's inability to account for context or draw from its own professional experience was apparent in how the AI "doesn't take into consideration the entire picture," with "answers [that] lacked a human aspect," including the AI's inability "to see patients as individuals." Some participants expressed frustration in working with the AI or giving its responses legitimate consideration. One participant wrote, "It was like hearing from a politician. Thanks for sharing, but I'm over here in the real world." Other participants expressed concrete issues with the AI's responses rooted in their discipline: "It seems the AI gave responses applicable to 'in an ideal world,' and missed some of the nuances of real-life issues/barriers/challenges to caring for people with addiction issues."

Related to these challenges were biases from and about the AI agent. Several participants expressed their bias towards the AI that influenced their perceptions, stating, "knowing it's a machine creates bias," "I am biased against it," and "I have realized that one of the challenges with using AI is that I can be biased when interpreting the answers." Similarly, participants were struck by the biases embedded in the AI's responses. One learner noted, "ideas can sometimes be unreasonable or biased," and another suggested, "AI has some bias, so some of the answers weren't the best way to navigate a situation." Ultimately, several participants framed their experience with the genAI agent in terms of perceived biases and the human or profession-specific quality of the AI's responses.

Discussion

This experimental integration of the genAI agent CALIE into a team-based PBL setting yielded a number of notable findings relating to student team formation, processes, and performance. More specifically, our findings address the following areas: (a) student perceptions of the genAI agent; (b) its integration into the student team process; (c) its influence on team discussion and outcomes; (d) the influence each team's faculty facilitator on the acceptance of the genAI agent; and (e) the essential question of whether introducing controversial viewpoints by a genAI agent can help steer groups away from groupthink.

A benefit identified through this research was the confirmation that inclusion of genAI agents within student teams has the potential to strengthen instructional outcomes related to PBL. These benefits were seen both in terms of team process and the substance of the discussion. Learners reported that the genAI agent stimulated critical thinking in groups, introduced outside viewpoints not present in the ongoing discussion, and provided a launching point for students to analyze its responses using their own disciplinary knowledge and training. Students commented on the quality of the AI's contributions from their discipline-informed perspectives, drawing from their professional training to support or refute aspects of the AI responses. This represented a new way for learners to demonstrate their awareness of professional roles and responsibilities in their interprofessional small groups, thus capturing an essential IPEC (Interprofessional Education Collaborative, 2023) competency outcome.

Disagreement with the genAI agent also appeared to influence teamwork dynamics positively. Learners actively engaged with the agent's responses regardless of perceived quality or relevance of its content. Contrary and adversarial views of the agent, either through baseline mistrust or the nature of its responses, offered students a socially permissible opportunity to speak up against it. Even when the agent replied outside the flow of group conversation, the genAI agent's disconnected responses did not negatively influence its ability to spark further discussion within the team. At times, learners situated the agent in counterpoint to the group's emerging cohesion due to the nature of the agent's responses or their baseline mistrust of AI. In turn, such situations stimulated critical thought and conversation flowing from the resulting group reflection and value ascribed to the agent's responses. This dynamic effectively counteracted passivity or inactivity that can occur in groups of unfamiliar interprofessional learners and practitioners (Dobbeck, 2024; Freeth et al., 2008; Reeves, 2005).

Results regarding bias were complex and messy with regard to participants' perceptions of AI in general and the genAI agent's perceived bias. A subset noted personal negative bias towards AI in their survey responses, and some of the most in-depth responses to the survey prompts were related to that bias. It was also unclear whether participants labeled controversial genAI agent responses as "biased" because they disagreed with the response content. Ultimately, the function of bias from, with, and about AI in an interprofessional learning environment remains a compelling area for future research.

An additional notable finding requiring further exploration is the role that leaders have in shaping team members' perceptions towards genAI agents in their team's process. There was a significant relationship found between a student's belief that their facilitator influenced their perception of CALIE and their perceptions of its helpfulness in the team's work on the case and perceptions of CALIE's role as team member. The research team did not capture information on whether that leader influence was perceived as a positive or negative, nor learner specific commentary on what types of leader behaviors can promote or negatively impact team member perceptions of genAI agents. This finding has direct implications for both academic and workforce settings and is identified here as another area of interest for continued study.

In terms of the potential for groupthink's emergence in small teams during this learning activity, indicators of this phenomenon were not observed in the quantitative or qualitative results. Behaviors known to be impeded by groupthink in academic settings, such as student's willingness to critically test, analyze, and evaluate ideas (Fong, 2010) were present and in many cases a vibrant part of the reported activity in small teams. Along these same lines, underlying behaviors leading to groupthink including limitations on sharing contrarian opinions (Robinson & Held, 2024) and a tendency to minimize conflict were not observed in student responses. In fact, open discussion of challenging topics appeared to occur robustly in small teams, with focus on issues of trust, bias, and ethics regarding AI's role in both the group's discussion and the larger context of the professional roles these students were training for.

Limitations

The most notable limitation of this research was the use of the CALIE agent itself. Several students noted the lack of interaction with CALIE given that the genAI output was pre-generated and read aloud in the session. While this allowed for more instructor and researcher control over the genAI output in the sessions, these participants rightly note that CALIE was not involved in the ongoing team discussion and processes beyond those brief interjections of potentially controversial concepts. Future iterations of this work should consider a more unstructured utilization of genAI agents like CALIE to study their influence on team processes and phenomena such as groupthink. Variations of this use may include individual student usage, shared team usage, and facilitator or other individuals acting as a mediator between the genAI agent(s) and the student teammates. Additionally, while it was generally understood from the qualitative results that behaviors indicating groupthink did not occur during the 60-minutes spent in teams, this time period itself may have been too brief to account for the initial novelty of the genAI agent to become a part of expected team processes. To address this gap, longitudinal studies of student teams interacting with genAI agents are required to understand their effects on team process and performance over time. Additionally, all health profession student learners are not represented in this study, future studies may want to include other health profession learners such as social workers and addiction sciences. Finally, given that this was some learners' first encounter with a genAI agent in the context of their academic and professional development, the novelty effect may have either amplified or otherwise influenced their experience and engagement in this team based activity.

Further Research

In addition to the areas for further research noted in the discussion, the researchers identified several additional areas for further study regarding genAI agents and their integration into group learning environments. Although participants noted the agent's influence on group dynamics, it was not clear whether the agent's inclusion influenced the group's team development. It is possible that the catalyzing effect the AI agent had on group interactivity allowed for more rapid team development and is noted as an area for further study.

Similarly, participants did not suggest feeling more psychologically safe as they disagreed with ideas put forward by the genAI agent as opposed to the potential conflict that may arise in disagreeing with peers; however, the level of engagement suggested this may be the case. It was also unclear how interacting with a genAI agent influenced learners' understanding of their roles and responsibilities in the group. Exploration of these factors could inform the work of educators and researchers focused on problem based learning and team performance in both educational and professional settings and expand the growing body of knowledge regarding integration of AI tools to support team collaboration.

Along these same lines, this particular application of genAI's ability to encourage newly formed student groups to challenge ideas and assumptions, both internal and external to the group, stimulating the co-creation of knowledge and steering that group away from a potential state of groupthink, in many ways meets the definition of "humanizing action" (p. 13) as defined in the "Framework for Ethical AI Use that Promotes Humanizing Action" (Swindell et al., 2024). We encourage further research in the area of educational application designs that can support these types of ethical and human-centered interactions.

Conclusion

This research highlights the introduction of a genAI agent into a collaborative problem-based learning setting focused on interprofessional collaboration for health sector professions. The introduction of the genAI agent was observed to positively influence group dynamics of newly formed student groups and limited their potential for groupthink. Our findings suggest that intentionally prompted genAI agents can catalyze engaged discussion by introducing novel and potentially controversial perspectives for students to react to, ultimately steering groups away from behaviors and team processes that may potentially lead to groupthink.

The use of genAI agents in this fashion is a strategic choice for educators and learning designers concerned with both student group process and products they produce. Educators who have perceived challenges with their own team based course activities relating to a lack of student engagement, a tendency to work from a narrow set of perspectives, or symptoms of groupthink may benefit from introducing genAI agents, using an approach similar to the one described here.

This research contributes to the existing literature on genAI in education through its focus on the integration of genAI agents into the processes of newly formed student teams. Our findings suggest that genAI agents can create and then inject new and potentially controversial viewpoints into student discussion groups, thus stimulating student engagement, potentially challenging individual viewpoints, and expanding the lens through which students are engaging in collaboration. While generalizable to many problem based learning settings, these findings are of particular note for interdisciplinary, transdisciplinary, and interprofessional settings where collaboration and team problem-solving between various professional perspectives are required.

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Appendix A

VIPE AI Survey

Q1 What group number were you a part of?
Q2 What is your age?
Under 18 (1)
18–24 (2)
25–34 (3)
35–44 (4)
45–54 (5)
55–64 (6)
65–74 (7)
75–84 (8)
85 or older (9)

Q3 What is your gender?
Male (1)
Female (2)
Non-binary / third gender (3)
Prefer not to say (4)
Other (5) ____

Q4 What is your highest level of education?
Less than high school (1)
High school graduate (2)
Some college (3)
2 year degree (4)
4 year degree (5)
Master's degree (6)
Doctorate (7)
Please include any degrees in progress. (8)

Q5 What professional degree are you representing during today's IPE?

Q6 Artificial intelligence's feedback was helpful in supporting my group's work on the case.
Strongly agree (1)
Somewhat agree (2)
Neither agree nor disagree (3)
Somewhat disagree (4)
Strongly disagree (5)

Q7 In a few sentences, please explain how.

Q8 I perceived the input from artificial intelligence as if it were part of the interprofessional team.
Strongly agree (1)
Somewhat agree (2)
Neither agree nor disagree (3)
Somewhat disagree (4)
Strongly disagree (5)

Q9 Please explain your response.

Q10 What challenges or gaps did you perceive in working with or incorporating the feedback from artificial intelligence?

Q11 Going into this activity, I believed that AI can be a useful tool to support health sector work and collaboration.
Strongly agree (1)
Somewhat agree (2)
Neither agree nor disagree (3)
Somewhat disagree (4)
Strongly disagree (5)

Q12 My small group facilitator influenced how our group responded to and integrated AI into our work.
Yes (1)
No (2)

Using a Mobile Vocabulary Application to Enhance L2 Learners' Vocabulary Acquisition: Possibilities and Challenges

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Abstract

The use of mobile technologies has increasingly changed how students learn in the digital age. This study examined the effectiveness of using a mobile application called Shanbay Dan-Ci (SBDC) for acquiring new English vocabulary. Participants included 70 Chinese undergraduate L2 learners. Following a quasi-experimental design, two groups of L2 learners were randomly assigned to two conditions: using the mobile-assisted language learning (MALL) application or using traditional wordlists. A mixed methods approach examined the effectiveness of using MALL applications in developing L2 learners' vocabulary knowledge and exploring L2 learners' vocabulary learning experiences. Results indicated that L2 learners who used SBDC outperformed those who used wordlists, though the difference was not statistically significant. The results also revealed that L2 learners' SBDC learning experiences were highly impacted by certain learning features and strategies such as personalized learning, rich content, and collaboration. The discussion concludes with possible reasons for the statistically insignificant findings, the challenges of learning in a mobile environment, and implications and directions for future research.

Keywords: English as a second language (L2), vocabulary learning, mobile learning, mobile-assisted language learning (MALL)

Xu, Q., Richardson, J. C., Zhang, Z., Cheng, Z., & Guo, F. P. (2025). Using a mobile vocabulary application to enhance l2 learners' vocabulary acquisition: Possibilities and challenges. *Online Learning, 29*(3), 66-102. https://doi.org.10.24059/olj.v29i3.4918

Introduction

The rapid development of mobile technologies has provided rich opportunities for embedding diverse resources and communicative features into second language (L2) learning. Using mobile devices to learn languages has gained popularity among language-teaching practitioners and researchers (Chwo et al., 2018). Mobile-assisted language learning (MALL) has the potential to cease limitations of physical location and time (Kukulska-Hulme, 2009) and facilitate learning in a more collaborative, authentic, and natural way (Komppa & Kotilainen, 2018; Lotherington, 2018).

Scholars regard vocabulary as a key component for achieving proficiency in a second language (Schmitt, 2008; Nation, 2022; Masrai, 2023). Unfamiliarity with certain words may slow or even stop the flow of information processing, as learners' attention might be focused on single words rather than full sentences (Nation, 2022). Thus, vocabulary learning is necessary to optimize L2 acquisition (Nation, 2022), and L2 teachers, researchers, and learners continuously seek effective strategies to learn vocabulary (Schmitt & Schmitt, 2020; Nation, 2022). As Castañeda and Cho (2016) observed, research on mobile-assisted language learning (MALL) tends to follow two primary trajectories: (a) descriptive studies that detail the implementation of mobile learning interventions, and (b) outcome-focused studies that examine the learning gains facilitated by MALL. However, beyond implementation and learning outcomes, learners' perceived learning experiences remain underexplored. In particular, there is a need to investigate which mobile app features learners find most useful and how they engage with these features to support vocabulary acquisition. While the iPAC framework (Kearney et al., 2019) has identified key design principles (i.e., personalization, authenticity, and collaboration) that can optimize mobile learning strategies, little is known about how learners perceive and interact with these features during vocabulary learning.

Moreover, several challenges in vocabulary instruction have been identified, such as limited instructional time, the need for repeated exposure and rehearsal, and constrained peer interaction (Nation, 2022), especially in large classroom settings common in Chinese L2 learning contexts. These barriers raise questions about whether mobile-assisted vocabulary learning can effectively address such limitations by enhancing both vocabulary learning outcomes and learners' learning experience. To address these gaps, the present study investigates the effectiveness of a mobile-assisted vocabulary learning tool and explores learners' perceptions of its features in supporting explicit vocabulary learning among native Chinese speakers learning English.

Literature Review

Second Language Vocabulary Learning Strategies

Research has summarized some persistent and well-documented challenges in learning vocabulary including (a) the large amount of vocabulary necessary to enable L2 learners' successful use of the language; (b) the different levels of knowledge needed for recognizing and using a word; and (c) the time necessary for sufficient rehearsal and consolidation of vocabulary to avoid forgetting (Nation, 2022; Schmitt, 2010). To overcome these barriers, two main vocabulary learning strategies have demonstrated success: *implicit* and *explicit* vocabulary acquisition (Ellis, 2015; Schmitt, 2010). Implicit vocabulary acquisition argues that vocabulary is acquired unconsciously through exposure to varying contexts, while explicit vocabulary acquisition indicates that the new vocabulary acquisition process can be effectively facilitated by metacognitive strategies: (a) identifying unfamiliar words; (b) attempting to infer words from contexts by using dictionaries or consulting experts; and (c) consolidating the new vocabulary by repetition, semantic, or imagery mediation techniques. Further, Ellis (1995, 2015) argued that vocabulary acquisition involves complex learning processes; for example, perceptual vocabulary knowledge such as phonetic and pattern recognition will likely be acquired implicitly via exposure while semantic knowledge will likely be learned explicitly. Semantic elaboration and imagery mediation are used as "deep processing" strategies for better learning results (Ellis, 1995).

Recent research focuses on both implicit and explicit vocabulary teaching. Specifically, implicit vocabulary teaching includes lexical glosses and dictionary use, whereas explicit vocabulary teaching involves reading plus exercise and explicit instructions (Nation, 2022). According to Ma (2009), the implicit method provides richer contexts for learners but often results in a low retention rate. Although researchers advocate implicit vocabulary learning as the main source for acquiring new words in contexts, studies indicated that explicit vocabulary learning strategies are also important supplementary resources to help L2 learners build an adequate vocabulary. Mobile-assisted L2 vocabulary learning has been shown to enhance both affective learning (e.g., self-regulatory and metacognitive skills) and cognitive learning (e.g., word decoding, automation through repetitive practice) (Elaish et al., 2019; Fathi et al., 2018; Kohnke, 2020; Okumuş, 2023). These improvements are often achieved by integrating technology features such as goal setting, peer interaction and competition, and personalized learning plans (Castañeda & Cho, 2016).

Vocabulary Knowledge and Learning Outcomes

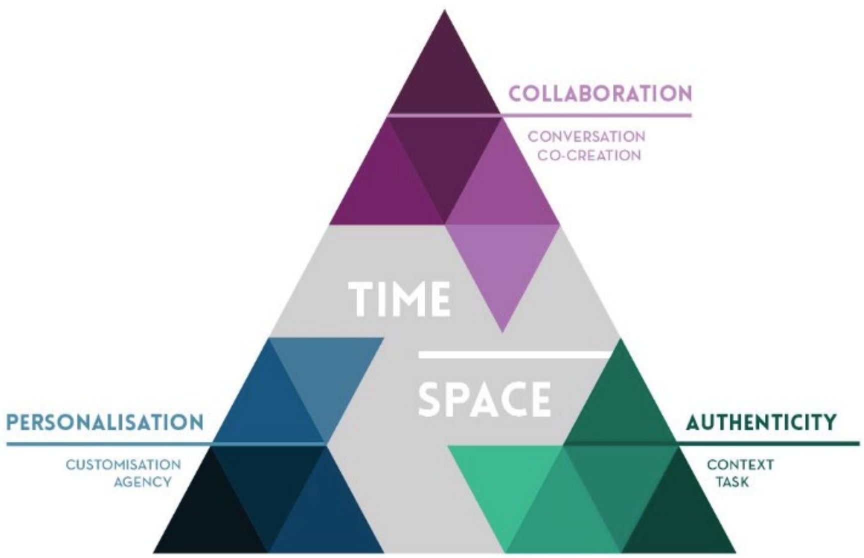
Anderson and Freebody (1981) first developed the concepts of *breadth* (i.e., how many words are known) and *depth* (how well those words are known) of vocabulary knowledge as two fundamental dimensions to measure vocabulary knowledge. As Nation (2022) explained, receptive vocabulary use is the ability to perceive the form and retrieve its meaning in reading and listening contexts, while productive vocabulary use is the ability to retrieve and produce the spoken or written form and express one's meaning. Nation (2022) found that knowing a word generally involves three levels: form, meaning, and use. Form includes spoken, written and word parts; meaning covers form and meaning, concept and referents, and associations; and use refers to the word's grammatical functions, collocations, and constraints on use. Receptive vocabulary knowledge refers to the ability to recognize the form-meaning linkage of a word, which represents an initial stage of the vocabulary depth dimension. Common assessment techniques for measuring form-meaning linkage include matching tasks, multiple-choice questions, translation exercises, and gap-filling activities (Sonbul, 2012). Linking form and meaning is beneficial, as it assesses whether learners can recall the meaning of a target word during reading or listening and retrieve its form or pronunciation when seeking to express the meaning (Nation, 2022). Thus, our study investigates how a mobile app serves as an explicit vocabulary learning tool improving L2 learners' form-meaning linkage knowledge, focusing on receptive vocabulary knowledge. Specifically, the dimension of vocabulary breadth.

The Personalization, Authenticity, and Collaboration (iPAC) Framework

This study used iPAC mobile learning as the framework (Kearney et al., 2020). Grounded in sociocultural theory, the iPAC framework highlights the unique affordances of mobile learning and consists of three dimensions: personalization, authenticity, and collaboration (PAC) (Kearney et al., 2020). Each dimension includes two sub-dimensions: the personalization dimension includes agency and customization; the authenticity dimension captures context and task; the collaboration dimension consists of conversation and co-creation.

Figure 1

The iPAC Framework



Note. The triangulate framework comprises three key components: personalization, authenticity, and collaboration. Positioned at the center of this framework are the interconnected elements of time and space.

This framework focuses on mobile learning beyond the tools (e.g., mobile devices, educational applications) and emphasizes the impact of learners' interaction. Stemming from Vygotsky's (1978) sociocultural learning theory, the iPAC framework suggests that learning is a social endeavor that can be modified through the mediation of mobile tools (Kearney et al., 2012). This study adopted the iPAC framework to explore learners' vocabulary learning experiences within a mobile environment. It was deemed an appropriate fit for the study based on the following: (a) the intervention activity occurred in a mobile environment that matches the distinction of the iPAC framework; (b) this study's embedded apps had several interactive features that allowed learners to engage and communicate within the learning community; (c) the application afforded personalized plans and supported adaptive learning for learners to interact with the content based on their learning progress. Table 1 outlines how the design of this study aligns with the iPAC framework. Key indicators are detailed in the fourth column.

Table 1

Dimensions and Key Indicators of the iPAC Framework as Applied in the Current Mobile-Assisted Vocabulary Learning Study

Dimensions	Sub-dimensions	Definition	Indicators elucidating the alignment of the study with the framework
Collaboration	Conversation	"The extent to which learners hold conversations around or through the mobile device with peers, teachers and other experts" (Kearney et al., 2019, p.753).	A social media group was created comprising consenting participants. Within the social media group, learners could ask questions and communicate with both instructors and peers.
	Co-creation	"The extent to which learners use a mobile device to co-create digital content and share information, data and artefacts" (Kearney et al., 2019, p. 754).	Learners were prompted to post their achievement badges, learning trajectories, or questions within the established social media group.
Personalization	Agency	"The extent to which learners have control over the place (physical and/or virtual), pace and time they learn, and autonomy over their learning content" (Kearney et al., 2019, p. 754).	Learners had the flexibility to access vocabulary learning content anytime and from any location through their mobile devices.
	Customizatio n	"The extent to which learners can customise their m-learning experience, both at the level of the tool (e.g., choice of apps, or the device itself) and the activity (e.g., adaptations of activity or challenge levels automatically provided by the app to suit the learner)" (Kearney et al., 2019, p. 754).	In this study, all learners used the same application. They configured their vocabulary study agendas and objectives based on their individual needs and requirements. The application also devised a vocabulary revision schedule based on the learner's proficiency.
Authenticity	Context	"The extent to which learners' mobile learning experiences are enhanced by	Audio, pronunciations and multiple example sentences were made available to assist

		realistic, meaningful content, or through ‘in situ’ learning in relevant physical and/or virtual settings” (Kearney et al., 2019, p. 754).	learners in understanding the target term in various contexts.
	Task	“The extent to which the mobile learning activities are realistic and offer activities relevant to the real world; and the extent to which the tasks and associated processes require use of apps and tools that replicate those of real-world practitioners.” (Kearney et al., 2019, p. 754)	For each target word, the application incorporated example sentences from past CET 6 readings, aiding learners in their preparations for subsequent examinations.

The Ambiguous Impact of Mobile Assisted L2 Vocabulary Learning

As mentioned earlier, L2 teachers have limited class time to teach vocabulary (Nation, 2022). Thus, it is necessary for both L2 teachers and learners to find an efficient self-directed strategy to learn vocabulary outside of the classroom. Mobile learning is recognized as an effective approach to bridging formal classroom instruction and informal situated learning experiences (Cochrane & Narayan, 2016). The personal and portable nature of mobile devices, as Kukulska-Hulme (2008) noted, enables continuous access to learning materials across various contexts. Learners find mobile learning more convenient, allowing them to access materials anytime, anywhere, so they can divide the learning into small chunks (Sung et al., 2016). This flexible structure aligns with cognitive principles such as microlearning and the spacing effect, both of which have been shown to enhance retention and long-term memory.

In addition, learners’ perceived learning perceptions toward a learning tool were found to be a crucial factor that impacts learning effectiveness and motivation (Habib et al., 2022; Li et al., 2021). For example, Castañeda and Cho (2016) found improvements in language accuracy and learning confidence among students using mobile applications. Li et al. (2021) also found that learners’ enjoyment while interacting with the mobile app positively influenced their perceived learning. However, Sharples (2006) noted that initial motivation might wane over time, highlighting the need for exploring sustained engagement strategies.

Despite the growing body of research, MALL studies face several challenges. Burston and Giannakou (2022) pointed out many studies are limited by small sample sizes (i.e., N < 10) or short treatment durations (i.e., T < 4 weeks), which can affect the reliability of results. In addition, with the continuous evolution of mobile technologies, the effectiveness of mobile-assisted vocabulary learning remains varied. While some research reports positive outcomes (e.g. Castañeda & Cho, 2016; Wu, 2015; Chen et al., 2019), others find no significant results (Stockwell, 2007, 2010; Tosun, 2015). Stockwell (2010) noted that learning on mobile devices requires more time compared to PCs. The increased time demand may contribute to user fatigue or reduced attention span, which are important factors to consider when evaluating the effectiveness and sustainability of mobile-assisted language learning, especially when discussing learners' engagement and persistence over time.

Recent studies have begun to address some of these gaps. Polakova and Klimova (2022) demonstrated the potential of mobile apps to enhance vocabulary performance and motivation in blended learning environments. Li and Hefner (2022) found that students using mobile tools outperformed those using traditional paper word lists in vocabulary acquisition. Our research builds on this by examining vocabulary learning behaviors outside the classroom in an informal setting, which demands higher self-directed learning skills (Cheng et al., 2025). We explore how students interact with mobile apps outside the classroom and manage their learning in non-formal contexts.

The field of MALL remains uncertain, necessitating additional empirical research for deeper exploration (Burson, 2014; Lin & Lin, 2019). The current study aims to build on this foundation by focusing on informal, self-directed learning outside the classroom. It examines mobile-assisted vocabulary learning through the iPAC framework, which considers personalization, authenticity, and collaboration. This research addresses several gaps in the field, including the need for longer treatment durations, exploration of informal learning contexts, and the application of the iPAC framework to MALL. SBDC, one of the most popular applications ranked in the iOS store's top 13 educational apps, was selected due to its popularity among Chinese college students for English vocabulary learning (Li & Wang, 2019). A survey by Wang (2020) and Su & Su (2015) revealed SBDC's appeal stems from its extensive vocabulary catalogs, gamification, robust scaffolding, learning analytics, attractive UI, and minimal advertisements. This study examined L2 students' form-meaning linkage of the target vocabulary and adopted the Shanbay Dan-Ci (扇贝单词) application (SBDC) as an explicit vocabulary learning approach.

Research Questions

1. Does the usage of the mobile-assisted vocabulary learning App SBDC improve L2 learners' vocabulary form-meaning linkage (VFML) knowledge compared to traditional paper wordlists?
2. What are L2 learners' perceived learning experiences (e.g., perceived satisfaction toward the app features, mobile learning perceptions, vocabulary learning goals, and strategies) of using SBDC?

Methods

Research Design

An explanatory sequential mixed methods design was adopted to examine the effect of SBDC on L2 learners' VFML and explore their experiences within the mobile application of SBDC (Clark & Ivankova, 2016). In the quantitative strand, a quasi-experiment was conducted to examine the effect of SBDC on L2 learners' VFML through pre- and post-word matching tests. Subsequently, qualitative data from questionnaires and interviews provided insights into learners' experiences and contextualized the quantitative findings.

Context and Participants

This study was conducted in a 16-week English course at a large university in Northern China in the spring of 2021. Clustered convenience sampling was applied to ensure participants had comparable intermediate-level English proficiency prior to the commencement of the intervention. They had passed the College English Test 4 (CET 4) before the study and were preparing for the College English Test 6 (CET 6) during their participation. A total of 74 freshmen were enrolled in two sections of the course and each section included the same instructor and content (e.g., materials, activities, assessments). Students were invited to participate in this study before the course started; all students agreed to participate and provided a signed consent form. However, four students missed the post-test and were therefore excluded from the study. The remaining 70 participants included 53 (76%) males and 17 (24%) females ranging from 18–21 years of age (M = 19.08). Following a quasi-experimental design, participants were assigned two conditions based on course sections. One section used the SBDC mobile application (experimental group), and the other section used a traditional wordlist (control group) to learn English vocabulary. The experimental and control groups included 32 and 38 participants, respectively. Human subject concerns have been addressed by obtaining the approval of Institutional Review Board (IRB).

Pre-Test Setup and Post-Test Timeline Overview

Within 10 weeks, both groups completed identical word matching pre-tests via Wenjuanxing (an online survey platform that allows users to create, distribute and manage survey data), which were randomly selected from the list of CET 6 vocabulary. All participants were provided with the same list of English vocabulary words, which were associated with the CET 6. The CET 6 is a national test that examines Chinese undergraduates' English proficiency according to the National College English Teaching Syllabuses (Zheng & Cheng, 2008).

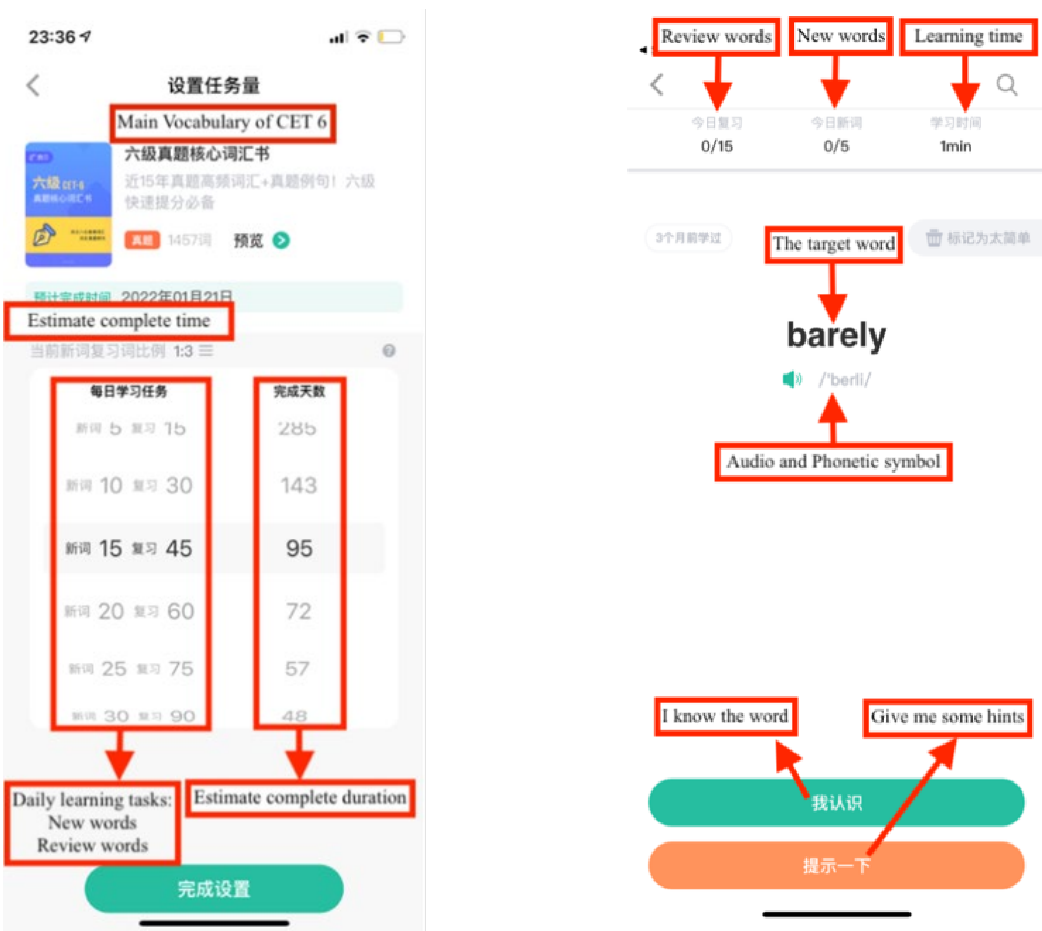
Participants were not given in-class time to learn English vocabulary but were encouraged to do so outside of class. The control group was encouraged to share photos of their learning notes, while the experimental group was encouraged to share digital learning badges within the group. To increase participants' likelihood of learning English vocabulary either through SBDC or the wordlist, a social media group was created for each group (experimental and control), which allowed learners to voluntarily share their daily vocabulary learning badges (see Figure 3, Screenshot C). It is important to note that social media groups were created for both the experimental and control groups to eliminate potential confounding effects of social media use on the study outcomes. This decision was made because the badge-sharing activity was not a built-in feature of the SBDC app but was instead facilitated through external social media platforms. Therefore, to maintain methodological rigor, equivalent social media environments were established for both groups.

Shanbay Dan-ci (SBDC) Application Features

The SBDC mobile application was used to facilitate the vocabulary learning intervention in the experimental group. The interface screenshots of the SBDC were captured in Figure 2 and Figure 3, and the authors obtained permission to publish the screenshots from the company. Key features employed in the study include personalized learning plans, audio pronunciations, Chinese translations, example sentences, a learning progress dashboard, and badge-sharing options. The app also tracks progress and generates reports on vocabulary mastery, learned words, and unfamiliar or unknown words. Social features encourage sharing digital badges on social media when daily goals are met. For this study, social media groups on QQ were set up for badge sharing among participants. Additionally, a digital calendar tracks login and badge sharing activities.

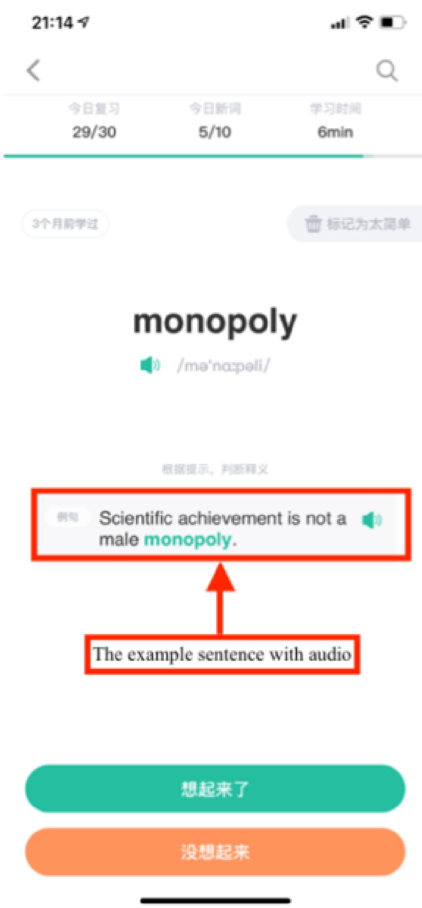
Figure 2

Shanbay Dan-Ci (SBDC) Vocabulary Learning Mobile Interfaces and Involved Social Media Groups



Screenshot (a)
Goal-setting page

Screenshot (b)
Recognition test page



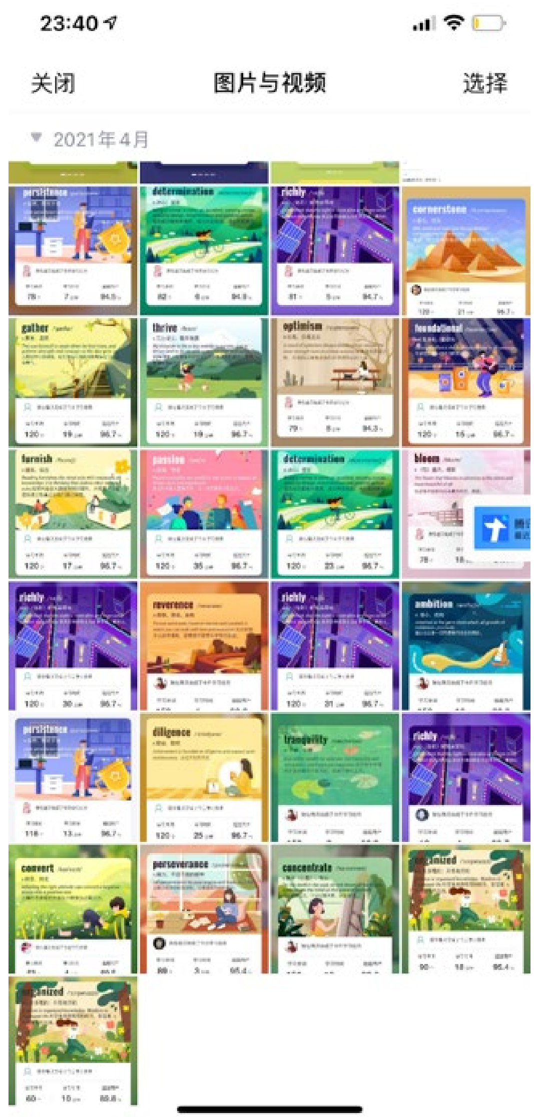
Screenshot (c)
Recognition test page with example sentence as hint

Screenshot (d)
Learning page with translations and example sentences

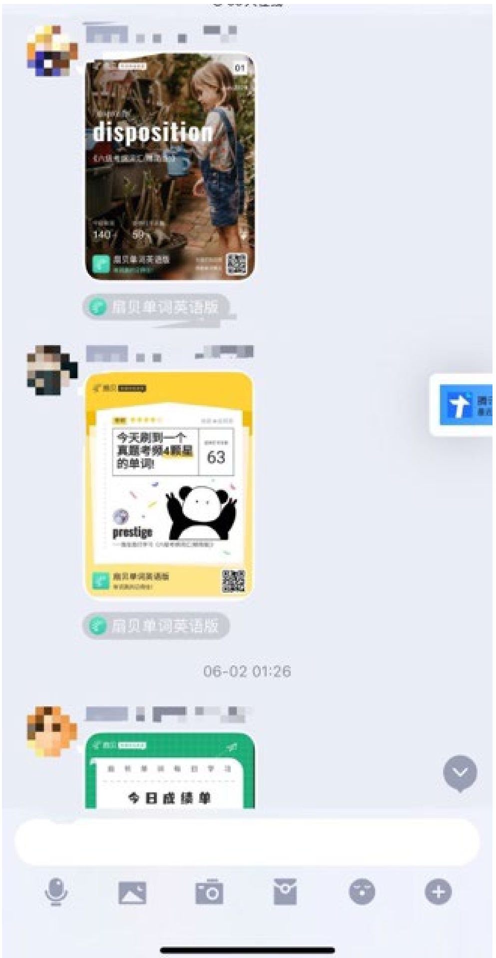
Figure 3

Learning Data and Activities

Screenshot (a)
Learning progress dashboard

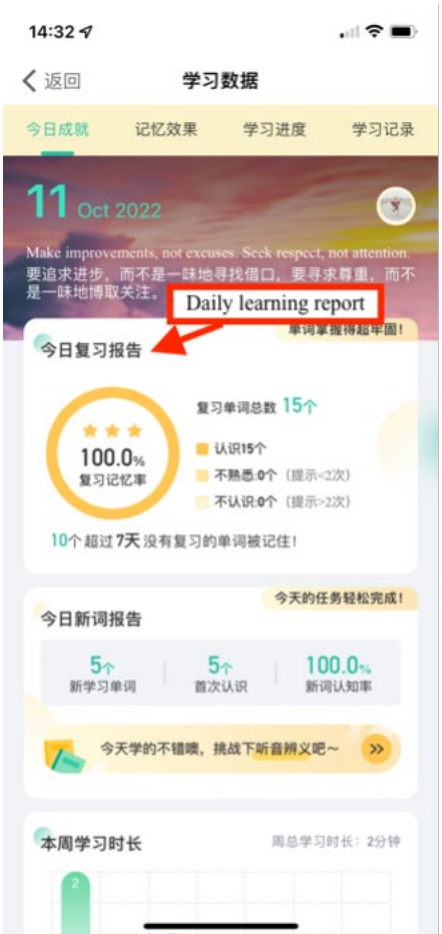


Screenshot (b)
Daily accomplishment badge sharing

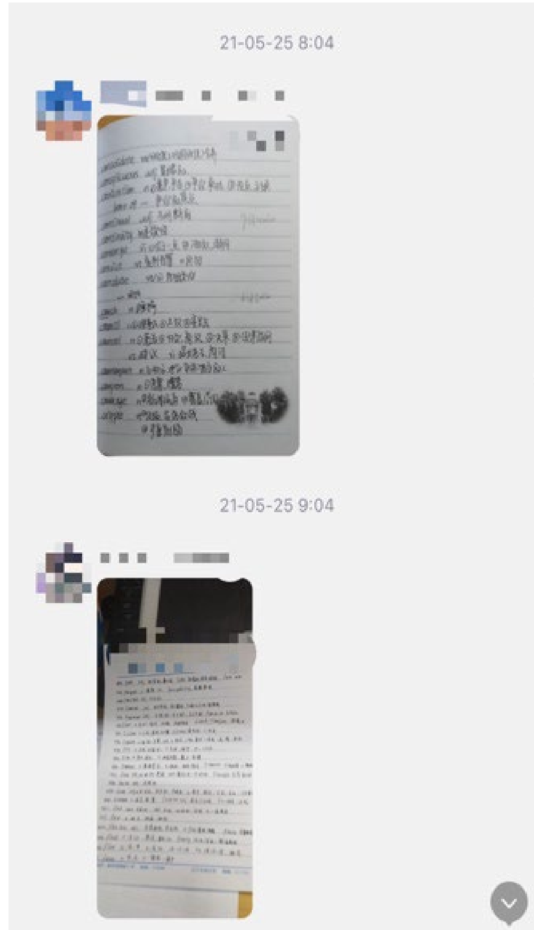


Screenshot (c)
Social media group

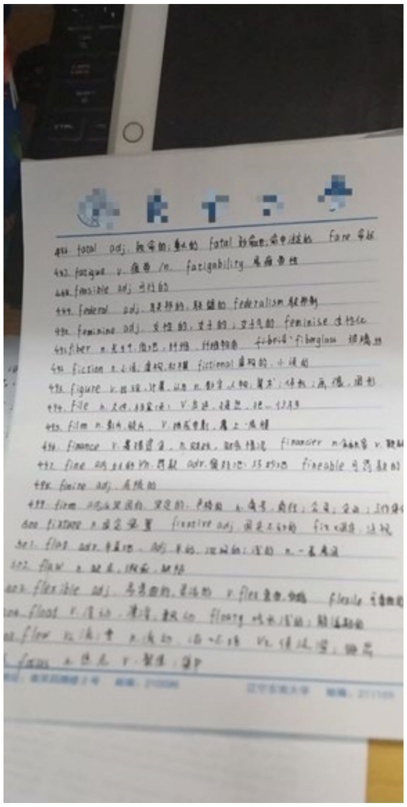
Screenshot (d)
Log data dashboard



Screenshot (f)
Learning report



Screenshot (g)
Control group accomplishment sharing



Screenshot (h)
Control group learning notes example

Data Collection

Quantitative Strand: Vocabulary Form Meaning Linkage (VFML) Knowledge

Quantitative data were collected through pre-and post-VFML tests (see Appendix B for sample questions), which assessed 75 randomly selected words from the 2416 CET wordlist, with each test using a different set of words. These tests were validated by three professors and demonstrating acceptable reliability (Cronbach's Alpha = .77) (George & Mallery, 2003). The test format was adapted from Webb et al. (2017), which used cluster matching format to increase transparency.

Qualitative Strand: L2 Learners' Perceived Learning Experiences using SBDC

To understand the influence of SBDC on learners' experiences, we conducted qualitative analyses guided by the iPAC framework, involving only the experimental group. After analyzing the quantitative data, an open-ended survey to evaluate and reflect on features of the mobile application was distributed to the experimental group (N = 32), from which eight participants were invited with their agreements for a post-course, semi-structured interview. Every student in the experimental group completed the open-ended survey, yielding a 100% response rate, and from this group, eight students were chosen to participate in interviews.

Open-ended survey. The survey (see Appendix C for specific open-ended questions) was distributed online via Wenjuanxing. Guided by the iPAC framework, the open-ended survey was designed to get more insights into how features in SBDC support personalization, authenticity, and collaboration. Participants spent 10–13 minutes completing the open-ended survey.

Semi-structured interview. Eight semi-structured interviews were conducted individually with one of the researchers. The interview questions were designed to investigate how learners perceived features in SBDC from the aspects of personalization, authenticity, and collaboration (see Appendix A for interview questions). All interviews were recorded and transcribed verbatim in preparation for data analysis. Each interview lasted approximately 30 minutes and was conducted online via Tencent Meeting, a video conferencing tool. All interview sections were recorded with the informed of each participant.

Interview case selection. For the interviews, participants were selected based on their outcome change in pre- and post-word matching tests. The learning outcome change refers to the difference in learners' vocabulary knowledge between the pre-test and post-test. For the interviews, participants were categorized into four groups based on the magnitude and direction of their score change: large negative change (≥10-point decrease), slight negative change (<10-point decrease), slight positive change (<10-point increase), and large positive change (≥10-point increase). (see Appendix D for interviewees' information). Previous studies reviewed that learners' learning outcomes correlated with perceived learning perceptions (e.g., Ozer & Kılıç, 2018; Mitchell et al., 2005), as such this study selected cases from different learning outcome change levels, to determine if there were any perceptual differences among learners in these groups. Since there was only one case in the large decrease group, we ended up selecting three cases in the slight decrease group.

Data Analysis

Quantitative Strand

Analysis of covariance (ANCOVA) was used to compare post-test VFML knowledge across groups while controlling for pre-test VFML knowledge as a covariate. Assumptions, including normality (skewness and kurtosis within acceptable ranges), homogeneity of variances (confirmed by Levene's test, $F = 0.32$, $p = 0.57$), and homogeneity of regression slopes (met with an interaction analysis, $F = 2.49$, $p = 0.09$), were satisfied. Notably, although the test for homogeneity of regression slopes exceeded the typical significance threshold (0.05), the marginal value (0.09) suggests that the ANCOVA results should be interpreted with caution.

Qualitative Strand

Coding was performed by a primary researcher and verified by a second coder to enhance reliability, using NVivo for qualitative data analysis. Two cycles of coding were conducted in accordance with Miles et al., (2014). Both inductive and deductive coding approaches were guided by existing knowledge, literature, and the central research questions to ensure alignment and trustworthiness in the findings (Braun & Clarke, 2006). Five predetermined aspects (collaboration, authenticity, personalization, time, and space) were generated from the iPAC framework and guided the coding process.

In the first cycle of coding, the primary coder adopted a holistic coding approach to first comprehend the general meaning of the responses to each question. Then a descriptive coding

(Saldaña & Omasta, 2016) strategy was used to generate the initial set of codes. We adopted In Vivo coding, using words or short phrases from the participants to generate first-level codes. Each code assigns related sentences or short paragraphs as data chunks. A total of 31 first-level codes were generated to cluster the segments relating to the research questions. The researchers grouped the codes into eleven categories (see Appendix E for the codes and the eleven categories).

In the second cycle of coding, the pattern coding strategy (Saldaña & Omasta, 2016) was used to revise, categorize, and summarize the codes generated from the first cycle. The categorization of the initial codes led to four themes related to different aspects of the learning experience within SBDC. First, the application features enhanced participants' learning experiences with regard to (1) Personalized learning within SBDC, (2) Collaboration supported by SBDC, and (3) Rich content. Second, from the interview data, (4) limitations and challenges experienced by participants emerged. Next, the identified themes were compared with the iPAC framework using a pattern-matching strategy (Miles et al., 2014). We compared patterns of similarities and differences across the eight cases with regard to their change-level differences.

Triangulation and Trustworthiness

To enhance face validity, two learners with similar characteristics and SBDC experience, along with a faculty member in educational technology, reviewed the learning outcomes test, open-ended survey, and interview protocol to ensure accurate representation of learners' perceptions using SBDC (Polit & Beck, 2006). Data from open-ended surveys and semi-structured interviews were collected to ensure triangulation (Merriam and Tisdell, 2016). After coding interviews, open-ended survey responses were compared and discrepancies were resolved through follow-up meetings with the instructor. Additionally, multiple coders were involved in the coding process to increase the internal validity (Merriam and Tisdell, 2016) and reliability. Regular research meetings were scheduled to discuss and solve questions and coding disagreements during the coding process. Both coders eventually achieved 100% agreement in the coding results. (See Appendix E for the coding scheme).

Results

Organized by the central research questions, the first set of results presents quantitative findings on the effects of SBDC's mobile-assisted vocabulary learning tool on learners' vocabulary learning outcomes. The second set of results presents qualitative findings on learners' perceptions and experiences organized by four themes: personalized learning, rich content, collaborative learning, and challenges of learning in a mobile environment.

RQ1: The effects of using SBDC on L2 learners' vocabulary form-meaning linkage (VFML) performance

The descriptive statistics in Table 1 show that L2 learners in the experimental group (M = 90.42%, SD = .06) scored an average of 1.3 percentage points higher than the control group (M = 89.12%, SD = .08) in the post-test. However, it's worth noting that, in the pre-test, L2 learners in the experimental group initially scored an average of 1.58 percent lower than the control group. These findings suggest that L2 learners who used SBDC for 10 weeks demonstrated superior performance compared to those in the control group, despite commencing the study with a lower average entry-level of VFML than their peers in the control group. Notably, although both the control and experimental groups showed a decrease in scores from pre- to post-test, this does not necessarily indicate a negative effect of the interventions. There are two main reasons. First, within-group pre/post comparisons can be misleading, as any observed changes may stem from uncontrolled confounding variables. Second, to enhance post-test reliability, in this study we excluded pre-test words when randomly selecting items from the 2,416-word CET list, ensuring the post-test assessed new vocabulary. While both tests drew from the same source, the randomly selected word sets may have differed in difficulty, making direct comparisons problematic. Therefore, in the inferential test, we focused on comparing post-test scores between groups using ANCOVA, controlling for pre-test scores.

Table 1

Descriptive Statistics of VFML in Pre- and Post-Test Across Groups

Group	Test	N	Mean (%)	SD
Control Group (wordlist)	Pre-test	38	93.31	.06
	Post-test	38	89.12	.08
Experimental Group (SBDC)	Pre-test	32	91.73	.07
	Post-test	32	90.42	.06

Table 2 displays the inferential results of the ANCOVA used to test the effect of using the mobile-assisted vocabulary learning application SBDC on L2 learners' VFML performance after controlling for their pre-performance in VFML. Results revealed that the covariate, pre-performance in VFML accounted for significant variance in L2 learners' VFML, F (1, 67) = 4.60, $p < 0.05$, thus confirming the necessity of this variable's inclusion in the model. A non-significant effect of integration of SBDC on VFML was detected, F (1, 67) = 1.02, $p = .315$. The inferential findings imply that while L2 learners who employed SBDC outperformed those who used a traditional word list in the post-test, this difference did not reach statistical significance after controlling for the baseline VFML scores measured in the pre-test.

Table 2

ANCOVA Results (Dependent Variable: Post-test VFML)

Source	Sum of Squares	df	Mean Square	F	P value
Intercept	.10	1	.10	18.85	<.001
Pre-test VFML (Covariate)	.03	1	.03	4.60	.036
SBDC versus wordlist (intervention)	.01	1	.01	1.02	.315
Error	56.73	67	.01		

RQ 2: L2 learners' perceived learning experiences of using the SBDC App

Even though interview participants were selected based on their learning outcome change, interestingly, perception differences were not identified between the two groups with extreme outcome changes. The four major themes (personalized learning, rich content, collaborative learning, and challenges of learning in a mobile environment) are elucidated in the following section.

Theme 1: Personalized Learning Within SBDC

Repetition and personalized review plan. One of SBDC's pre-designed features mentioned by interviewees was the "review" function. As Fang mentioned:

> I found the review function helpful because it forced me to review. Previously, I [didn't] like reviewing. […] But this time the app put the word in front of me and [told] me, "You do NOT know this word," [which forced] me to learn it again. This is very helpful.

The review feature also helped learners correct their interpretations. As Xing indicated:

> Sometimes I think I know what it [the word] means, and then I click on "I know this word". When its translation pops up, I find it doesn't match what I think. Then when I review it the next day, I see the word and I remember that I made some mistakes on this word.

Qing also found the app to be more helpful than a paper book or wordlist:

> Previously [when using the paper book to learn vocabulary], if there was a word that I [was] not familiar with, I learned it once and after that, I didn't review it at all. On the opposite, the app will keep showing me the word that I am not familiar with until I remember it.

Self-checking and reflecting. The pre-set instructional design offered learners time to self-check and guess the meaning based on context provided by the example sentences. For example, Fang expressed:

> I look at the example sentence and guess what it means. In sum, I recall the meaning of the word according to the format, or I recall the meaning of the word in the context by using example sentences. These two are the most important to me.

Goal-setting. One of the features that interview participants mentioned was the goal-setting feature that is embedded in the app. The auto-generated plan of study provided learners with clear information for daily tasks (i.e., the number of new words to be learned and the number of review words remaining), as well as estimated finish time to help learners design the learning plan according to their needs. Fang shared,

> I know I have to learn 2,416 words in 3 months in order to make myself well prepared for the CET 6 […] I pushed myself so hard and I felt tired during the learning process.

> However, I [couldn't] finish the list if I didn't set up the plan, so I appreciate it. The learning process was tough, but I appreciate it.

Throughout the learning process, the app allowed learners to modify their goals based on their learning pace. Lu described,

> Initially, I set up 200 new words per day. I modif[ied] the daily goal to 50 new words, which [was] manageable. If I wanted to continue, I [could] click on "Continue".

Self-monitoring: Recognizing learning progress. The learning dashboard page embedded in the app recorded learners' learning data. According to the open-ended survey responses, there is a dashboard that allows learners to track learning progress, time spent, and log frequency. Four survey respondents mentioned that they felt rewarded when their persistence and progress were acknowledged between learning activities.

Further, the daily learning report page (Figure 8) provided learners the opportunity to recognize their overall progress, personal strengths, and opportunities for growth. Han found the learning report page particularly helpful and stated:

> The report page tells me how many "new words" and "review words" I have mastered. Now, my mastery rate is between 65%–75%, which means I know at least 65%-75% of CET 6 vocabulary. I think this is a good reference to know my vocabulary level.

Learning environment and time choice. Mobile learning is known for its flexibility in that learners can access the material anytime. As indicated by participants in the open-ended survey, they learned lexical knowledge in different settings including dormitory, classroom, library, bus station, and canteen.

In the interviews, some participants indicated that they did not allocate specific times for learning; rather, they occasionally used spare time to complete their daily tasks. For example, Lu said he chose different places for vocabulary learning when using a mobile device rather than paper books:

> I usually learned vocabulary in the dormitory when I was using [a] vocabulary book, which is my typical learning place for other subjects as well. When I used my mobile phone, I learn[ed] it anytime if I have time.

<u>Theme 2: Rich Content</u>

Multiple learning resources: Audio and example sentences. The technology-enhanced learning environment has embedded vocabulary translation, audio, and multiple example sentences to help learners develop their vocabulary knowledge. In the open-ended survey, 24 respondents indicated that they found the audio helpful because (a) it helped them correct inaccurate pronunciations and (b) it enhanced students' capability of memorizing new words. Xing explained:

> Audio and example sentences are the most helpful features of the app. By adding pronunciation and pop-up example sentence, you [as a learner] can quickly reflect the meaning and has a deep impression of the word.

Rong agreed that the audio helped activate his visual and auditory senses, which enhanced his memorization of the target word:

> I didn't pay much attention to pronunciation when I was using a book to memorize vocabulary. In the App, it will automatically pop up the word pronunciation and read the example sentence for me. I feel like not only my eyes are learning, but also my ears.

Theme 3: Collaborative Learning Supported by SBDC

Social interaction: Badge sharing. Overall, participants found badge sharing to be helpful reminders for ongoing learning. For example, Xing said:

> When I was browsing Weibo or playing games, there [were] some messages from the QQ group showing that my peers are sharing the badge. I knew it wouldn't take a long time to complete today's task, so I would rather open the app and finish it. It [was] a good reminder for me.

Interestingly, Qing found some social incentives by sharing the badge. One of QQ's features involves rewarding a "spark" icon to users who participate in the conversation for more than seven days. Qing said the "spark" icon became her motivation to persist in the learning activity and share the badge:

> If I skip[ped] my learning for a day, my spark icon disappear[ed]. […] I wanted to avoid this, so I follow[ed] the pace and complete[d] my [vocabulary learning] task on time."

Hong also found that badge sharing supported his learning persistence:

> Badge sharing push[ed] me to learn it every day. […] It was hard for me to persist. Sometimes I am just lazy to do it [vocabulary learning]. I see that everyone is sharing the badge. Then I feel like I have to complete today's learning task, and I go ahead and finish it.

Fang said he was able to finish the CET 6 vocabulary list learning goal mainly because of the badge sharing activity:

> It is very necessary for me to have the QQ group share the badge. I bought two books for my CET 4, but the final result is that I never opened them. So, I am proud that I have finished learning the vocabulary list of CET 6 this time.

Theme 4: Challenges of Learning in a Mobile Environment

Content limitation. In the interviews, learners indicated that their receptive vocabulary knowledge increased but felt that productive vocabulary knowledge was not emphasized throughout the process. For example, Han indicated, "my expectation of learning vocabulary within the app is to recognize the meaning in the reading process, but I don't think I know how to use the new word in writing and speaking because the app didn't introduce related knowledge."

Further, Fang criticized the app's focus on connecting a word's form and meaning without providing opportunities to learn other areas of vocabulary knowledge (e.g., spelling, grammar functions, and collocation). Fang explained:

> It [the vocabulary learning activity] helped me in reading tasks, but I don't know how to use it and when to use it. How can I know if I "remember" the word?

Distractions. Participants found it hard to concentrate in a mobile learning environment. Lu shared:

> I usually finish my daily task in the dormitory or canteen because I want to use the spare time to finish the task. However, I found it hard to concentrate because there are so many distractions. Some notifications or messages are also very distract[ing].

Some learners indicated too much multimedia information was distracting and overwhelming. For example, Fang said: "I was using another app that provides pictures related to the target words. Some pictures are confusing and unspecific, so I was distracted by the picture instead of focusing on memorizing the meaning of the new word."

Usability issues. Participants were also dissatisfied with the quality of the app, which contributed to their giving up on the learning goal. Ming explained: "The app adds all newly learned vocabulary to the review list. I have to click on 'remove this word from my list' so it will remove. It is dumb."

Mobile learning acceptance. Although digital learning has gained popularity and is widely used among college students, the general acceptance of mobile learning environments varies. As Lu indicated: "I don't like learning with digital devices. I would prefer to use a paper list to learn."

Compared to paper books, mobile vocabulary learning is more flexible; however, this does not always benefit learners. For example, Han said:

> Paper books might be better for me because I would take the learning activity seriously. For example, I will allocate a specific time and find a quiet place to learn if I use a paper book. That would become a routine for me.

Discussion

This study distinguished itself from previous studies in several ways. Firstly, the treatment duration extended to 10 weeks, which could be considered a longer treatment duration (Lin & Lin, 2019). Secondly, the study was conducted in informal settings and offered learners enhanced autonomy in their learning process—a factor seldom encountered yet and was highly valued in mobile-assisted vocabulary learning research (Lin & Lin, 2019). Although mobile-assisted vocabulary learning research has proliferated since the 2000s (Burston & Giannakou, 2022; Lin & Lin, 2019), limited studies contextualized mobile-assisted vocabulary learning within the iPAC framework, which concentrates on the personalization, authenticity and collaboration dimensions of mobile learning. This study highlights and interprets students' technological usage through the lens of iPAC. As the use of digital devices and mobile software proliferates, it is necessary to explore ways to leverage technology for learning (Kearney et al., 2020). Research question one investigated if the SBDC experimental group demonstrated significant vocabulary acquisition improvement compared to the control group. Results revealed that participants in the experimental group had a lower level of VFML performance than the control group at the beginning and ended up outperforming the control group in the post-test, although the difference in the post-test was not statistically significant. This result aligned with Burston's (2015) meta-analysis of 291 MALL studies, which found four vocabulary-focused studies that revealed no significant improvement in learning outcomes using mobile Apps. Several potential reasons may explain the insignificant results. First, vocabulary learning is an incremental process that requires long-term investments (Nation, 2022). As Lin & Lin (2019) noted, treatment duration is a key factor that moderate the effect of mobile-assisted vocabulary learning. Even though a 10-week intervention has been considered a comparatively long treatment duration in the MALL field (Burston, 2015), it is still not enough to observe a significant vocabulary acquisition improvement. In addition, observations from the social media group indicated that control group learners engaged in note-taking. Note-taking had been recognized by previous researchers as a key strategy for vocabulary learning as it allows learners to actively reflect on their learning process (Jin & Webb, 2021). This reflective practice is recognized as a self-regulatory behavior strategy, which has been shown to have a strong correlation with learning outcomes (Cheng et al., 2025). Furthermore, due to the voluntary nature of the research, students' time spent on vocabulary learning varied. Kojic-Sabo and Lightbown (1999) noted that time spent and learning independence (i.e., autonomous sourcing, practice opportunities, personalized activity preference) significantly impact the vocabulary learning outcomes. They found that increased time and effort in vocabulary study led to greater vocabulary learning success. Given the fact that this study dates back over two decades, questions arise about its applicability in the context of MALL. Do digital tools inspire L2 learners to invest more time in vocabulary study and enhance their autonomy, or does MALL lead to a more efficient learning process with less time invested but improved outcomes? Can digital tools equalize learning time and effort, or do they reinforce learner independence gaps? Further research is needed to answer these questions.

Moreover, the lasting impact of mobile-assisted vocabulary learning on learning outcomes remains unclear. As noted by previous researchers (Sung et al., 2015; Lin & Lin, 2019) on the ongoing issue of MALL: distinguishing whether the language learning improvements are genuinely due to the mobile learning intervention or just from the novelty effects of mobile technology's advanced features. Future research is called to track changes in learners' attitudes over time and consider extending the duration of the intervention for a more precise conclusion.

Regarding the second research question, while SBDC was deemed helpful for its engaging learning design, challenges and concerns were also identified. In the following section, we will explore how the findings of this study correspond to or deviate from prior literature based on the iPAC framework. Concluding thoughts, along with recommendations and implications, will be addressed at the end.

Personalization Dimension

Kearney et al. (2020) defined mobile learning personalization as the learning tool's flexibility allowing learners to tailor their learning activities by time, pace, and location based on individual needs and preferences. Findings in the qualitative part amplify the personalization dimension of the iPAC framework from the perspective of individualized goal setting; personalized review plans; repetition; self-check and monitoring; rich learning resources. These features align with criteria in Nation's Technique Feature Analysis (NTFA), which is used to evaluate the effectiveness of a vocabulary learning activity. According to the NTFA (Nation, 2022), a productive vocabulary learning activity should involve: motivation (e.g., clear vocabulary learning goals); noticing (e.g., increased awareness of new vocabulary learning); retrieval (e.g., multiple retrieval, recall, and spacing repetition opportunities); varied use (e.g., marked change that involves the use of other words); retention (e.g., meeting and linking the correct form and meaning) (p. 103).

Aligning with previous research (Cheng et al., 2025; Li et al., 2021) that emphasizes the role of goal setting and learning progress monitoring in undergraduates' learning with technologies, this study found these features fostered metacognition. Students benefited from setting goals, tracking, and reflecting on their progress, which is crucial for mobile learning's objective of enabling learning beyond classrooms (Kearney et al., 2020). The goal-setting and progress monitoring features supported learners' autonomy in managing and reflecting on their learning progress (Li et al., 2021). In addition, Xu and Richardson (2024) found that certain app features, such as badge-sharing, can effectively enhance students' self-regulation skills, such as time and environmental management, goal setting, and self-evaluation. The personalization of learning plans, particularly the tailored review of vocabulary, facilitated efficient learning by focusing on individual needs. This method leverages the spacing effect—revisiting material after intervals—for effective vocabulary acquisition (Nation, 2022), reinforcing the concept of dividing content into small chunks for improved knowledge retention (Giurgiu, 2017).

Collaboration Dimension

The study illuminated the collaboration dimension within the iPAC framework, emphasizing conversation and co-creation as described by Kearney et al. (2020). Learners were motivated by observing other peers' vocabulary learning progress in the badge sharing activity, aligning with the framework's call for collaborative, relevant activities in mobile learning. Furthermore, Consistent with social cognitive theory, observing peers' progress (i.e., behavior modeling) enhances learners' self-efficacy and learning strategies (Compeau & Higgins, 1995). This is a valuable gamification feature that facilitates L2 vocabulary learning.

Although L2 learners benefit from MALL tools in many aspects, there are challenges in leveraging the full communicative potential of mobile technologies for language learning (Kukulska-Hulme et al., 2017; Burston, 2015). In this research, students shared achievements via badges but lacked deeper interaction, such as discussing learning experiences or seeking peer or instructor support within the app. Strategies that can foster further interaction and engagement among students require further exploration.

Authenticity Dimension

Kearney et al. (2020) frame authenticity in learning through relevant context and real-world tasks. Although the mobile-assisted vocabulary learning activities in this study incorporated authentic elements, the qualitative data revealed limitations in providing comprehensive vocabulary knowledge. SBDC's design focused predominantly on receptive knowledge, leaving learners less prepared for productive application in speaking and writing. This input-centric approach resulted in superficial vocabulary acquisition, echoing concerns by Bahari et al. (2022) about the digital learning focus on receptive skills. This finding aligns with Mahdi's (2018) meta-analysis which concluded that most mobile-assisted vocabulary learning studies focus on the receptive area of knowledge. This further aligns with Schmitt & Schmitt's (2020) conclusion that learning vocabulary from a wordlist enables students to learn limited aspects of knowledge (i.e., word form, meaning, form and meaning linkage), but ignores the depth of the knowledge which makes it difficult for learners to apply target words in speaking and writing tasks. While an explicit vocabulary learning strategy is an effective way to expand vocabulary size, massive reading and implicit learning remain the main sources of acquiring new vocabulary. Both L2 learners and educators need to recognize the value of integrating explicit and implicit vocabulary learning strategies. Beyond merely using mobile-assisted vocabulary learning tools as supplemental resources, it is crucial to enhance exposure to the target vocabulary within authentic English contexts.

Overall Mobile Learning Experiences

Maintaining concentration in a mobile learning environment can be challenging. This is unsurprising given the fact that mobile devices were originally designed for entertainment and communication purposes. Using mobile devices for learning and pedagogy is an ongoing area of exploration (Kearney et al., 2020). In this study, participants had trouble concentrating on learning due to distractions in both physical and online environments. For example, some learners did not allocate a specific time or reserve a location to proceed with the learning task but instead chose to complete the daily learning task in a dormitory, bus station, or canteen. Although the informal environment provides extra flexibility for learners, it also adds distractions (Kearney et al., 2020). In addition, instant messages, notifications, and phone calls can interrupt the learning process. The challenges identified in this study echo those noted in previous research findings. For example, technological constraints, including insufficient cellular network or limited wireless access, small screen, short battery, can impede learning (Criollo et al., 2018, 2021; Dashtestani, 2016; Saikat, 2021). Personal learning choices, such as unwillingness to try new software, limited experience in using mobile devices to learn, could also hinder learners' engagement within the mobile learning environment (Dashtestani, 2016; Criollo-C et al., 2018, 2021; Saikat, 2021), particularly among aged learners (Saikat, 2021). In addition, incompatibility with social norms, such as source of distraction, fail to facilitate collaboration in real learning settings, additional efforts to facilitate mobile learning activity, privacy concerns, limited communication opportunities or technology anxiety can pose significant challenges for learners (Saikat, 2021; Criollo-C et al., 2018, 2021). Besides, several limitations of the App were also identified from the qualitative results. For example, there was a lack of opportunities for students to acquire productive vocabulary knowledge, environmental distractions posed challenges, self-evaluation opportunities were limited, and the app was not sufficiently intelligent to create personalized vocabulary study plans (see Section *6.2.4 Theme 4:*

Challenges of Learning in a Mobile Environment for more details). These findings echo previous studies indicating that mobile language learning, especially mobile vocabulary learning, should strive to create a more contextualized, personalized, and socially interactive environment to better facilitate students vocabulary learning (Kukulska-Hulme et al., 2017; Lin & Lin, 2019; Stockwell & Hubbard, 2013; Tommerdahl et al., 2024).

Limitations

Several limitations are present in this study. First, while the intervention duration of 10 weeks is considered long by some standards (Burston 2022; Lin & Lin, 2019), it may not be sufficient to assess vocabulary retention fully. Given that vocabulary acquisition is a gradual process, significant gains might not be evident within a brief four-month timeframe. Future studies might benefit from lengthening the intervention period to observe potential differences. Second, this research primarily centered on learners' passive knowledge, specifically the linkage between form and meaning. Subsequent research might broaden its focus to explore other facets of vocabulary acquisition, such as lexical depth and fluency. In addition, this study included 70 participants ($N = 38$ in the control group and $N = 32$ in the experimental group), which is a relatively small sample size for detecting statistically significant effects. While ANCOVA was employed to control for initial differences in performance, the limited sample size may reduce statistical power and increase the risk of a Type II error. However, this limitation was mitigated by our follow-up qualitative analysis, which triangulated the quantitative data and provided deeper insight into the participants' learning experiences. Nevertheless, future studies should consider recruiting a larger sample to enhance statistical power and generalizability. Lastly, despite efforts to ensure that the control group used traditional paper-based materials and the experimental group utilized the mobile app, there's a possibility that some participants in the control group accessed the app without reporting.

Conclusion

This study examined the impact of mobile applications on L2 learners' English vocabulary learning. In the digital age, mobile technology, including mobile language learning, has been applied to promote flexible, self-directed learning. Various mobile vocabulary applications are available on the market, but limited research explains how they impact the learning process and whether they are effective in improving learning outcomes. This study found that mobile application users' learning outcomes will not significantly improve in a short period. However, the mobile application's digital dashboard function facilitates peer monitoring and promotes the metacognitive learning process. The affordance of the mobile application itself supports flexible use, which allows learners to learn anywhere and anytime; in this study, participants shared their daily accomplishments within the social media group, which served as a self-monitoring process. This article provides up to date insights into the effects of mobile application use on vocabulary acquisition for L2 learners, teachers, and mobile application designers. Nevertheless, as asserted by Nation (2022), technology tools can facilitate vocabulary learning but do not magically improve vocabulary learning. L2 learners may note that expanding vocabulary size is a long-term commitment.

In addition, this article provides insight into the effects of mobile application use on vocabulary acquisition for L2 learners, teachers, and mobile application designers. Regarding implications, L2 learners should note that expanding vocabulary size is a long-term commitment. While teaching vocabulary is not the main objective during class time, L2 teachers can embed technology-based activities to enhance vocabulary acquisition beyond the classroom. This is especially true for L2 teachers who have large classes, allowing them to use mobile technology to further support personalized learning. In addition, technology can potentially help teachers create collaborative opportunities in the class, so learners can benefit from observing peers' learning strategies. Although learners in the 21st century have been recognized as "digital natives" (Prensky, 2010), they do not necessarily know how to incorporate mobile technology into their learning. Thus, when embedding mobile technology, L2 teachers should be aware of the different needs of learners and consider alternative ways for learners who are not comfortable learning in a mobile environment. Lastly, it is essential for software designers to understand the cognitive process of vocabulary acquisition and explore additional features such as multimedia resources, language contexts, and grammar usage to better assist users' vocabulary acquisition.

The study unearthed an intriguing observation: although learners in the twenty-first century have been recognized as "digital natives" (Prensky, 2010), they do not necessarily know how to incorporate mobile technology into their learning. Thus, when embedding mobile technology, L2 teachers should be aware of the different needs of learners and consider alternative ways for learners who are not comfortable learning in a mobile environment. Lastly, it is essential for software designers and mobile language learning App developers to understand the cognitive process of vocabulary acquisition and explore additional features such as multimedia resources, language contexts, and grammar usage to better assist users' vocabulary acquisition.

In the digital age, mobile language learning apps promote self-directed learning. Mayer (2020) emphasizes the flexibility of mobile apps in a special issue on mobile learning, noting their capacity to enable learning at any time and place. Users often employ social media for self-monitoring, and these apps provide tailored learning opportunities and support micro-learning, allowing students to break down knowledge into small chunks. While recognizing the value of flexibility, personalization, and micro-learning facilitated by mobile learning, Mayer (2020) notes that many studies overlook a critical aspect: learning outcomes. This study contributes to the gap by examining actual learning outcomes to determine the effectiveness of mobile learning apps in the language learning process but finds nuanced evidence. Results indicated that while mobile apps may not significantly improve learning outcomes in the short term, they support flexible learning and peer monitoring through digital dashboards and social media sharing. These findings highlight the need for further research into the long-term impact of mobile learning. As mobile technology continues to evolve, it's crucial to explore how learners' attitudes change and which psychological learning theories can be adapted to suit the unique nature of mobile learning. More comprehensive studies are essential to deepen our understanding of these issues.

Declarations

The authors declare no conflicts of interest.

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Appendix A

Semi-structured Interview Questions

1 General questions:

1.1 Did you use any other mobile vocabulary learning Apps except Shanbay? If yes, do you like them? Why or why not?

1.2 Before participating in the Shanbay activity, how did you learn English vocabulary? What kind of strategies did you use?

1.3 During the Shanbay learning activity, can you share your general satisfaction with the App? Do you like it? Why or why not?

2 Pedagogical features in SBDC that potentially support personalization, authenticity, and collaboration during the learning process:

2.1 Which feature(s) of Shanbay do you like the most? Why?

2.2 Which feature(s) of Shanbay do you like the least? Why?

2.3 What are your vocabulary learning expectations? Do you aim to recognize them during reading and listening tasks, or use them in writing and speaking? Did you find Shanbay helpful in helping you reach your expectations? How?

3 Learning perceptions related to the mobile-learning environment:

3.1 In most situations, where did you complete vocabulary learning tasks? What kind of learning environments did you choose? Why?

3.2 How do you feel about learning in a mobile environment?

3.3 Will you continue to use Shanbay in your future English vocabulary study? Why or why not?

Appendix B

Form-meaning Test Sample Questions

* 1. Choose the right answer

	加强，加固；强化	燃烧；发光；怒视；宣扬	负责的，可靠的	管理；规则	初步的；开始的	抑制，控制；约束
blaze	○	○	○	○	○	○
preliminary	○	○	○	○	○	○
regulation	○	○	○	○	○	○

* 2.

	精确的；明确的	纬度；界限	前任，前辈	经度；经线	官僚主义	初步的；开始的
bureaucracy	○	○	○	○	○	○
latitude	○	○	○	○	○	○
predecessor	○	○	○	○	○	○

* 3

	派遣，发送	压坏，压扁	人群；观众	交叉，十字	重要的；决定性的	种植；收割；修剪；剪短
dispatch	○	○	○	○	○	○
crowd	○	○	○	○	○	○
crop	○	○	○	○	○	○

Appendix C

Open-ended Survey

Open-ended survey

What time of day do you most often use the Shanbay App for your daily learning tasks, and why do you prefer this time? Please describe your typical situation or context when using the app.

Please describe the place where you usually complete your daily learning tasks with the Shanbay App. What makes this location suitable for your studies?"

Which following features of the Shanbay App have you used as part of your learning process? Please explain how you use each feature and assess its usefulness. Additionally, if there are any features you have consciously chosen not to use, please explain your reasons.

Audio pronunciation_______________
Example sentences_______________
Example sentences specifically from CET 6 _______________
Set daily learning goal_______________
Badge-sharing_______________
Badge-sharing calendar_______________
Unfamiliar words book_______________
Notes_______________
Notifications_______________
Other features _______________

Appendix D

Interview Participants' Demographic Information

Participant (Pseudonym)	Gender	Major	Pre-test	Post-test	Learning outcomes change (Largest decrease: -13, largest increase: +13)
Ming	Male	Civil Engineering	91.67	78.67	Large decrease (-13)
Hong	Male	Information engineering	93.75	89.33	Slight decrease (-4.41)
Qing	Female	Information engineering	93.75	90.67	Slight decrease (-3)
Rong	Male	Information Science and Technology	97.92	97.33	Slight decrease (-0.58)
Fang	Male	Biological Sciences and Medical Engineering	95.83	97.33	Slight increase (+1.5)
Lu	Male	Computer Science and Engineering	93.75	97.33	Slight increase (+3.58)
Han	Male	Computer Science and Engineering	81.25	94.67	Large increase (+13.42)
Xing	Male	Computer Science and Engineering	81.25	94.67	Large increase (+13.42)

Appendix E

Coding Scheme

Codes	Code Frequency	Categories	Themes
Audio	12	Multiple learning resources	Authenticity: Rich contents
Example sentence	7		
Learn in contexts	8		
Badge sharing	26	Social interaction	Collaboration: Collaboration supported by SBDC
Social media recognition	4		
Reminder	3		
Review learned words	3	Repetition and personalized plan	Personalization: Personalized learning within SBDC
Correct wrong memorization	1		
Save unfamiliar words	2		
Enhance memorization	4		
Guessing	1	Self-check and reflecting	
Testing	2		
Hint	1		
Daily new vocabulary task set up	1	Goal – setting	
Daily review vocabulary task set up	1		
Learning pace modification	2		
Progress checking	5	Learning progress monitoring	
Learning data	1		
Feeling of awarded	4		
Location of the learning activity (e.g. dormitory, classroom, library, bus station, canteen).	9	Learning environment and time choice	
Time management	4		
Anti-digital	1	Mobile learning acceptance	Challenges of learning in a mobile environment
Too flexible	2		
Message and notifications	2	Distraction	
Overwhelmed	1		
Technology is not function well	1	Ease of use	
Picture disadvantage	5	Content limitation	
Reading only	2		
Spelling	2		
Productive use	3		
Vocabulary learning preference	5		

From Burnout to Belonging: A Sequential Mixed Methods Study of Comprehensive Support Structures for Online Adjunct Faculty

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Abstract

Online adjunct faculty often face significant challenges, including burnout, inadequate support, and organizational cynicism, which can result in poor student outcomes. Surprisingly in Phase 1 of this sequential explanatory mixed methods study, employing a quantitative correlational approach ($n = 101$) at one private online university, revealed exceptional outcomes that contradicted established literature patterns: high personal accomplishment scores ($M = 38.01$, $SD = 8.21$) with 82% in the high range, low emotional exhaustion ($M = 7.56$, $SD = 8.74$), low depersonalization ($M = 2.95$, $SD = 3.47$), and minimal organizational cynicism ($M = 0.76$, $SD = 2.09$), with significant inter-college variation ($F(5,95) = 2.54$, $p = .033$, $\eta^2 = .12$). Phase 2 employed a case study methodology with participants representing all institutional colleges: online adjunct faculty ($n = 16$), college leaders ($n = 23$), and support personnel ($n = 13$). This study sought to understand mechanisms behind these positive results. Grounded in Communities of Practice theory. Open-ended questionnaires were developed through document analysis using Cardno's systematic framework, which revealed comprehensive support mechanisms, including structured recruitment, extensive mentorship, ongoing development, and authentic relationship building. Thematic analysis identified four key themes that explain the quantitative outcomes: strategic leadership implementation, systematic support infrastructure, structural policy commitment, and genuine community building. Results provide evidence-based practices that enable institutions to achieve positive online adjunct faculty outcomes through systematic organizational commitment, offering a replicable framework for improving online adjunct faculty experiences.

Keywords: online adjunct faculty, faculty support, higher education, faculty development, Communities of Practice, sequential mixed methods

Reed, R., Carriere, J., Pipoly, L., & Bennett, A. (2025). From burnout to belonging: a sequential mixed methods study of comprehensive support structures for online adjunct faculty. *Online Learning, 29*(3), 103-129. https://doi.org.10.24059/olj.v29i3.5026

Introduction

The use of adjunct faculty in higher education has increased significantly, driven by declining public financing and institutional efforts to reduce operational costs (Danaei, 2019). Despite their critical role, adjunct faculty face unique challenges that negatively impact both their well-being and student outcomes, including burnout, excessive course loads, administrative work, inadequate training, role ambiguity, and limited institutional connection (Butters & Gann, 2022; Gelman et al., 2022). In Phase 1, quantitative correlational research conducted at a private online university yielded exceptional outcomes that contradicted established literature patterns: high Personal Accomplishment (PA), low Emotional Exhaustion (EE), low Depersonalization (DP), and minimal Organizational Cynicism (OC) among online adjunct faculty. These unexpected positive findings created an opportunity to understand the mechanisms behind these results. Phase 2 employed a qualitative case study methodology to investigate the institutional support mechanisms that contributed to the outcomes of Phase 1, using open-ended questionnaires with online adjunct faculty, academic leaders, and support staff from the same institution.

Problem Statement

Due to the increasing reliance on online adjunct faculty, higher education institutions must find ways to provide support that meets faculty needs while fostering engaged interactions with students and achieving quality outcomes (Gelman et al., 2022). The challenges are multifaceted. An online adjunct faculty member may struggle with skills required for effective online education delivery, inconsistently receive necessary preparation and development in impactful teaching practices, feel disconnected from institutional communities, and experience burnout that negatively affects their facilitation practices (Butters & Gann, 2022). The problem this study addresses is the gap between the documented challenges faced by adjunct faculty and the potential solutions demonstrated by an institution that exhibits high levels of engagement among its online adjunct faculty. Understanding the policies and people who comprise the support structures can provide best practices for broader implementation in higher education, resulting in an engaged online adjunct faculty workforce.

Purpose

This sequential explanatory mixed methods study explored support structures, policies, and practices at a private online university. Phase 1, the quantitative phase, demonstrated exceptional online adjunct faculty engagement outcomes. Following the quantitative findings, Phase 2 employed a qualitative case study methodology to investigate the perspectives of online adjunct faculty, college leaders, support departments, and institutional policies, to understand the comprehensive support mechanisms that contributed to the positive outcomes identified in Phase 1. The goal was to identify transferable best practices that bridge the gap between theory and practice, providing an in-depth understanding of how institutions can systematically support online adjunct faculty.

Literature Review

Phase 1: Quantitative Theoretical Framework

<u>Burnout</u>

Phase 1 quantitative research was grounded in established psychological and organizational theories. The study employed Maslach and Jackson's (1981) conceptualization of burnout as a psychological syndrome including three components: EE, DP, and PA. In terms of burnout, heavy workloads, job demands, limited autonomy, and emotional labor contributed to faculty burnout rates (Yin, 2023; Lubbadeh, 2020). Adjunct faculty are particularly vulnerable due to job insecurity, isolation, multiple job holdings, and late course assignments (Coaston & Cook, 2017; de Araújo Leite et al., 2020). While online adjuncts may face slightly less stress, issues such as a lack of feedback and professional development contribute to burnout (McCann & Holt, 2009; Kara & Vildirim, 2022).

Cynicism

Burnout and cynicism are closely intertwined and can hurt faculty engagement and student learning. Based on Dean et al.'s (1998) framework, organizational cynicism was conceptualized as resulting from changes in employer-employee relationships and violations of psychological contracts (Grama, 2015). In higher education, rapid change, unclear communication, and administration-driven decision-making often led to cynicism, lower morale, and increased turnover (Chi et al., 2020; Yawer et al., 2019). Adjunct faculty, due to their marginal status, limited support, and exclusion from decision-making, are especially at risk (Yıldırım, 2022; Kim et al., 2019).

Contemporary Burnout Prevalence in Higher Education

Current data reveals stark realities of traditional adjunct faculty support. Recent statistics indicate that 35% of university teachers report feeling burned out very often or always at work, ranking them as the second-highest occupation for burnout (Alves et al., 2019). A comprehensive systematic review by Fernández-Suárez et al. (2021) analyzed the prevalence of burnout among 2,841 university professors from 2005 to 2020 and found consistently high levels, indicating a need for intervention. The review identified EE (23%), DP (16%), and PA (50%) as particularly problematic areas requiring institutional intervention (Fernández-Suárez et al., 2021).

Adjunct Faculty Challenges

Literature reveals three primary factors contributing to adjunct faculty dissatisfaction. Online adjunct faculty are hired into lower-paid roles with less job security, fewer benefits, and lower status than full-time faculty (Parsons et al., 2021). Many online adjunct faculty members reported that inconsistent compensation necessitated multiple institutional affiliations to achieve a sustainable income. Despite increased use of online adjunct faculty, temporary role perceptions create issues with feelings of belongingness (Swann et al., 2021). Kelley and Kilburn (2023) reported that online faculty dissatisfaction may lead to reduced classroom time, which can hinder students' success.

Phase 2: Qualitative Foundation Theoretical Framework

Communities of Practice

The Phase 2 qualitative investigation was grounded in Communities of Practice (CoP) theory, emphasizing collaborative learning and knowledge sharing among individuals with common interests, goals, and expertise (Wenger, 1998). CoP theory further addresses the formation and identification of communities among online adjunct faculty, emphasizing spaces where faculty connect, share experiences, and develop a collective identity (Wenger et al., 2002). Specifically relevant are Virtual Communities of Practice (VCoPs), highlighting knowledge sharing through online forums, virtual meetings, and technology-mediated interactions (Beres & Janes, 2022). As institutions increasingly rely on online adjuncts, their limited access to institutional resources, professional development, and decision-making weakens their integration into academic communities (Swann et al., 2021; Kelley & Kilburn, 2023). CoP theory further emphasizes the importance of shared learning and mutual engagement, suggesting that institutional leaders must actively support adjuncts' sense of belonging and professional identity to enhance institutional effectiveness (Layou et al., 2022; Tarbutton & Swisher, 2023).

Employment Lifecycle

The employment lifecycle framework provides a systematic approach to understanding employee experiences throughout their entire organizational journey, initially conceptualized by Ulrich (1997) and encompassing six primary stages: attraction, recruitment, onboarding, development, retention, and separation (Gladka et al., 2022). Recent scholarship has introduced the Faculty, Academic Careers, and Environments (FACE) framework, which explicitly addresses contemporary shifts to faculty contracts and roles in higher education (Culver et al., 2025). This framework is particularly relevant given that nearly 70% of U.S. faculty members held contingent positions in fall 2021, representing a significant increase, 47%, since 1987 (American Association of University Professors, 2023). Sato et al. (2019) suggest that employees encounter distinct challenges and opportunities at each stage of the lifecycle, with cumulative experiences shaping long-term organizational outcomes. For adjunct faculty specifically, the lifecycle approach addresses the reality that traditional support models often treat adjunct positions as isolated teaching assignments rather than integral components of faculty careers (Culver et al., 2025).

Traditional Adjunct Faculty Support Models and Their Limitations

Research consistently documents inadequate support for adjunct faculty across higher education institutions. Traditional models typically provide minimal systematic support, treating adjunct faculty as temporary contractors rather than integral members of the academic community (Kelley & Kilburn, 2023). According to Butters and Gann (2022), some adjuncts feel unprepared to teach courses, have limited time and resources to prepare, struggle with Learning Management System technology, and require improved communication methods. Traditional models often fail to recognize specialized skills required for online instruction. Despite increased reliance on adjunct instruction, perceptions of part-time, temporary, or contract roles create a sense of not belonging (Parsons et al., 2021; Swann et al., 2021). Many adjunct faculty members need clear and consistent access to professional development and administrative support (Layou et al., 2022). This lack of professional support, combined with the need for improvement in administrative policies, could lead to a decrease in commitment to institutional goals (Purdum & Evans, 2024).

Contrasting Approaches: Emerging Best Practices

Some institutions have developed systematic approaches recognizing that effective online education requires specialized skills and sustained faculty engagement. These comprehensive models typically include systematic onboarding programs, structured mentorship systems, performance-based support, and authentic community building (Sayyadi & Provitera, 2022; Tarbutton & Swisher, 2023). Research on the effectiveness and implementation mechanisms of comprehensive support models remains limited. There is a growing need to examine how these frameworks align with community of practice (CoP) principles, particularly in fostering faculty identity, shared learning, and a sense of belonging (Wenger, 1998; Layou et al., 2022). While some models incorporate virtual collaboration and feedback loops, few are evaluated for long-term impact on teaching quality or institutional integration of adjunct faculty (Beres & Janes, 2022; Butters & Gann, 2022).

Methodology

Research Design

This study employed a sequential explanatory mixed-methods design (Creswell, 2014), where the quantitative results from Phase 1 directly guided the qualitative investigation in Phase 2. This approach was particularly appropriate because Phase 1 established that exceptional outcomes exist. In contrast, Phase 2 could explore the underlying mechanisms, providing both evidence of effectiveness and an understanding of the processes that create transferable best practices. The sequential design enabled the quantitative findings to inform the development of targeted qualitative research questions, ensuring that the subsequent investigation could explain the mechanisms behind the measured exceptional outcomes.

Phase 1: Quantitative Foundation

Phase 1 aimed to explore relationships between burnout, OC, and performance among online adjunct faculty. The study was conducted at a private online university in the United States, which has over 2,500 active adjunct faculty members. The university employs a practitioner model, where most faculty members are online adjuncts contracted on a class-by-class basis. The study included 101 online adjunct faculty members across six colleges within the university system. Participants demonstrated varying tenure lengths, with 34.65% having 11–15 years of experience and 30.69% having 16–20 years of experience. This distribution provided representation across experience levels while ensuring participants had sufficient institutional exposure to assess support structures and their effects on well-being outcomes meaningfully**.**

Phase 1 Quantitative Research Questions

RQ1**.** To what extent is there a statistically significant relationship between online adjunct faculty burnout and their facilitation performance?
RQ2. To what extent is there a statistically significant relationship between online adjunct faculty organizational cynicism and their facilitation performance?
RQ3. To what extent is there a relationship between online adjunct faculty burnout, organizational cynicism, and their facilitation performance?

Phase 1 Instrumentation

Three validated instruments were employed to measure the key constructs. The Maslach Burnout Inventory-Educator Survey (MBI-ES) served as the primary measure of burnout, using a 22-item instrument that assesses three burnout dimensions, EE, DP, and PA using a 7-point Likert scale ranging from 0 (never) to 6 (every day). The instrument demonstrates strong psychometric properties with internal consistency estimates of Cronbach's alpha of .90 for EE, .76 for DP, and .76 for PA (Iwanicki & Schwab, 1981). OC was measured using the cynicism subscale of the MBI-ES, which focuses on emotional disengagement from the workplace as conceptualized by Viljoen and Claassen (2016). Faculty performance was assessed using the institution-specific Faculty Performance Evaluation (FPE), developed in 2019 through collaboration with college leaders and academic affairs personnel, based on current literature that measures faculty performance and its impact on student outcomes. The FPE consists of 12 facilitation practices covering engagement, feedback, and general classroom management requirements, using a 4-point rating scale from -1 (Needs Improvement) to 2 (Consistently Exceeds).

Phase 1 Data Analysis

Using Intellectus Statistics™ (2023) software, Phase 1 data analysis employed descriptive statistics to characterize the sample and identify distribution patterns, Pearson correlations to examine relationships between burnout dimensions and performance measures, and ANOVA to investigate differences across colleges. Effect sizes were calculated and interpreted using Cohen's standards to assess practical significance. The analysis revealed exceptional outcomes that contradicted established patterns in the literature, including remarkably low burnout levels, minimal OC, and significant inter-college variation in PA scores. This finding lays the groundwork for a Phase 2 qualitative investigation into the mechanisms underlying these positive results.

Phase 2 Qualitative Exploration

Phase 2 employed an exploratory case study methodology to understand how and why the exceptional Phase 1 quantitative outcomes occurred (Yin, 2013). A case study design was selected because it enables in-depth exploration of complex organizational phenomena within real-life contexts, making it particularly suitable for examining the mechanisms behind measured results while maintaining a contextual understanding. The exploratory approach enabled the investigation of "how" and "why" questions regarding support structures that foster positive faculty outcomes, providing explanatory power for the statistical findings observed in Phase 1.

Phase 2 Qualitative Research Questions

RQ4. What are college leaders' perceptions of online adjunct faculty support throughout the support lifecycle that may explain the high engagement and low burnout levels found in Phase 1?
RQ5. What are the support services departments' perceptions of support practices throughout the support lifecycle that may contribute to exceptional outcomes identified in Phase 1?
RQ6**.** What processes and policies are used for online adjunct faculty support throughout the support lifecycle that may create structural foundations for positive experiences?
RQ7. What are online adjunct faculty's perceptions of support practices that may explain their high PA and low organizational cynicism found in Phase 1?

Phase 2 Participants

The Phase 2 sample consisted of 52 participants from four stakeholder groups, representing all institutional colleges to ensure a comprehensive representation of diverse perspectives. Online adjunct faculty comprised of 16 participants (10% response rate from 158 invited), selected based on criteria including online teaching only, onboarding within the past five years, and representation across all colleges. College leaders were composed of 23 participants (a 37% response rate from 63 invited), including deans and faculty supervisors with direct adjunct oversight responsibilities. Faculty engagement personnel contributed 9 participants (a 28% response rate from 32 invited), representing all employees from departments that provide onboarding, training, or ongoing support services. The curriculum personnel included 4 participants (a 10% response rate from 40 invited), consisting of curriculum designers and managers involved in course development and faculty support activities. This purposive sampling strategy ensured representation across all stakeholder groups involved in online adjunct faculty support, while maintaining college-level representation to understand implementation variations identified in Phase 1.

Phase 2 Data Collection

The questionnaire development process followed a systematic approach designed to explain the Phase 1 quantitative findings, which revealed exceptional faculty outcomes, including 82% high PA, low EE (M = 7.56), and minimal OC (M = 0.76). Questions were structured around the employment lifecycle and FACE frameworks from recruitment through separation, with different versions targeting each stakeholder group while maintaining core alignment for triangulation purposes. This lifecycle approach recognized that faculty needs vary by career stage and cumulative experiences influence long-term outcomes.

Questions were developed leveraging the research team's extensive institutional knowledge and understanding of departmental interconnections to ensure alignment with research objectives. The researchers' deep familiarity with institutional terminology, policy implementation, and support structure operations enabled them to interpret stakeholder perspectives while maintaining comprehensive lifecycle coverage accurately. Table 1 presents some representative questions that demonstrate the systematic approach to understanding how institutional practices contribute to positive faculty outcomes.

Table 1

Representative Survey Questions by Stakeholder Group and Lifecycle Coverage

Stakeholder Group	Lifecycle Phases Covered	Example Questions	Purpose
Online Adjunct Faculty	Recruitment, Onboarding, Development, Ongoing Support	"What factors influenced your decision to become an online adjunct faculty member?" "Please describe your experience with onboarding and mentorship." "How do performance reviews contribute to your professional development?"	Understand direct experiences with support mechanisms, creating high personal accomplishment, and preventing burnout
College Leaders	All Phases (Recruitment through Separation)	"What strategies does your college use to promote community and belonging?" "How does your college handle the separation of online adjunct faculty members?"	Identify leadership practices across complete lifecycle explaining inter-college variation ($F(5,95) = 2.54$, $p = .033$)
Faculty Engagement Services	Onboarding, Development, Ongoing Support,	"How is the onboarding of online adjunct faculty approached?" "How does your	Examine systematic prevention of typical adjunct problems

	Quality Assurance	department promote community and belonging?”	through proactive support mechanisms
Curriculum Personnel	Development, Ongoing Support, Academic Integration	“How does the curriculum department collaborate with online adjunct faculty?” “How does the curriculum department evaluate support effectiveness?”	Explore faculty involvement in meaningful academic work contributing to professional satisfaction

Online adjunct faculty questions focused on direct experiences from recruitment through ongoing employment, excluding separation, since the sample consisted of actively employed faculty. College leaders and Faculty Engagement Departments addressed all lifecycle phases, including separation processes, due to their overlapping responsibilities and oversight. Curriculum personnel focused on continuous support phases where their expertise directly affects faculty.

Phase 2 Document Analysis

Document analysis employed Cardno’s (2018) policy evaluation framework to systematically evaluate 15 institutional policies found in Table 2 and procedures across faculty lifecycle phases. Following Cardno’s systematic evaluation approach, each policy was analyzed using five criteria: purpose, ownership, values, summary, and impact. This analysis provided a structural context for understanding the mechanisms behind the exceptional outcomes in Phase 1.

Table 2

Summary of Institutional Policies and Procedures by Faculty Lifecycle Phase

Lifecycle Phase	Policy/Procedure	Primary Purpose	Key Values Demonstrated
Recruiting & Onboarding	Content Area Requirements Approvals	Ensure faculty qualifications meet accreditation standards	Quality assurance, credentialing integrity
	Faculty Hiring Process and Lifecycle	Systematic recruitment and onboarding framework	Comprehensive support, clear expectations
	Faculty Interview Guide	Standardizing the selection process	Fairness, consistency in hiring
	Job Requisition Creation	Define role requirements and qualifications	Transparency, strategic planning

	Mentorship SOP	Structured new faculty support and development	Investment in growth, quality teaching
Ongoing Support & Development	Annual Recognition Program	Acknowledge faculty contributions and achievements	Recognition, community building
	Annual Self-Reflection	Promote faculty self-assessment and growth	Professional development, continuous improvement
	Classroom Issue Management	Address teaching challenges systematically	Support over punishment, problem-solving, and quality assurance
	Classroom Performance Reviews (CPR)	Monitor and support teaching effectiveness	Development focus, quality assurance
	CPR Inquiry Process	Faculty appeals and clarification procedures	Fairness, due process
	Faculty Scheduling and Solicitation	Coordinate course assignments efficiently	Flexibility, communication
	Faculty Supervisor Job Guide	Define supervisor roles and responsibilities	Clear expectations, consistent support
	On-the-Spot Recognition	Immediate acknowledgment of excellence	Timely feedback, appreciation
	Progressive Discipline Process	Provide improvement support before termination	Development over punishment, second chances
	Schedule Changes/Requests/Preferences	Accommodate faculty scheduling needs	Flexibility, work-life balance

Separation	Faculty Resignation Process	Manage voluntary departures professionally	Respectful transitions, knowledge retention
	Progressive Discipline Process	Final step for performance improvement	Due process, fair treatment

Phase 2 Thematic Data Analysis

The questionnaire responses were uploaded, coded, and thematized using Intellectus Qualitative™ until saturation was reached (Intellectus Qualitative, 2024). Phase 2 data analysis employed systematic thematic analysis, with two researchers independently coding 25% of the responses, achieving an intercoder reliability of 89%. Disagreements were resolved through consensus. The initial coding process used both deductive codes derived from Phase 1 findings and inductive codes generated from emerging data. Theme development identified patterns that explained quantitative outcomes until saturation was reached. Triangulation across survey responses, document analysis, and Phase 1 findings validated themes through multiple perspectives, ensuring qualitative findings explained exceptional outcomes.

Phase 1 Results

Exceptional Outcomes Contradicting Literature Patterns

The summary statistics presented in Table 3 reveal a remarkably positive profile that directly contradicts typical adjunct faculty experiences documented in the literature. When compared to established benchmarks for postsecondary teachers (Maslach et al., 2018), this study's participants demonstrated EE levels ($M = 7.56$) approximately 59% lower than the benchmark average of 18.57, and DP scores ($M = 2.95$) approximately 47% lower than the benchmark of 5.57. PA scores ($M = 38.01$) remained comparable to the benchmark ($M = 39.17$), indicating that while participants avoided the negative aspects of burnout, they maintained similar levels of professional fulfillment as their peers in traditional settings. The OC measure ($M = 0.76$, $SD = 2.09$) approached theoretical minimums, suggesting minimal cynical attitudes despite the contingent employment status typical of adjunct positions.

Distribution Characteristics Indicating Systematic Positive Experiences

Distribution characteristics (Table 3) illuminate exceptional outcomes. EE and DP showed positive skewness (1.50 and 2.02) with high kurtosis, indicating faculty clustered at low burnout levels. PA demonstrated negative skewness (-1.39), with faculty concentrated at high satisfaction levels. These distribution patterns suggest a systematic rather than random pattern of positive experiences, indicating that institutional factors may be creating conditions that prevent typical adjunct faculty problems while fostering high levels of professional satisfaction.

Table 3

Summary Statistics Table for Interval and Ratio Variables

Variable	*M*	*SD*	*n*	SE_M	Min.	Max.	Skewness	Kurtosis
EE	7.56	8.74	101	0.87	0.00	35.00	1.50	1.45
DP	2.95	3.47	101	0.35	0.00	19.00	2.02	4.76
PA	38.01	8.21	101	0.82	9.00	48.00	-1.39	2.06
OC	0.76	2.09	101	0.21	0.00	12.00	3.61	13.25

Personal Accomplishment: Evidence of Exceptional Faculty Engagement

The PA scores reveal particularly compelling evidence of exceptional faculty experiences. With 82% of faculty scoring in the high range (scores > 34), this population demonstrates remarkably high levels of professional fulfillment, which contradict typical patterns in the literature on adjunct faculty. The eight-item PA subscale measures feelings of competence and achievement in one's work, with lower scores corresponding to greater experienced burnout (Maslach & Jackson, 1981). The mean score of 38.01 (SD = 8.21) approaches the theoretical maximum for this subscale, with negative skewness (-1.39) indicating that most faculty members cluster at the highest levels of professional satisfaction. This concentration at high PA levels suggests that faculty members experience genuine meaning and impact in their work, feeling successful in their educational roles and confident in their ability to make a positive difference in students' lives. Maintaining high levels of personal accomplishment, even in contingent employment positions typically associated with professional dissatisfaction, suggests that systematic institutional factors foster faculty success and recognition (Parsons et al., 2021).

Correlation Patterns: Theoretical Consistency with Practical Implications

The correlation analysis revealed theoretically consistent but practically significant patterns. The strong positive correlation between EE and DP ($r = .73$, $p < .001$) aligns with established burnout theory, which posits that emotional depletion leads to cynical attitudes toward work (Maslach & Jackson, 1981). The moderate negative correlation between EE and PA ($r = -0.34$, $p = 0.019$) indicates that even minimal levels of EE in this population are associated with reduced feelings of accomplishment. The strong correlation between OC and DP ($r = .78$, $p < .001$) confirmed theoretical expectations that cynical workplace attitudes manifest as interpersonal detachment (Dean et al., 1998). Burnout symptoms are measured by high scores on the EE and DP scales and low scores on the PA scale. Nevertheless, these correlation patterns occur within a restricted range of predominantly positive scores, suggesting that the institutional environment successfully prevents the typical escalation from low-level stress to significant burnout symptoms.

Performance Relationships: Ceiling Effects and Measurement Considerations

The absence of significant correlations between burnout dimensions, cynicism, and faculty performance measures provides important insights about both the population and measurement considerations. The clustering of participants at the positive end of well-being measures may create conditions where traditional burnout-performance relationships are challenging to detect due to a restricted range, rather than a genuine absence of relationships. Uttl (2005) defined ceiling effects as occurring when tests or scales are relatively straightforward, such that substantial proportions of individuals obtain either maximum or near-maximum scores, and the true extent of their abilities cannot be accurately determined.

Given the concentration of faculty at low burnout and high engagement levels found in Phase 1 (82% high PA, M = 38.01 for PA; low EE, M = 7.56), combined with uniformly high-performance scores, this likely reflects ceiling effects rather than a genuine absence of relationships. Uttl (2005) demonstrated the attenuation in reliability and validity that occurs when ceiling effects are present, using empirical data. This interpretation is supported by the fact that significant correlations were detected between burnout dimensions themselves, such as EE-DP $r = .73$ and EE-PA $r = -.34$, suggesting that the instruments retained sensitivity for detecting relationships within their effective range. At the same time, the performance measures may have had insufficient variance to detect relationships with well-being indicators.

While the absence of burnout-performance correlations might suggest that faculty well-being is not related to their performance in this institutional context, ceiling effects provide an alternative explanation that performance measures may lack sufficient sensitivity to detect such relationships when faculty well-being is uniformly high. The restricted range in both burnout measures and performance outcomes in this study suggests that this institutional model successfully maintains both faculty well-being and teaching effectiveness simultaneously, creating conditions where traditional burnout-performance relationships may not manifest due to measurement limitations rather than actual absence of relationships.

Inter-College Variation: Evidence of Implementation Differences

The statistically significant differences in PA by college ($F\ (5,95) = 2.54$, $p = .033$, $\eta^2 = .12$) provide crucial evidence that institutional practices, rather than external factors, influence faculty outcomes. With two colleges showing lower mean PA scores than others, this variation suggests differential implementation of support practices across units. This finding suggests that, although the institution overall achieves exceptional outcomes, consistency in support delivery varies, creating opportunities for sharing best practices within the organization. The medium effect size ($\eta^2 = .12$) suggests that these differences are not only statistically significant but also practically meaningful, potentially reflecting differences in leadership approaches, communication patterns, or resource allocation across colleges within the same institutional framework.

Implications for Phase 2 Investigation

These exceptional Phase 1 outcomes established this institution as demonstrating outcomes that contradict established literature patterns of high burnout in adjunct faculty, creating a compelling research opportunity to understand the specific mechanisms behind these positive results. These findings guided the development of Phase 2 qualitative research questions designed to understand how comprehensive support structures create and maintain these exceptional faculty outcomes, transforming this from a problem-focused investigation to a solutions-oriented exploration.

Phase 2 Results

Phase 2 Document Analysis Findings

Policy analysis revealed a systematic institutional commitment to comprehensive online adjunct faculty support that fundamentally differs from traditional models documented in the literature. Three interconnected patterns emerged that collectively explain the exceptional quantitative outcomes observed in Phase 1.

Systematic Investment in Development

The institution demonstrates systematic investment in online adjunct faculty development rather than treating them as temporary contractors. Policies spanning recruitment through separation create comprehensive support structures that address the economic insecurity and institutional disconnection identified by Parsons et al. (2021) as primary sources of dissatisfaction among adjunct faculty. This systematic approach provides a structural foundation for the high PA scores ($M = 38.01$, $SD = 8.21$) documented quantitatively, as faculty experience genuine institutional investment in their professional success.

Development Over Punitive Approach

The policy framework emphasizes development-focused rather than punitive approaches for faculty management. The Progressive Discipline Process, Classroom Performance Reviews, and related policies prioritize coaching, support for improvement, and professional growth over compliance monitoring. This supportive orientation directly explains the exceptionally low OC scores ($M = 0.76$, $SD = 2.09$) found in Phase 1, as faculty experience institutional care rather than bureaucratic indifference that typically characterizes adjunct employment relationships.

Systematic Community Building

Formal policies mandate systematic community building through recognition programs, regular communication, and structured development activities. Unlike institutions where faculty connection occurs by chance, these policies require specific activities that address the institutional marginalization identified by Swann et al. (2021). The Annual Recognition Program, Faculty Supervisor Job Guide, and related policies create systematic opportunities for belonging and professional identity development that contribute to sustained faculty engagement.

Collectively, these policy patterns create an integrated support ecosystem that transforms typical online adjunct faculty experiences from marginalization to meaningful membership in a professional community. The systematic nature of this approach, formalized through institutional policies rather than dependent on individual supervisor discretion, provides a sustainable foundation for the exceptional faculty outcomes documented in Phase 1 quantitative analysis.

Thematic Analysis Findings

Thematic analysis of Phase 2 qualitative data revealed four interconnected themes that systematically explain the exceptional quantitative outcomes documented in Phase 1. Each theme directly corresponds to and answers one of the four Phase 2 research questions, demonstrating how comprehensive institutional practices create conditions for high faculty engagement, prevent burnout, and minimize OC among online adjunct faculty.

Theme 1: College Leaders' Comprehensive Support Strategy for Online Adjunct Faculty

This theme directly answers the research question: What are college leaders' perceptions of online adjunct faculty support throughout the online adjunct faculty support lifecycle, that may explain the high engagement and low burnout levels found in Phase 1? The analysis of college leaders' responses (201 coded excerpts across 10 sub-themes) revealed that leaders perceive their role as strategic architects of faculty success through four interconnected practices that directly explain Phase 1 outcomes. College leaders' comprehensive approach encompasses the entire faculty lifecycle, from recruitment through ongoing development, creating systematic conditions that produce high engagement and prevent burnout.

Strategic Recruitment

The strategic recruitment processes emphasized character assessment alongside technical qualifications. As one leader explained, "I look for certain qualities explicitly. But I try to stay alert for things the potential faculty member may do or say that provide insights into their character... Being conscientious is something I look for as well as the ability to communicate clearly and confidently, especially when discussing their professional roles and when explaining and relating course content to careers." This careful selection process ensures faculty-institutional alignment that supports sustained engagement.

Authentic Relationships

Authentic relationship building formed the foundation of leader-faculty interactions. Leaders prioritized genuine connection over bureaucratic management: "Building relationships with faculty so they feel a sense of belonging and investment in the success of the programs in which they teach. Regular communication with faculty about college happenings and opportunities." This personal approach directly explains the exceptionally low OC scores ($M = 0.76$, $SD = 2.09$) found in Phase 1, as faculty experience authentic personal attention rather than administrative indifference characteristic of traditional adjunct employment relationships.

Comprehensive Onboarding

Comprehensive onboarding ensures systematic preparation for faculty success. Leaders described structured support transitions: "Once hired, the faculty member undergoes a training program with a faculty mentor. After completing the training, the new faculty member is supported directly by their Faculty Supervisor." This systematic preparation contributes to high PA scores by ensuring faculty enter roles well-prepared rather than overwhelmed, directly addressing the preparation challenges identified by Butters and Gann (2022).

Performance-Based Support

Performance-based support emphasizes development over punishment. Leaders implemented supportive approaches to performance challenges: "We follow the PDP process and allow faculty members to improve before termination. For valued faculty members, we look for other opportunities for them to stay engaged with our programs." This development-focused orientation maintains faculty engagement while constructively addressing performance concerns.

Theme 2: Support Departments' Holistic Approach to Supporting Online Adjunct Faculty

This theme directly addresses the research question: What are the perceptions of support services departments regarding support practices throughout the online adjunct faculty support lifecycle that may contribute to the exceptional faculty outcomes identified in Phase 1? Support departments' responses (76 coded excerpts across six sub-themes) revealed that support personnel perceive their role as systematic prevention specialists who proactively address potential faculty problems before they develop into burnout or cynicism. Their holistic approach encompasses three specific mechanisms that directly contribute to the exceptional Phase 1 outcomes: comprehensive onboarding, authentic personal attention, and intentional community building.

Comprehensive Onboarding

Multi-stage comprehensive onboarding prevents overwhelm through systematic preparation. Support staff described detailed processes: "There are multiple stages to the faculty onboarding process. Once hired, the Faculty Credentials & Onboarding team sets up the necessary systems for the faculty member and then reaches out to schedule a live welcome call. The welcome call covers everything from walking the faculty through the systems, to providing links and resources, to advising about faculty requirements." This systematic preparation directly explains low EE scores, as faculty enter roles well-prepared rather than struggling with unclear expectations.

Authentic Relationships

Authentic personal attention creates a genuine institutional connection. Support personnel demonstrated investment in faculty as whole persons: "Our department promotes a sense of belonging by welcoming the new faculty members and by getting to know our faculty. Checking on them when they let you know they are sick or there is a new baby... What I have found is that faculty share their lives with us, and they must know what they share is important to us." This genuine investment explains low OC scores, as faculty experience institutional care rather than the bureaucratic indifference typical of contingent employment relationships.

Systematic Community Building

Systematic community building fosters intentional opportunities for individuals to feel a sense of belonging. Support departments prioritized connection: "Creating a sense of belonging and connection is a critical part of onboarding and faculty development... The personal touch is important, so connecting with the mentor and supervisor by phone works well." This intentional community-building directly connects to the high PA scores documented in Phase 1, addressing the institutional disconnection that Swann et al. (2021) identified as a primary source of dissatisfaction among adjunct faculty.

Theme 3: Systematic Faculty Lifecycle Support Framework Through Institutional Policies

This theme directly addresses the research question: What processes and policies are employed for online adjunct faculty support throughout the online adjunct faculty support lifecycle that may establish the structural foundations for positive faculty experiences? A document analysis of 15 institutional policies and procedures revealed systematic processes that create the structural foundations for the positive faculty experiences documented in Phase 1.

Unlike institutions that treat adjunct faculty as temporary contractors, these policies demonstrate comprehensive investment throughout the employment lifecycle, from recruitment through separation. The systematic policy framework addresses each phase of faculty employment with specific processes designed to prevent typical adjunct faculty challenges and create conditions for success.

The recruitment phase establishes success through a comprehensive needs assessment, detailed job descriptions that emphasize practitioner experience, and multi-stage interviews with college leaders, ensuring suitable faculty selection and clear expectations. The onboarding phase includes credential evaluations, content area assessments, HR enrollment, and an introduction to university resources, thereby preventing overwhelming experiences that can contribute to faculty burnout. Training and certification include orientation, performance criteria training, and policy education, addressing preparation gaps identified by Butters and Gann (2022). The mentorship phase offers structured support through experienced faculty partnerships, supervised teaching, weekly feedback, and Faculty Quality Assurance oversight, creating meaningful development experiences that contribute to high PA scores

Analysis of institutional policies and qualitative responses revealed a systematic timeline for first-year support, demonstrating the university's structured approach to developing online adjunct faculty. This timeline illustrates how support intensity progressively decreases as faculty develop independence while maintaining consistent access to institutional resources. Table 4 visualizes this comprehensive support structure and its alignment with faculty developmental needs.

Table 4

First-Year Online Adjunct Faculty Support Timeline and Activities

Timeframe	Phase	Support Activities	Support Level
Months 1–3	Intensive Onboarding	Welcome communication from supervisors; introduction to Faculty Resources Center; guidance on Faculty Viva Engage Community participation; first Annual Classroom Performance Review; coaching support implementation	High
Months 3–6	Development	Regular supervisor check-ins, facilitation skills development recommendations, performance evaluation preparation, and continued encouragement of community engagement	Moderate
Months 6+	Independence	Policy guidance provision, student challenge preparation, professional development invitations, second Annual Performance Review, and ongoing coaching as needed with a performance-based approach to feedback and recognition.	Sustained

Theme 4: Faculty Experiences and Development Creating Exceptional Quantitative Outcomes

This theme directly addresses the research question: What are the perceptions of online adjunct faculty regarding support practices provided through the faculty support lifecycle that may explain their high PA and low OC found in Phase 1? Online adjunct faculty responses (102 coded excerpts across six sub-themes) revealed that faculty perceive institutional support practices as genuinely transformative professional experiences that directly generate the exceptional quantitative outcomes documented in Phase 1. Faculty described four types of experiences that explain their high PA scores ($M = 38.01$, $SD = 8.21$) and exceptionally low OC levels ($M = 0.76$, $SD = 2.09$): meaningful professional growth opportunities, supportive rather than punitive evaluation processes, responsive and caring supervision, and connection to meaningful professional purpose.

Meaningful professional growth experiences created transformative development opportunities. Faculty described comprehensive mentorship: “It was one of the best experiences in my academic life... I learned a great deal during the mentorship process, including patience, empathy, and, above all, the art of teaching. The mentor was always available, provided constructive feedback, and helped me understand not just what to do, but why certain approaches work better for online students.” These transformative experiences directly explain the high PA scores ($M = 38.01$, $SD = 8.21$) documented in Phase 1, as faculty experience genuine professional growth rather than the stagnation typical of adjunct employment.

Supportive evaluation approaches seemed to foster development rather than anxiety. Faculty valued constructive feedback: “Performance reviews validate my teaching methods. I got some constructive feedback, which I found helpful.” This positive approach to evaluation explains low EE scores, as faculty view feedback as a development opportunity rather than criticism or threat, contrasting with the punitive evaluation experiences documented in traditional adjunct employment literature.

Responsive supervision created authentic institutional relationships. Faculty experienced genuine support: “My faculty supervisor is amazing and answers any questions I have. My faculty mentor is also wonderful and supportive... If he did not know the answer to my question, he looped in someone who did.” These supportive relationships account for the exceptionally low OC scores, as faculty members experience genuine institutional care rather than the neglect or exploitation characteristic of typical adjunct employment relationships.

Professional purpose connection sustained engagement through meaningful work. Faculty described authentic motivation: “My passion to help others (Students) be successful by sharing my experiences... Passing Knowledge to the next generation of professionals.” This connection to meaningful work contributes to sustained PA and engagement, addressing the professional isolation and meaninglessness that contributes to adjunct faculty burnout, as documented in the literature.

Triangulation of Mixed Methods Data

The convergence of data across multiple sources, quantitative outcomes, faculty experiences, leadership strategies, support mechanisms, and policy frameworks provides robust validation of the comprehensive support model’s effectiveness. According to Creswell (2014), triangulation in mixed methods research enhances the validity and credibility of findings by providing multiple perspectives on the same phenomenon. This triangulation employed both methodological triangulation, utilizing multiple data collection methods (quantitative surveys, qualitative questionnaires, and document analysis), and data triangulation, which involved different stakeholder groups (faculty, college leaders, and support personnel) and institutional policies to validate findings across the same organizational context. This approach reveals how systematic institutional practices at different organizational levels work synergistically to create exceptional faculty outcomes.

Each quantitative result corresponds directly to specific qualitative experiences across all stakeholder groups. For instance, the high PA scores ($M = 38.01$) found in Phase 1 are explained through faculty reports of “meaningful mentorship experiences,” leaders’ implementation of “strategic recognition programs,” support departments’ “comprehensive onboarding processes,” and formal “mentorship policies with quality assurance” documented in institutional procedures. Similarly, the exceptionally low EE levels ($M = 7.56$) align with faculty descriptions of “supportive evaluation approaches,” leaders’ emphasis on “performance-based coaching,” support staff focus on “proactive problem prevention,” and institutional “development-focused review procedures” that emphasize growth over punishment.

The triangulation also reveals the interconnected nature of support mechanisms across organizational levels. Faculty experiences of authentic supervisory relationships, which contribute to low OC scores (M = 0.76), are facilitated by leaders’ consistent communication practices, support departments’ emphasis on personal connection, and institutional community-building practices. This systematic alignment across stakeholder groups and organizational policies demonstrates that exceptional outcomes result from coordinated institutional commitment rather than isolated interventions or individual leadership efforts.

Most significantly, the triangulation outlined in Table 5 confirms that the comprehensive support structure functions as an integrated system, where each department or role reinforces the others. Quantitative outcomes serve as measurable evidence that qualitative support practices achieve their intended effects. The qualitative data explains the specific mechanisms through which institutional policies and practices translate into positive faculty experiences.

Table 5

Mixed Methods Triangulation: Explaining Phase 1 Quantitative Outcomes Through Phase 2 Qualitative Data

Phase 1 Quantitative Outcome	Qualitative Faculty Experience	Qualitative Leader Strategy	Qualitative Support Mechanisms	Policy Document Analysis
High PA (M = 38.01)	Meaningful mentorship experiences Professional purpose connection	Strategic recognition programs	Comprehensive onboarding and mentorship processes	Formal mentorship policies with quality assurance

Low EE (M = 7.56)	Supportive evaluation approaches	Performance-based coaching	Proactive problem prevention	Development-focused review procedures
Low OC (M = 0.76)	Authentic supervisory relationships	Consistent communication practices	Personal connection focus	Community-building policy requirements

Discussion

This sequential explanatory mixed-methods study successfully identified the mechanisms behind the exceptional online adjunct faculty outcomes documented in Phase 1 quantitative research. The four themes emerging from the Phase 2 qualitative analysis provide comprehensive answers to all research questions, while revealing transferable best practices that explain how this institution achieves results that contradict typical patterns in adjunct faculty literature.

College Leadership as Strategic Engagement Catalyst

The first research question examined college leaders' perceptions of online adjunct faculty support throughout the support lifecycle and how these practices explain high engagement and low burnout levels. Analysis revealed that college leaders function as strategic engagement catalysts through four interconnected practices: strategic recruitment aligned with institutional values, authentic relationship building that fosters genuine belonging, comprehensive onboarding to ensure success preparation, and performance-based development that emphasizes growth over punishment.

This comprehensive leadership approach could directly explain the high PA scores (M = 38.01, SD = 8.21) documented quantitatively. By investing in authentic relationships and strategic support, leaders can prevent the institutional disconnection that Swann et al. (2021) identified as a primary source of dissatisfaction among adjunct faculty. Unlike the minimal oversight typical of adjunct faculty management (Parsons et al., 2021), these leaders demonstrate that exceptional outcomes result from intentional institutional practices.

Support Services as Systematic Prevention Infrastructure

The second research question examined the perceptions and contributions of support services departments to exceptional faculty outcomes. Findings revealed that support departments function as a systematic prevention infrastructure through multi-stage, comprehensive onboarding, authentic personal attention, and genuine institutional investment, demonstrating a commitment to community building that creates opportunities for belonging. This proactive support directly accounts for the exceptionally low EE levels (M = 7.56, SD = 8.74) observed in Phase 1. Unlike institutions that provide minimal orientation and crisis-intervention support (Butters & Gann, 2022), these departments implement comprehensive preparation that prevents the overwhelming experiences contributing to faculty burnout, as documented in traditional adjunct faculty literature.

Institutional Policies as Structural Success Foundation

The third research question examined the institutional processes and policies used to support online adjunct faculty throughout their employment lifecycle. Document analysis revealed a systematic policy commitment that fundamentally differs from treating online adjunct faculty as temporary contractors. These policies demonstrated comprehensive investment through formal mentorship programs, quality assurance, performance-based review systems, and development, recognition, and advancement programs, all of which emphasized the importance of systematic communication requirements. This structural commitment directly supports the low OC scores ($M = 0.76$, $SD = 2.09$) documented in Phase 1. Unlike institutions where adjunct faculty experience policy neglect and bureaucratic indifference (Dean et al., 1998), these formal commitments prevent the perceived injustices that lead to OC, while providing a sustainable foundation for positive faculty experiences.

Faculty Experiences Support Quantitative Outcomes

The fourth research question examined online adjunct faculty's perceptions of support practices and how these experiences contribute to their exceptional quantitative outcomes. Analysis revealed that faculty experience institutional support as genuinely transformative professional development through meaningful professional growth, achieved via comprehensive mentorship, supportive evaluation that emphasizes development over criticism, responsive supervision that provides authentic care, and a connection to a meaningful professional purpose. These transformative experiences directly explain the convergence of high PA and low cynicism documented quantitatively. Faculty experience genuine institutional investment, rather than the exploitation and neglect characteristic of typical adjunct employment relationships, as documented in the literature (Kelley & Kilburn, 2023).

Comparison to Traditional Models: Evidence-Based Transformation

These findings provide compelling evidence that systematic institutional support can transform typical adjunct faculty experiences from problematic to exceptional. The study reveals how comprehensive approaches address the three primary challenges identified in the literature:

<u>Economic Insecurity Transformation</u>

This institution demonstrates faculty value through extensive training investment, formal mentorship programs, systematic recognition, and advancement pathways, creating engagement despite contingent employment status.

<u>Institutional Disconnection Prevention</u>

Systematic community-building, authentic relationship development, and meaningful participation opportunities create genuine belonging, transforming faculty from peripheral contractors to integrated community members.

<u>Professional Development Integration</u>

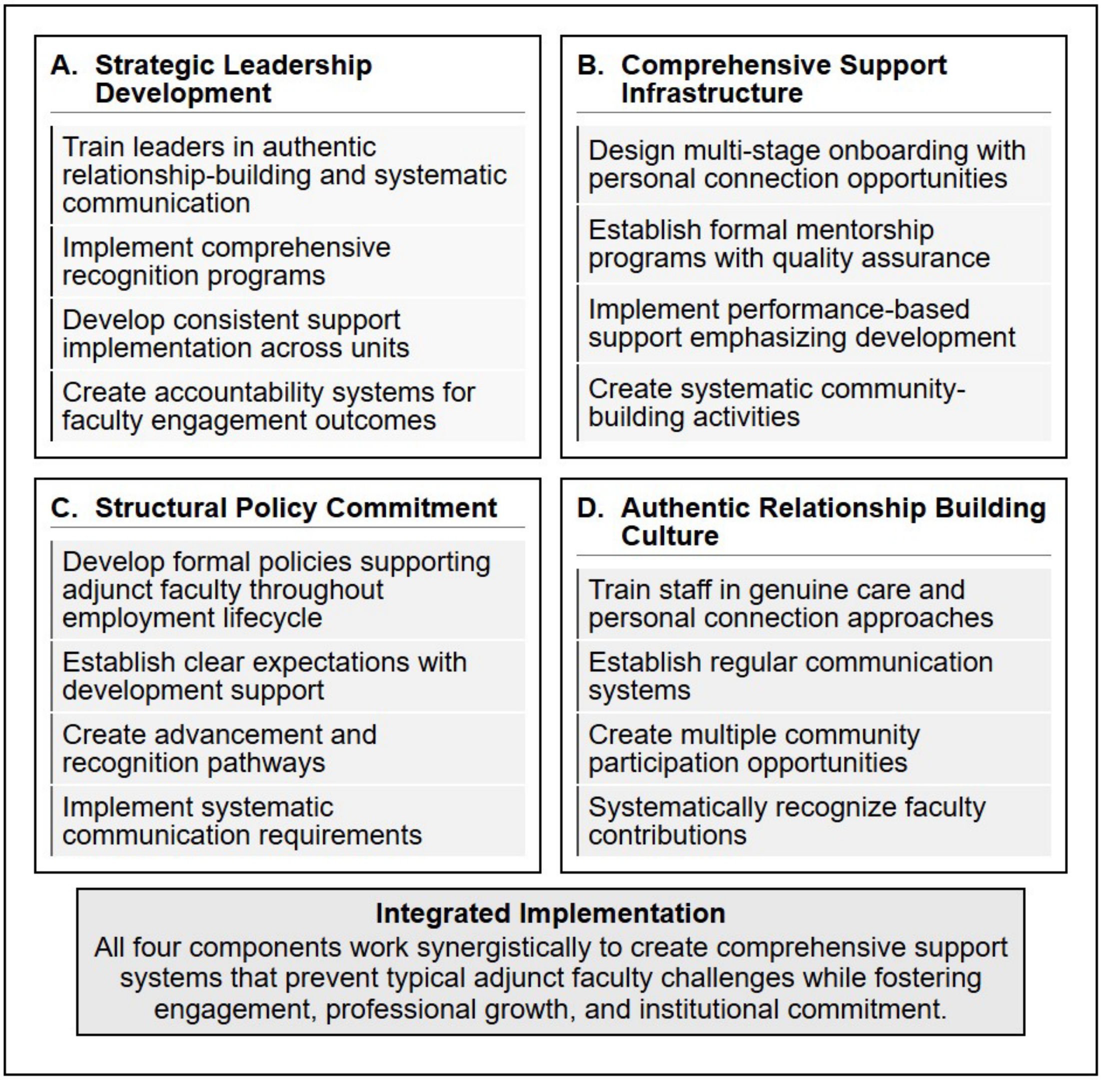
Comprehensive growth frameworks, including mentorship, ongoing training, performance-based coaching, and career advancement, create systematic professional development that enhances teaching effectiveness and career satisfaction.

Transferable Best Practices Framework for Implementation

Based on a systematic analysis of successful mechanisms, institutions seeking to improve online adjunct faculty support can implement four evidence-based areas. As illustrated in Figure 2, these components work synergistically to create comprehensive support systems that prevent typical challenges faced by adjunct faculty while fostering engagement, professional growth, and institutional commitment.

Figure 2

Transferable Best Practices Framework for Online Adjunct Faculty Support



Note. Transferable Best Practices Framework for Online Adjunct Faculty Support. Framework components emerged from a thematic analysis of mixed-methods data explaining exceptional quantitative outcomes, including high PA and low EE.

This framework provides institutions with evidence-based guidance for improving systematic online adjunct faculty support. Each component demonstrably contributes to positive faculty outcomes as documented in the quantitative phase. The strategic leadership development component (A) emphasizes authentic relationship-building that directly addresses the OC challenges typically experienced by adjunct faculty, partnered with accountability and recognition. A comprehensive support infrastructure (B) prevents the EE typically documented in traditional adjunct models through systematic onboarding, mentorship, continuous development support, and VCoP’s. Structural policy commitment (C) creates an institutional foundation that transforms online adjunct faculty from temporary contractors to valued community members by establishing clear expectations, values, and vision for faculty and those who support them. Finally, an authentic relationship-building culture (D) operationalizes genuine care, recognition, and understanding communication.

Implications for Online Learning Practice and Theory

This research demonstrates that comprehensive online adjunct faculty support is both achievable and measurably effective, offering transformative possibilities for institutions struggling with the typical challenges of adjunct faculty. The sequential mixed methods approach proves that positive outcomes can be systematically created through intentional organizational practices. The four-component framework provides actionable guidance that institutions can adapt while maintaining core principles of comprehensive systematic support, offering alternatives to accepting typical challenges as inevitable. Investment in comprehensive online adjunct faculty support yields measurable positive outcomes that likely enhance student experiences and institutional effectiveness, providing a sustainable foundation for scaling online education while maintaining quality. The research provides empirical evidence that VCoP principles lead to measurable engagement when implemented systematically, demonstrating how theoretical frameworks are translated into practical approaches with documented outcomes.

Limitations

This private online university study may require adaptation for public institutions with different constraints and regulatory environments, as private institutions often have greater flexibility and resources. The support mechanisms require significant organizational commitment that many institutions may be unwilling or unable to provide, with implementation feasibility varying across institutional contexts. While providing insight into "what works," the research offers limited understanding of how to transform struggling institutions from their current state to the implementation of best practices. Voluntary participation may have excluded less satisfied community members, though strong response rates (10%–37% across groups) partially offset this limitation. This snapshot study lacks longitudinal data to understand the evolution, sustainability, or continued effectiveness of the support structure over time.

Conclusion

This study successfully identified comprehensive best practices that explain exceptional online adjunct faculty outcomes, demonstrating that positive results can stem from a systematic institutional commitment to excellence. The research provides an evidence-based explanation of how comprehensive support creates measurable positive outcomes, offers a systematic framework for preventing typical problems through proactive support, and demonstrates that online adjunct faculty can achieve high engagement through institutional commitment. The four-component framework (strategic leadership development, comprehensive support infrastructure, structural policy commitment, authentic relationship building) provides institutions with adaptable guidance while maintaining core systematic support principles. As institutions increasingly rely on online adjunct faculty for delivering online education, this research demonstrates that comprehensive support is both possible and effective, offering evidence-based guidance for improving faculty experiences and student learning outcomes.

Ethics Statement

This study was approved by the University's Institutional Review Board (IRB) and the Committee on Research (COR). All participants were provided with informed consent, ensuring confidentiality and anonymity. Given hierarchical relationships, researchers ensured voluntary participation free from supervisory influence.

Conflicts of Interest

The authors systematically addressed potential conflicts through comprehensive ethical safeguards. Two researchers work in the institution's quality assurance department, and all four serve as online adjunct faculty at the studied institution; however, the quality assurance researchers had no direct supervision of faculty participants. Anonymous survey responses with no individual linking capability, exclusion of staff-adjunct dual-role faculty, multiple researcher coding for bias reduction, systematic triangulation across data sources, elimination of researcher influence on responses, IRB/COR conflict review and approval, and no outcome-related compensation. Researchers' institutional knowledge enhanced the interpretation of terminology and support structures, while ethical safeguards preserved research integrity and participant confidentiality, contributing to the depth of analysis without compromising objectivity.

Acknowledgments

This research was conducted as part of the 2023 and 2024 Research Labs led by Dr. Mansureh Kebritchi and Dr. Stella Smith. The authors acknowledge Connie Houser, MSN, RNC, CNE, and David Mailloux, MS, who participated in Phase 1 quantitative research, which provided the foundation for this investigation. Although they did not continue to the second phase of the research, including the development of this manuscript, their contributions are appreciated.

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Applying the TAM Framework to Inform Faculty Participation in Course Quality Reviews

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Abstract

Higher education institutions increasingly promote course quality reviews (CQRs) to enhance the quality of online learning. However, limited research has examined the factors influencing faculty participation in these initiatives. This study used the Technology Acceptance Model (TAM) as a theoretical framework to inform faculty intentions to engage in CQRs. A context-specific survey instrument was developed and administered to 119 faculty members eligible to complete course reviews. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Findings revealed that perceived usefulness was the strongest predictor of intention to participate, followed by subjective norm, which also significantly influenced perceived usefulness. Additionally, technology self-efficacy contributed to perceived ease of use. These results offer insights into the motivational and social factors shaping faculty engagement and provide practical implications for institutional strategies aimed at improving participation in quality assurance processes.

Keywords: course quality reviews, technology acceptance, TAM, online courses, technology self-efficacy, structural equation modeling

De la Mora Velasco, E., Miller, R., Williams, F., & deNoyelles, A. (2025) Applying the TAM framework to inform faculty participation in course quality reviews, *Online Learning*, *29*(3), 130-157. https://doi.org.10.24059/olj.v29i3.5079

Introduction

Quality assurance in online courses is fast becoming a key process in many higher education institutions (HEI). Even though for some "quality" is an ideology more than a measurable construct (Pitsoe & Maila, 2014), in the research, quality in online education has gained traction and is repeatedly associated with aligned (Sridharan et al., 2015), engaging (Martin & Bolliger, 2018), effective (Smith & Macdonald, 2015), accessible (Timbi-Sisalima et al., 2022), and culturally inclusive (Williams, 2024) online courses. The growing number of associations and organizations dedicated to promoting quality in online learning has made the use of quality measures more widespread and common across HEIs. Quality Matters (2025) reported 1,300 HEIs from around the world being members of the organization, and the State University of New York (SUNY, 2025) in partnership with the Online Learning Consortium reported 1,170 institutions and organizations accessing their online quality scorecards during the year of 2022. Additionally, multiple universities (e.g., University of Central Florida), have created policies, infrastructure, and support systems to promote quality in online learning, as well as created, adapted, and promoted their online course review instruments and processes to guide and support faculty members in the improvement of their online and blended courses (Zimmerman et al., 2020).

There are four contextual factors that explain why quality in online education is a central concern for many HEIs. First, the growing demand for online education due to its convenience, flexibility, and lower cost, puts pressure on HEIs to offer online courses that exceed the expectations of learners (Muthuprasad et al., 2021), which in turn, leads to positive word-of-mouth recommendations and attracts and retains more students. Second, given the plethora of online programs and courses offered by HEIs, high-quality online courses can increase perceived credibility and reputation and turn into a competitive advantage (Miotto et al., 2020). Third, since regional accreditation is often a requirement for HEIs to obtain government funding, high-quality online courses that meet accreditation criteria allow access to it (Goodhue et al., 2012). Last, many HEIs are committed to ongoing improvement of their educational programs, and course quality reviews, along with the use of instructional design models for designing and developing instructional materials (Castro & Tumibay, 2021), facilitate obtaining expert feedback (e.g., instructional designers, external subject matter experts) and application of research-based guidelines and documented best practices for improving online course deliveries.

Despite the increased interest and implementation of course quality review processes by many HEIs around the globe, our empirical understanding of the facilitating factors, conditions, and antecedents of the acceptance of course quality reviews by faculty is scarce. Course quality reviews are processes that allow faculty to have their courses reviewed based on a set of criteria focused on effectiveness and engagement and are conducted internally by instructional designers or faculty, or externally by external reviewers or organizations (Newell et al., 2021). HEIs typically implement course quality reviews using one of two approaches. Some institutions require quality reviews prior to being offered to students (Missouri Online, 2025), while others offer them as optional opportunities for faculty (Brown et al., 2024; UCF, 2025). Even though the mandatory use of educational processes or innovations ensures faculty use and compliance and can help to quickly meet quality requirements, requiring the completion of course quality reviews can lead to resistance due to the perception of threat to academic freedom (Perrotta & Bohan, 2020). Another result of mandatory course quality reviews is excessive focus on meeting requirements rather than genuinely improving the course design (Chowdhary, 2023).

The present study is relevant for stakeholders involved in the design and implementation of strategies to promote course quality reviews (e.g., managers, instructional designers, faculty). By using a well-established theoretical framework, the Technology Acceptance Model (TAM), it examines key antecedents and predictors of faculty intentions to engage in course quality reviews. Our findings provide education leaders, faculty developers, and instructional designers guidelines on how to promote quality of online instruction through course review processes while maintaining faculty autonomy and enhancing faculty-instructional designer collaborations, and ultimately, enhancing student learning outcomes.

The present article is structured as follows. First, prior research on course quality reviews is synthesized and used to identify gaps addressed by our study. Second, a review of factors influencing the acceptance of course quality reviews is offered and used to underpin our hypotheses. Third, a methods section explains the participants, measurement instrument, and data collection and analysis processes. The fourth section presents the results of Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis to confirm or refute our hypotheses. The last section elaborates on the theoretical, managerial, and practical implications and the limitations of our study that serve to guide future research opportunities.

Review of Literature

Prior research has examined factors influencing faculty's use and participation in e-learning systems and processes. Gunasinghe et al. (2020) used the UTAUT-3 model to explore the adoption of e-learning among academicians, revealing that factors such as performance expectancy, effort expectancy, habit, and hedonic motivation significantly influenced adoption, while social influence and personal technology innovativeness were not significant predictors. Gunasinghe et al. also highlighted the importance of addressing individual perceptions and motivations when implementing technological innovations in online teaching and quality review tasks. Similarly, Long et al. (2019) used the UTAUT framework to investigate instructors' adoption decisions regarding the flipped classroom instructional model, finding that performance expectancy and technology self-efficacy were significant predictors. According to Long et al., facilitating conditions were not a significant predictor of flipped learning approaches, suggesting a need to focus on improving instructors' confidence and expectations regarding technology self-efficacy to facilitate successful adoption of educational innovations and processes.

Studies explored course design and the adoption of quality assessment procedures among faculty teaching in online modalities. Ralston-Berg et al. (2015) and Bagasra and Mackinem (2019) found that, while students value aspects such as clear instructions and ease of navigation, they may not prioritize elements such as interaction with peers and instructors as highly as quality rubrics suggest. This calls for course designers to incorporate student feedback and observations from live courses into their design process to ensure that online courses effectively meet student needs and expectations. Similarly, Rucker et al. (2015) argued the importance of internal quality assurance processes in maintaining the quality of online courses, highlighting the need for faculty buy-in and ongoing support to ensure successful implementation. Collectively, these studies underline the complexity of factors influencing the adoption of course quality review processes for online learning environments, which calls for the need to explore further what internal and external conditions facilitate faculty participation in course quality reviews.

Technology Acceptance Model

The TAM is a foundational theoretical framework for exploring factors that influence the adoption of educational systems in higher education. Rooted in the psychology of decision-making, the TAM provides a structured approach to understanding an individual's acceptance of technology-driven educational processes. The original framework (Davis, 1989) focused on perceived usefulness and perceived ease of use as core constructs. In the context of higher education teaching, *perceived ease of use* represents the degree to which users believe that using a system will require minimal effort, while *perceived usefulness* reflects the extent to which they believe it enhances their teaching performance (Davis, 1989). The model was expanded (TAM2) by Venkatesh and Davis (2000) to explain why a person might find technology useful, identifying social factors such as subjective norm. *Subjective norm* refers to the social pressure individuals feel to adopt or reject a technology. The TAM2 was further expanded (TAM3) by Venkatesh and Bala (2008) to account for individual differences and includes computer self-efficacy as a factor that predicts ease of use. All these perceptions directly impact *future intention of use*, which determines whether users will engage with the system or technology (Venkatesh & Bala, 2008). Over the past decades, the TAM has been widely applied to examine digital learning platforms, virtual classrooms, and AI-driven educational tools (King & He, 2006; Scherer et al., 2019).

TAM was selected as an informing framework because of its' simplicity and effectiveness in smaller-scale studies. It is widely established in educational research and offers many factors that can be applied in various contexts. In addition, the TAM is relevant in settings where use is voluntary rather than mandatory, since the focus on the model is on intention to use. However, little has been done to explore if the TAM can be used to inform the adoption of course quality review systems in higher education.

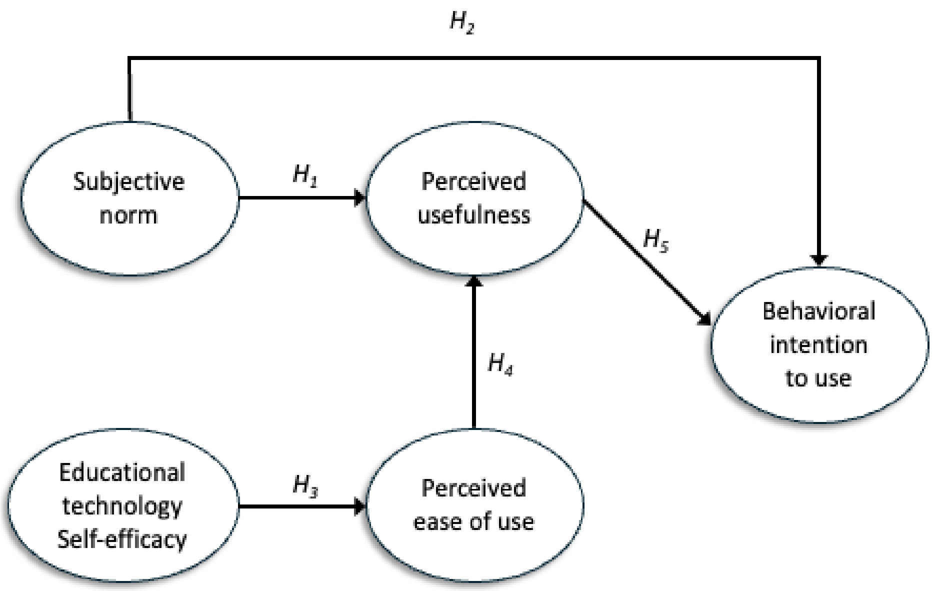
Despite its extensive application, the TAM has faced several criticisms, including its limited scope in addressing the dynamic nature of user adoption and the role of external factors like self-efficacy and affective components (Marangunić & Granić, 2015). Recent advancements in the TAM have integrated additional constructs such as technology self-efficacy, which reflects users' confidence in their ability to use educational technologies effectively (Abdullah & Ward, 2016; Park, 2009). However, the TAM's predictive power remains constrained when accounting for rapidly evolving digital learning environments, where factors such as motivation, enjoyment, and institutional support also play significant roles (Scherer & Teo, 2019). Building on these theoretical advancements and identified gaps, the following section outlines the study's hypotheses, which draw on the TAM framework as a foundational lens to examine faculty engagement with course quality review systems.

Hypotheses Development

The theoretical framework for this study is illustrated in Figure 1, which is designed in the context of faculty using (i.e., participating in) course quality reviews. Within this framework, five hypotheses are formulated. The empirical support for these hypotheses follows.

Figure 1

Theoretical Model



Research supports that subjective norm affects the perceived usefulness of learning platforms and systems. Altawalbeh (2023) investigated the adoption of learning management systems among academic staff in Jordanian universities and found that subjective norm significantly influenced perceived usefulness. When academic staff perceived that their peers and colleagues endorsed the learning management system (LMS), they were more likely to perceive the system as useful. In the context of course quality reviews, faculty may be persuaded to adopt course quality reviews if endorsed by their peers. This aligns with the original TAM proposition that subjective norm affects behavioral intention, which, in turn, impacts technology adoption. Similarly, Alkindi et al. (2022) explored the relationship between attitude, perceived usefulness, perceived ease of use, behavioral intention, and subjective norms in the context of faculty adoption of mobile learning applications. Their study revealed that subjective norms played a crucial role in faculty adopting mobile learning. Alkindi further found that when faculty perceived social pressure or expectations from their peers to use mobile learning apps, it positively influenced their perceived usefulness and intention to adopt the technology. Therefore, social influence might positively influence faculty participation in course quality review processes. Cilsalar-Sagnak and Baran (2021) studied teachers planned technology integration behavior within a technology mentoring program and found that faculty perceptions of social expectations and norms influenced their intentions to integrate technology into their teaching practices. Taken together, these findings underscore the importance of subjective norm in shaping technology-related behaviors. Research has consistently found that subjective norm plays a significant role in influencing perceived usefulness and behavioral intentions related to learning technologies and systems adoption. As such, the TAM framework provides valuable insights into how social influence impacts individuals' decisions to embrace new technologies and may be applied to the adoption of quality reviews in educational contexts. Therefore, the first hypothesis is proposed:

> *H1 Subjective norm is positively associated with perceived usefulness of course quality reviews.*

Studies show that subjective norm, alongside other factors like perceived ease of use and usefulness, significantly influences behavioral intention to use educational technologies and, by extension, adopt course quality reviews (Burch & Mohammed, 2019; Granić, 2022; Wright, 2018). Sadeck (2022) studied theory testing during the COVID-19 pandemic. Sadeck's work indicated that no use (in this case, no adoption) is also a reality impacting TAM's applicability, and an understanding of these dynamics is essential to inform effective technology adoption in higher education. Subjective norm, which reflects an individual's perception of social pressure or influence, directly shapes their behavioral intention to use course quality reviews. This perspective is reflected in Granić's work, which explored several constructs from which subjective norm emerged as a significant predictor of behavioral intention. Granić found that faculty perceptions of social expectations regarding technology use impact their willingness to adopt educational technologies. In other words, when individuals perceive that others, such as peers, colleagues, or experts, expect them to use course quality reviews, they are more likely to intend to do so. The studies collectively explore how faculty might navigate adoption and highlight the interplay between social influence, individual perception, and type of technology, which may align with the adoption of course quality reviews. As a result, the next hypothesis is:

> *H2 Subjective norm is positively associated with behavioral intention to use course quality reviews.*

Technology self-efficacy is critical for shaping faculty intentions to participate in course quality reviews that rely on LMS and other technology-enhanced tools. This position is consistent with findings in the research on adoption and use of LMSs. For instance, Fearnley and Amora (2020) investigated factors influencing the adoption of an LMS by higher education teachers using an extended TAM. They found that technology self-efficacy directly and strongly influenced perceived ease of use. In an earlier work, Fathema and Sutton (2013) found that faculty with positive beliefs about their ability to use the LMS also perceive it as both useful and easy to use. Both studies recommend that institutions should focus on improving system quality and fostering positive self-efficacy among faculty through training and policy development. While these factors are related to LMS adoption, the recommendations may be relevant to course quality review adoption among higher education faculty. Moreover, Abdallah et al. (2019) researched factors influencing LMS adoption from the instructor's perspective and found that multiple factors (e.g., social, individual, organizational) relate to perceived ease of use and emphasized the need for quality assurance in LMS design and implementation. Even though explicitly related to LMS adoption, the findings of these studies can also be applied to course quality review adoption, policy, training, and promotion. Thus, the next hypothesis is proposed:

H3 Technology self-efficacy is positively associated with perceived ease of use of course quality reviews.

The TAM and its subsequent extensions provide a robust framework for understanding the relationship between perceived ease of use and perceived usefulness in the context of higher-education faculty acceptance of quality reviews for online courses. Davis (1989) established that perceived ease of use and perceived usefulness are fundamental determinants of user acceptance of new technologies. Perceived ease of use directly influences perceived usefulness. Venkatesh and Davis (1996) further demonstrated that users' computer self-efficacy significantly affects perceived ease of use, both before and after exposure to a technological system. This suggests that faculty who find the quality review process easy to navigate are more likely to perceive it as useful for improving their teaching performance. Moreover, the theoretical extensions of TAM, such as TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008), reinforce the positive association between perceived ease of use and perceived usefulness. Venkatesh and Davis (2000) found that perceived ease of use fully mediates the effect of computer self-efficacy on behavioral intention to use a technology, indicating that ease of use is a critical factor in determining the perceived usefulness of any system. Complementarily, Venkatesh and Bala (2008) highlighted that perceived ease of use is a significant predictor of behavioral intention to use a technology, particularly for users with little to no prior experience. In the context of online course quality reviews, this implies that faculty who perceive the review process to be easy to complete are more likely to find it useful and, consequently, are more inclined to participate in it. Smith and Sivo (2011) supported this idea by demonstrating that perceived ease of use and perceived usefulness are significant determinants of teachers' intent to continue using e-learning for professional development. In sum, a course quality review process that is perceived as easy to use can enhance its perceived usefulness, thereby encouraging greater faculty participation. Therefore, the next hypothesis is proposed:

H4 Perceived ease of use of course quality reviews is positively associated with perceived usefulness of them.

Perceived usefulness is widely studied in the literature related to technology acceptance and user behavior. Scholars suggest that perceived usefulness of a system may depend on individual goals and preferences (Schmitz & Hanke, 2023) as well as contextual factors (Akram et al., 2021; Kamble et al., 2022). High-quality courses take alignment with learning objectives and engaging learning materials into account to foster a positive learning experience. Kamble found that course quality significantly influences learners' continuance intentions in MOOCs, with this relationship being mediated by perceived usefulness, highlighting its key role in translating quality into sustained use. Akram similarly suggested that when educators perceive course quality reviews as useful, they are more likely to adopt online teaching tools. Schmitz and Hanke further supported this by showing that high-quality design enhances user attitudes and engagement, indicating that when users find the quality aspects useful, they are more inclined to continue using the system. Moreover, Podsiad and Havard (2020) explored faculty acceptance of a peer assessment collaboration evaluation tool in their qualitative study and found that when faculty perceive a tool as useful, they are more likely to adopt it, aligning with the hypothesis that the perceived usefulness of course quality reviews is positively associated with attitudes toward using them. In a similar study on mobile technology adoption, Wright (2018) assessed faculty acceptance of mobile devices using the TAM framework and found that faculty who perceive mobile applications as useful are more likely to adopt them for educational purposes. This finding has implications for the hypothesis that subjective norm is positively associated with behavioral intention to use course quality reviews. This finding underscores the importance of perceived usefulness in faculty technology acceptance. The findings collectively emphasize the role of perceived usefulness and course quality in shaping attitudes toward using online teaching tools. Consequently, the last hypothesis is proposed:

> *H5 Perceived usefulness of course quality reviews is positively associated with behavioral intention to use them.*

The literature revealed a gap in the research relating to our empirical understanding of facilitating factors of faculty intention to engage in course quality reviews. This study focused on improving our collective understanding of these factors, which, in turn, can provide practical implications for institutional strategies aimed at improving participation in quality assurance processes. To gain these insights, we surveyed faculty who were eligible to participate in voluntary quality reviews of online courses, as described in the following section.

Method

Measurement

An instrument was designed to measure faculty willingness to adopt (i.e., participate in) course quality reviews, with items adapted from established scales in the literature. Specifically, perceived usefulness, perceived ease of use, and intention to use were adapted from Ibrahim et al.'s (2017) work on e-learning acceptance. Technology self-efficacy and subjective norm items were based on the work of Salloum et al. (2019). The instrument included 24 5-point Likert-scale items adapted from the TAM framework, as shown in Table 3. Five demographic questions to gather information on participants' gender, age, years of experience teaching online or blended courses, highest academic degree attained, and prior quality review experience were included.

Although pilot testing of the instrument was not conducted, both face validity and construct validity were addressed to ensure clarity, contextual relevance, and theoretical alignment of the instrument with the TAM in the context of HEI course quality reviews. Face validity was established through expert judgment by a panel of faculty who reviewed and revised the survey. The panel reviewed items derived from validated TAM instruments used in prior studies. First, the TAM items published by Ibrahim et al. and Salloum were compiled. Then, the researchers conducted meetings to adapt the items for the specific context of course quality reviews in HEIs.

For example, the original item "Interacting with the e-learning system does not require a lot of my mental effort" was adapted to "Completing future course quality reviews would not require a lot of my mental effort," preserving the core construct while increasing contextual specificity. This process was applied to all the items, and revisions were made iteratively until consensus was reached among the researchers. In addition to face validity, construct validity was considered to ensure that the adapted items accurately reflected the core dimensions of the TAM. Careful attention was given to retaining the theoretical meaning of each item during adaptation.

After the items were collaboratively adapted and consensus was reached, the instrument was put in an online survey platform to facilitate data collection.

Participants and Data Collection

The target population consisted of 886 faculty members at a public research university in the southeastern U.S. who were credentialed to develop and teach online or blended courses at the institution. These faculty had all completed required training about the design and development of online and blended courses. They may or may not have participated in course quality reviews, but they were all eligible to voluntarily request a quality review of an online or blended course they developed. The course quality review process at this institution is that once a course review has been requested, an instructional designer will collaborate with the faculty member to review the course for elements such as clear structure and organization, content that is accessible for all students, and activities and assessments that support student achievement of stated learning goals. When the course is recognized as providing these elements, it is awarded a Quality designation. A digital Quality emblem is placed prominently in the course, and the faculty member receives a letter of recognition and becomes eligible for online and blended teaching awards. The items and process (see https://cdl.ucf.edu/services/instructional/ucf-quality-initiative/) have been deemed equivalent to the widely known Quality Matters certification process, as required by the state university system.

The 886 faculty who were credentialed to develop and teach online or blended courses were included in the recruitment process, regardless of whether they had participated in course quality reviews. Participation in the study was voluntary with the option to withdraw at any time or skip specific questions. Ethical approval for this study was obtained from the university's Institutional Review Board (IRB). Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Respondents were assured of the confidentiality and anonymity of their responses and were informed that they could withdraw from the study at any time without penalty. After obtaining IRB approval, an invitation was emailed to all eligible faculty in the fall of 2024, soliciting their participation to complete the instrument. The questionnaire was distributed via an online survey system and included clear instructions to ensure informed consent and a short and informative video about the course quality review process in the HEI. To enhance participation rates, reminders were distributed over a one-month period. The survey was de-identified to protect faculty confidentiality.

Data Screening and Demographics

The survey collected 131 responses, of which 119 were deemed valid after excluding 12 incomplete submissions. The demographic data collected from the 119 valid survey responses is presented in Table 1. The demographic profile of faculty surveyed indicates a highly experienced and academically qualified group, with nearly 60% reporting more than 10 years in online or blended teaching. The majority held doctoral degrees, suggesting strong research and academic background. Additionally, the distribution across age groups reflects a predominance of mid-career and senior faculty, which may influence their perspectives on course quality and institutional review processes. Notably, women comprised the majority of respondents (59.7%). These characteristics suggest that the surveyed faculty are well-positioned to provide informed insights into course quality reviews.

Table 1

Demographic Data

Category	*N*	%
Gender		
Women	71	59.7%
Men	35	29.4%
Non-binary	1	0.8%
Prefer not to answer	9	7.6%
NS	3	2.5%
Age		
20–29	2	1.7%
30–39	12	10.1%
40–49	32	26.9%
50–59	36	30.3%
60–69	21	17.6%
70+	2	1.7%
Prefer not to answer	11	9.2%
NS	3	2.5%
Years Teaching Online		
0–5 years	19	16.0%
6–10 years	34	28.6%
11–15 years	34	28.6%
16–20 years	15	12.6%
21+ years	15	12.6%
NS	2	1.7%
Academic Degree		
Master's	25	21.0%
Doctoral	90	75.6%
Other	2	1.7%
NS	2	1.7%

Note. NS = not specified.

Data Analysis

The collected data were processed using IBM SPSS Statistics (Version 29.0.1.1) and SmartPLS (Version 4.1.0.9). SPSS was used to examine the dataset for incomplete and straight-lining responses by identifying missing values and calculating response variances, respectively. All calculated variances were above 0, indicating sufficient variation in responses; therefore, all cases were considered valid for analysis.

Table 2 presents the Pearson correlations among all constructs in the CQR-A instrument, with most showing moderate to strong positive relationships. For example, perceived usefulness (PU) and intended use (IU) are highly correlated ($r = .677$, $p < .01$). Educational technology self-efficacy (SE), however, shows weaker associations moderately correlated with perceived ease of use (PEU; $r = .339$, $p < .01$) and weakly with intended use (IU; $r = .189$, $p < .05$), but not significantly related to perceived usefulness or subjective norm. This suggests self-efficacy may play a more peripheral role in the model.

Table 2

Correlations Between Factors in the Model

	PU	PEU	IU	SE	SN
PU					
PEU	.459**				
IU	.677**	.635**			
SE	.071	.339**	.189*		
SN	.465**	.411**	.582**	.116	

Note. PU = perceived usefulness, PEU = perceived ease of use, IU = intention to use, SE = educational technology self-efficacy, SN = subjective norm. ** = correlation is significant at the 0.01 level (2-tailed). * = correlation is significant at the 0.05 level (2-tailed).

The SPSS dataset was then imported to SmartPLS software to conduct the hypothesis testing using a variance-based SEM. SEM offers the benefit of simultaneously examining relationships among indicator variables (measurement model) and latent constructs within the theoretical framework (structural model). Specifically, PLS-SEM was employed to estimate the theoretical model. This approach is particularly useful in exploratory research contexts, as it allows for the assessment of complex cause-effect relationship models with multiple constructs and indicators, even when data does not meet the strict assumptions of covariance-based SEM. The PLS algorithm, with its minimal assumptions about residual distributions, is well-suited for prediction-focused research and has been proved to work well for small samples and non-normal distributions compared to covariance-based SEM (CB-SEM) (Afthanorhan, 2013; Goodhue et al., 2012; J. Hair et al., 2017). Considering the exploratory and predictive purposes of this study, PLS-SEM was determined to be the most appropriate method.

Results and Analysis

Measurement Model Evaluation

The measurement model was assessed to ensure the reliability and validity of the constructs. The constructs measured in the model demonstrate strong internal consistency reliability and convergent validity, meeting established thresholds outlined in the literature.

Table 3 presents the factor loadings for individual survey items across the five measured constructs. All items loaded strongly onto their respective factors, with loadings ranging from 0.662 to 0.934 and all factor loadings statistically significant at $p < .001$. These results provide evidence of good construct validity, particularly for perceived usefulness, behavioral intention, and subjective norm, which demonstrate consistently high loadings. The findings support the structural integrity of the measurement model used in the study.

Table 3

Factor Loadings for Individual Items

Construct	Measurement Item	Factor Loadings
Perceived Usefulness	Completing quality reviews could help my online courses be more effective.	0.889
	Completing quality reviews could improve my online courses.	0.879
	Completing quality reviews could increase my productivity.	0.843
	Completing quality reviews could be useful in my work.	0.916
Perceived ease of use	I know how to request a course review.	0.662
	Completing future course quality reviews would not require a lot of my mental effort.	0.860
	I would find course quality reviews to be easy to complete.	0.903
	It would be easy to become skillful at completing course quality reviews.	0.903
	There would be clarity and understanding in my interactions when completing course quality reviews.	0.857
Behavioral Intention	I intend to complete course quality reviews for my future courses.	0.899
	I would recommend course quality reviews to other faculty.	0.934
	I think course quality reviews should be completed by other faculty.	0.846
Educational Technology Self-Efficacy	I feel confident using educational technologies (e.g., Webcourses) when no one is there for assistance.	0.735
	I have sufficient skills to use educational technologies.	0.818
	I feel confident when designing my online or blended courses.	0.838

	I feel confident when organizing content and assessments within my online or blended courses.	0.828
	I feel confident when designing online course introduction and learning activities.	0.831
	I feel confident using a variety of online teaching strategies.	0.837
	I feel confident dealing with online teaching issues and challenges.	0.861
	I feel confident communicating with students in online or blended courses.	0.736
Subjective Norm	I should participate in course quality reviews, according to my chair or dean.	0.808
	I should participate in course quality reviews, according to other instructors.	0.866
	I should participate in course quality reviews, according to the people who influence my behavior or whose opinions I value.	0.885
	Generally, I think that course quality reviews are supported by the university.	0.723

Note. All loadings are significant at $p < 0.001$.

Table 4 shows that Cronbach's alpha values for all constructs exceed the recommended threshold of 0.70, indicating a high level of internal consistency (Hair et al., 2014). Similarly, composite reliability *rho_a* and *rho_c* values are above 0.70 for all constructs, confirming adequate reliability of the measurement instruments (Hair et al., 2019). Furthermore, the Average Variance Extracted (AVE) for all constructs surpasses the minimum recommended threshold of 0.50, establishing convergent validity (Fornell & Larcker, 1981). These results suggest that the constructs reliably measure their respective latent variables and that the items within each construct capture the intended dimensions effectively. Such findings indicate that the reflective measurement model is robust and suitable for subsequent structural model evaluation. We also assessed the standardized Root Mean Square Residual (SRMR), which provides an absolute measure of model fit by assessing the average discrepancies between observed and model-implied correlations. The SRMR value for the saturated model is 0.075, which falls below the commonly accepted threshold of 0.08, indicating a good fit (Henseler et al., 2015; Hu & Bentler, 1999).

Table 4

Reliability and AVE (Reflective Constructs)

Reflective constructs	α	CR *rho_a*	*CR rho_c*	AVE
Behavioral Intention to Use	0.873	0.877	0.922	0.798
Perceived Ease of Use	0.894	0.914	0.923	0.708
Perceived Usefulness	0.905	0.914	0.933	0.778
Educational Technology Self-Efficacy	0.926	0.929	0.939	0.659
Subjective Norm	0.839	0.850	0.893	0.677

Note. α = Chronbach's alpha, CR = composite reliability, AVE = average variance extracted.

The discriminant validity of the constructs was assessed using the Heterotrait-Monotrait (HTMT) ratio of correlations and the Fornell-Larcker criterion. The HTMT values for all construct pairs were below the threshold of 0.90, as recommended by Henseler, et al. (2015), confirming adequate discriminant validity (see Table 5). For instance, the HTMT value between *Perceived Usefulness* and *Subjective Norm* was 0.543, demonstrating clear distinction between these constructs. Additionally, the Fornell-Larcker criterion supported these findings, with the square root of the average variance extracted (AVE) for each construct exceeding its highest correlation with any other construct (Fornell & Larcker, 1981). This indicates that each construct shares more variance with its indicators than with any other construct, further confirming their discriminant validity. Therefore, the constructs in the model are empirically distinct, enabling a reliable interpretation of relationships within the structural model. By meeting the established thresholds for discriminant validity, the study ensures that the theoretical framework is robust, and the findings can be confidently used to advance understanding in faculty adoption of course quality reviews.

Table 5

HTMT Results

	Technology Self-Efficacy	Behavioral Intention to Use	Perceived Ease of Use	Perceived Usefulness	Subjective Norm
Technology Self-Efficacy	--				
Behavioral Intention to Use	0.203	--			
Perceived Ease of Use	0.349	0.718	--		
Perceived Usefulness	0.103	0.791	0.538	--	
Subjective Norm	0.133	0.694	0.507	0.543	--

Structural Model Evaluation

The structural model was evaluated using the coefficients of determination (R^2). The R^2 value for behavioral intention to use was 0.644, indicating that 64.4% of the variance in this construct was explained by the model's predictors. Similarly, perceived usefulness and perceived ease of use exhibited R^2 values of 0.308 and 0.119, respectively, reflecting moderate and small explanatory power. These findings align with the benchmarks proposed by Chin (1998), who categorized R^2 values of 0.19, 0.33, and 0.67 as weak, moderate, and substantial, respectively.

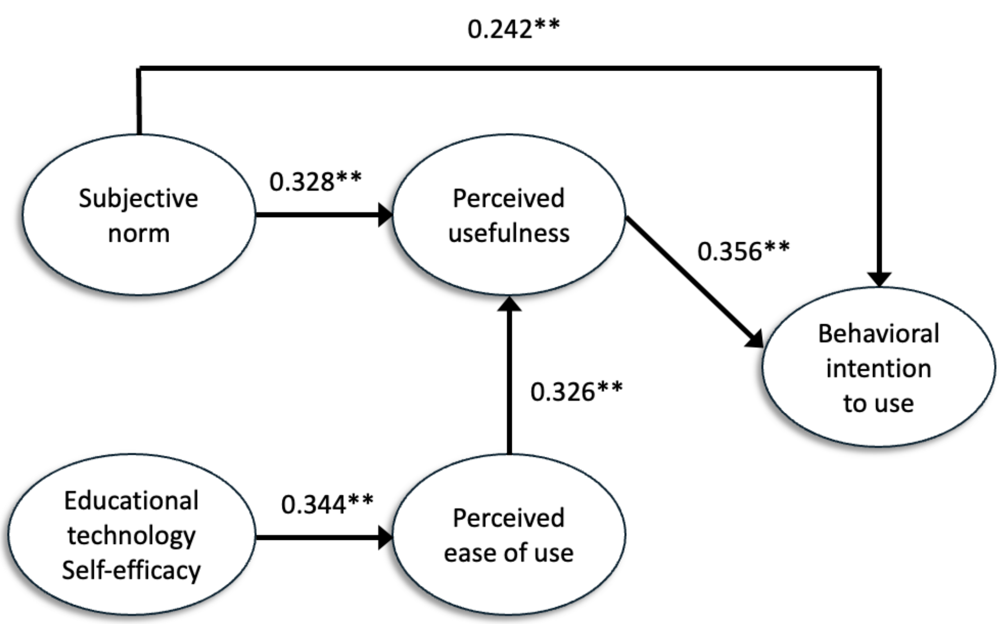
In practical terms, the model's explanatory power has meaningful implications for promoting faculty adoption of course quality reviews. The substantial R^2 value for behavioral intention to use (0.644) suggests that faculty members' willingness to engage in course quality reviews is strongly influenced by perceived usefulness, perceived ease of use, and subjective norms. The moderate R^2 for perceived usefulness (0.308) indicates that perceptions of a review's utility are moderately shaped by ease of use and social influences, while the small R^2 for perceived ease of use (0.119) reflects that technology self-efficacy has a limited but non-negligible impact. These findings imply that to foster faculty acceptance, institutional efforts should prioritize communicating the benefits of quality reviews, reinforcing peer support, and simplifying the review process.

Hypothesis Testing

Bootstrapping with 5,000 subsamples was conducted to assess the significance of the hypothesized relationships (see Figure 2). All path coefficients were statistically significant, supporting the proposed hypotheses. Subjective norm positively influenced perceived usefulness ($\beta = 0.328$, $t = 3.855$, $p < 0.001$) and behavioral intention to use ($\beta = 0.242$, $t = 3.524$, $p < 0.001$), indicating that social influence plays a significant role in shaping faculty perceptions and behaviors regarding course quality reviews. Educational technology self-efficacy had a significant positive effect on perceived ease of use ($\beta = 0.344$, $t = 4.803$, $p < 0.001$), highlighting the importance of self-confidence in navigating an LMS and similar educational technologies.

Figure 2

PLS Results of the Structural Model



Note. ** Significant at $p < .001$

Perceived ease of use significantly predicted perceived usefulness (β = 0.326, $t = 4.120$, $p < 0.001$) confirming its central role in the adoption process. Notably, perceived usefulness exhibited the strongest effect on behavioral intention to use (β = 0.356, $t = 5.565$, $p < 0.001$), underscoring its critical influence on faculty decision-making (see Table 6). These findings align with the TAM (Davis, 1989) and its extensions, which emphasize the interplay of perceived ease of use, usefulness, and subjective norm in course quality review engagement.

Table 6

Results of Hypothesis Testing

Hypothesis	Coefficient	*t*-value
H1: Subjective Norm → Perceived Usefulness	0.328	3.855
H2: Subjective Norm → Behavioral Intention to Use	0.242	3.524
H3: Technology Self-Efficacy → Perceived Ease of Use	0.344	4.803
H4: Perceived Ease of Use → Perceived Usefulness	0.326	4.120
H5: Perceived Usefulness → Behavioral Intention to Use	0.356	5.565

Note. These significance levels are determined via bootstrapping analysis (Hair et al., 2011).

The results suggest that perceived usefulness and ease of use are fundamental in driving faculty intentions to participate in course quality reviews. The role of technology self-efficacy in enhancing perceived ease of use highlights the importance of providing faculty with targeted training to increase their confidence in using instructional technologies. Furthermore, subjective norm's influence on both perceived usefulness and behavioral intention underscores the need to foster supportive social environments and encourage peer endorsement of course quality reviews. These findings are consistent with recent literature on technology acceptance in educational settings, which underline the importance of usability, perceived value, and social factors in shaping systems adoption (Venkatesh et al., 2012).

Discussion

Theoretical Implications

The original TAM primarily focused on the use of technology. Over time, it has been adapted to include additional factors such as social influence and technology self-efficacy and has been applied to various contexts. This study uses the well-established TAM to better understand the factors that predict faculty intention to engage in course quality reviews. In this complex context, the focus extends beyond the adoption of a review instrument to encompass relational dynamics, evaluative processes, and critical reflection on pedagogical practice. The findings proposed in this study highlight two key factors that inform faculty intentions: subjective norm and technology self-efficacy. Both factors appear to strongly influence a teacher's intention to engage in the voluntary course review process.

Subjective norm was found to positively influence perceived usefulness. In other words, when faculty perceive influence from peers, colleagues, or leadership, it shapes their perceptions of the usefulness of engaging in the review process. This finding supports previous work in this area, such as Altawalbeh (2023) on the adoption of LMS and Alkindi et al. (2022) on mobile learning applications. In this study, it was found that subjective norm also positively influences the intention to use technology; this was also noted by Sagnak and Baran (2021) in their study on integrating technology. The belief that participation in the course review is expected and accepted by others appears to significantly affect faculty decisions to engage in the process.

Technology self-efficacy significantly affected perceived ease of use. This finding supports the notion that the more confident faculty feel about designing and teaching online courses, as well as using educational technology in general, the easier they find it to request and complete a review successfully. Additionally, ease of use was a strong predictor of both perceived usefulness and intention to use, confirming previous iterations of the TAM. In short, when a tool, process, or system is perceived as useful, faculty are more likely to adopt it, as demonstrated by Podsiad and Havard (2020). Essentially, self-perceived confidence in the use of instructional technologies leads to perceptions of ease and usefulness, which in turn increases engagement with course review systems and tools.

Our findings align with Burch and Mohammed's (2019), who found that technology adoption is not straightforward, and this complexity extends to engaging (i.e., continually participating) in an online quality review process, which goes beyond simple adoption. The TAM framework helps us understand how faculty perceive the review process, which could positively influence more widespread adoption. Improved design of online courses, resulting from increased engagement in quality reviews, can have a cascading effect on student perceptions. Our findings are consistent with studies on more straightforward technology adoption, suggesting similar dynamics in the context of quality reviews. Given these findings, studies examining processes that incorporate a technological component may benefit from assessing subjective norm and technology self-efficacy, as both factors positively impact faculty intentions to engage with the system.

Practical Implications

Encouraging faculty to engage in online course reviews can be challenging, especially when participation is voluntary. The present study, which explored various constructs of the TAM also suggests practical recommendations to improve faculty acceptance of online course review processes. Based on our findings, we organize these implications across four levels: institutional, departmental, peer, and student.

Institutions might prioritize quality interventions by focusing on enhancing perceived usefulness and fostering supportive social norms, as these factors were strongly associated with faculty intention to engage in course quality reviews. Targeted professional development and peer-led initiatives could be especially effective in reinforcing these perceptions and encouraging broader participation.

Institutional Level

Subjective norm was found to positively affect the intention to use. When faculty believe that their peers, colleagues, or leadership expect them to participate in the course review, they are more likely to engage. Faculty buy-in is therefore essential for successful implementation (Rucker et al., 2015). In turn, when faculty perceive the review process as useful, they are more likely to participate (Podsiad & Havard, 2020). Therefore, fostering a collective sense of the importance of reviews, especially voluntary ones, is crucial. Moreover, institutions can strengthen subjective norms by publicly recognizing faculty who participate in reviews. Recognition on social media or institutional websites, along with testimonials using direct quotes from faculty, can reinforce the value of the process. Engaging directly with faculty to understand their perceptions and impact is crucial.

The relationship between educational technology self-efficacy and ease of use was significant. This study aligns with previous literature (Long et al., 2019) that technology self-efficacy plays a role in predicting adoption decisions. Faculty who lack confidence in using educational technology may also lack confidence in completing the online course review process successfully. Paradoxically, those who might benefit most from the course review may be the least likely to engage in it. Addressing self-efficacy through targeted training, resources, and ongoing support is essential to ensure successful course review implementations. To encourage self-efficacy, institutions should also promote faculty-driven quality reviews through peer-led initiatives and recognition. Fathema and Sutton (2013) suggested that faculty with positive beliefs about their ability to use an LMS perceive it as useful and easy to use. They recommend improving system quality and fostering self-efficacy through training and policy development, which is relevant to course quality review adoption.

Rucker et al. (2015) called for ongoing support to ensure successful quality assurance processes. Increased confidence can lead to a greater willingness to engage in the review process. Venkatesh and Bala (2008) noted that perceived ease of use predicts intention to use for those with little experience, but this effect decreases as experience increases. This underscores the importance of encouraging faculty to engage in the review process often and early. Ease of use and perceived usefulness determine the intent to continue e-learning to meet professional development needs (Smith & Sivo, 2011).

Institutions can leverage peer influence and faculty networks to foster a culture of engagement. Encouraging participation through strategic communication, showcasing benefits via faculty testimonials, and framing reviews as professional development rather than evaluation can be effective. Tailoring promotional efforts to highlight ease of engagement and the benefits experienced by others can also help.

Departmental Level

At the departmental level, leadership buy-in and ongoing visibility of course quality reviews are essential to reinforcing subjective norms. Department chairs and program coordinators can model engagement by participating in reviews themselves and including discussions about course reviews in meetings, communities of practice, or settings where faculty can share experiences. Personal acknowledgment, clear expectations, and inclusion of participation in reviews as part of evaluation, promotion, and awards are important.

Fostering a culture of technological confidence through mentoring and collaborative training can enhance self-efficacy. When faculty support each other and share experiences, particularly around perceived challenges or successes, reviews are more likely to be viewed as accessible and worthwhile. Departments may also consider recognizing participation in reviews as part of promotion, evaluation, and awards processes. Positioning reviews as intuitive and beneficial with clear messaging and accessible support is also crucial.

Peer Level

Faculty peers are influential in shaping engagement with quality reviews. The review process should be as faculty-owned as possible. Including faculty in the development of review items and processes, and encouraging them to become peer reviewers, can increase perceived usefulness and engagement. Direct conversations with faculty about their perceptions and feedback on new iterations of the review process can further enhance faculty investment and commitment. Moreover, faculty champions (those who have successfully navigated the review process) can serve as credible role models and mentors, offering practical insights, sharing positive experiences, and reducing apprehension among their colleagues. This peer-driven approach not only normalizes participation but also cultivates a collaborative culture around quality improvement in online teaching.

Student Level

Although not often discussed, the influence of students should be considered. Courses are designed to teach students, and positive feedback from students on courses that have undergone the review process can reinforce faculty motivation. Students also communicate with each other, spreading the word about the benefits of well-designed courses. These social dynamics can influence faculty perceptions of their work's impact and may contribute to perceived usefulness

Limitations and Future Work

It is important to acknowledge four limitations of this study that should be addressed in future studies. First, the scope of this study was limited to faculty at one large metropolitan research university who have been credentialed to develop online and blended courses, making them eligible to voluntarily participate in course quality reviews at their institution. To improve generalizability, future studies could include faculty from other institutions, varying in size, cultural setting, type, and voluntariness of participation in course quality reviews.

Second, this study used a quantitative research approach, which could limit the depth of understanding of the TAM constructs. Future studies could incorporate a qualitative study of faculty experiences in course quality reviews, including the phases of the process and their concerns. Such a study could include faculty participants with varying levels of experience, from novice to power user. Although the TAM model proved helpful as an informing framework, other frameworks such as UTAUT show promise and could be explored. Also, the present research collected data from faculty at a single point in time (e.g., cross-sectional). It is recommended that future research conducts a longitudinal study to further understand the interrelationships among the factors that may play a significant role in influencing faculty use of course quality reviews over time.

Third, the data collected were self-reported by faculty participants, so the reliability of the data is dependent on the participants' accuracy of their responses. For example, to what extent do faculty responses reflect their actual intention to engage in course quality reviews? Future research addressing the relationship between TAM constructs and objectively measured engagement in course quality reviews is needed to more conclusively predict engagement in quality course reviews. The proposed acceptance model is not a fixed model and is open to continual development. Future studies may extend or modify this acceptance model by adding other dimensions, such as perceived facilitating conditions and perceived organizational support to engage in course quality reviews (Venkatesh & Bala, 2008).

Additionally, previous literature on student perceptions of online course quality has suggested that they may value aspects of quality course design in a slightly different manner. For instance, ease of navigation may be more important to students than peer interaction (Ralston-Berg et al., 2015). Further research is needed that incorporates perspectives of students as stakeholders in quality course design. For example, how do student interpretations of quality standards compare with those of faculty and reviewers? Students could be surveyed in selected courses about specific elements of quality course design, and the results could be compared with faculty who designed or taught the courses. Future studies could empirically examine the impact of course quality reviews by analyzing student engagement, motivation, and learning outcomes through comparisons—such as courses that have been awarded a designation of Quality as a result of a review process compared with courses that have not undergone a Quality review process. Future research could also incorporate qualitative methods, such as interviews or open-ended survey responses, to capture deeper insights into faculty experiences, motivations, and contextual factors that may not be fully reflected in quantitative data. These perspectives could enrich the interpretation of findings and uncover nuanced barriers or enablers to course quality review participation. Addressing these limitations in future studies will contribute to a more comprehensive understanding of factors that influence instructors' decisions to participate in course quality review processes.

Conclusion

The present study underscores the importance of perceived usefulness and ease of use in driving faculty intentions to engage in course quality reviews. Acknowledging subjective norm and technology self-efficacy provides valuable insights into factors influencing faculty participation in course quality reviews. Subjective norm impacts perceived usefulness and behavioral intention, highlighting the role of social influence in shaping faculty attitudes towards course quality reviews. Additionally, technology self-efficacy enhances perceived ease of use, suggesting that faculty confidence in using instructional technologies is crucial for successful engagement in the review process. This addresses the importance of the data for making decisions about integrating course quality reviews into existing processes.

Our findings provide a pathway for HEIs to develop comprehensive recognition systems that value faculty engagement in course quality reviews as a key component of professional development and institutional excellence. Fostering a supportive environment that recognizes and promotes faculty participation in course quality reviews, leveraging peer influence and faculty networks to encourage engagement is essential. Departments can also enhance self-efficacy through targeted professional development workshops that align with faculty objectives, demonstrate practical benefits of course quality reviews, aligning performance metrics and promotion criteria to recognize meaningful contributions to course quality improvement. The present article suggests that peer-driven approaches can normalize faculty participation and cultivate a culture of quality improvement by creating structured opportunities for sharing insights and best practices. Providing ongoing technology training and user-friendly course review platforms or processes can reduce barriers to participation and develop mentorship networks that foster continuous pedagogical improvement. Furthermore, positive student feedback on courses that have undergone course quality reviews can reinforce faculty motivation, with transparent feedback mechanisms demonstrating how student input can directly contribute to course improvement.

The TAM framework provides a robust theoretical foundation for better understanding faculty adoption of course quality reviews. By explicating the complex interplay among subjective norms, educational technology self-efficacy, perceived usefulness, and behavioral intention, this research offers critical insights into the motivational dynamics of faculty engagement. The developed framework illuminates the factors driving faculty participation while providing a nuanced lens for HEIs to enhance online course quality, ultimately benefiting both faculty professional development and student learning experiences. These findings are consistent with existing literature on technology acceptance in educational settings (Akram et al., 2021; Schmitz & Hanke, 2023), which underlines the importance of usability, perceived value, and social factors in shaping systems adoption (Venkatesh et al., 2012).

The rapid evolution of educational technologies and the increasing complexity of online learning environments underscore the critical need for adaptive research frameworks. Future investigations should therefore seek to refine and adapt this model across diverse institutional contexts, exploring how faculty engagement in course quality reviews can be effectively supported in an era of dynamic technological change. By developing a more nuanced understanding of the factors influencing technology adoption, researchers can contribute to the design of more agile, responsive systems that support continuous educational improvement. The present research illuminates the current landscape of faculty technology acceptance while providing a foundational model for understanding how higher education can develop more flexible and collaborative approaches to quality assurance in an increasingly digital learning ecosystem.

Ethics Statement

The research reported in this paper was reviewed and approved by the UCF IRB committee under approval MOD00006007.

Conflict of Interest Statement

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

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Insights at the Nexus of Instructional Design and Student Success: An Institutional Analysis Using LMS Accessibility Metrics

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Abstract

This study explores the influence of Learning Management System (LMS) course site design on student failure and withdrawal rates (DFW) in undergraduate courses in a residential hybrid educational context. We used multiple linear regression analysis to explore the interactions between course-level DFW, enrollment, student satisfaction, and counts of instructor-embedded content in LMS course sites in 925 course sections in one semester at a public research university in the southern United States. Findings suggest that optimal LMS course site design supports lower DFW rates. The findings are contextualized within the Community of Inquiry (CoI) Framework, and a case is made that certain types of instructor-embedded content in LMS course sites can serve as a measurable proxy for teaching presence. This study contributes to the discourse on the impact of digital learning environment design on student outcomes and provides actionable insights for educators aiming to design student-centered digital learning spaces.

Keywords: LMS course design, student success, hybrid learning environments

Freels, J. & Sankaranarayanan, R. (2025). Insights at the nexus of instructional design and student success: An institutional analysis using LMS accessibility metrics. *Online Learning, 29*(3), 158-175. https://doi.org.10.24059/olj.v29i3.4965

Introduction

Researchers have extensively investigated the relationship between instructional design and student success in higher education settings (Ralston-Berg & Braatz, 2021; Robertson & Doloc-Mihu, 2024; Sung & Mayer, 2012). As the internet matured, learning-management systems (LMS) emerged as the digital backbone of colleges and universities, supporting face-to-face, hybrid, and fully online instruction (Rhode et al., 2017). Most higher education institutions now integrate the LMS with their campus information systems, encourage widespread faculty adoption, and provide ongoing training and support, turning the LMS into a ubiquitous hub for content delivery, assessment, and student engagement across all course modalities.

Yet ubiquity alone does not guarantee effectiveness. When LMS course sites are poorly designed, students can experience disengagement (Heilporn et al., 2021), increased cognitive load (McGuire, 2017), and confusion about course requirements and objectives (Fayer, 2014). For some students, especially those enrolled in multiple courses with disparate design schemes (or no scheme at all), the need to navigate and adapt to those varying contexts can impose a heavy cognitive load that inhibits learning and success across their entire course load. Over time, these issues can result in diminished learning outcomes, reduced persistence, and lower overall student success, highlighting the need for well-structured and effective instructional design in digital learning environments.

In recognition of these challenges, some higher education institutions have adopted standardized LMS course site templates to promote a more uniform digital learning experience across their online offerings (Henry et al., 2008; Williams et al., 2022). In those cases, the aim is a more consistent user experience that reduces variability in LMS course site quality and guides students intuitively towards the attainment of course learning outcomes. Higher levels of student satisfaction often result as well (Watson et al., 2017). Despite the benefits of standardization, many institutions allow instructors the autonomy to design their course sites based on their personal preferences. This flexibility fosters innovation and allows educators to tailor their course sites to specific pedagogical needs, but it also leads to higher levels of variability in the quality and structure of digital learning environments.

The study described in this paper was conducted at a large public research university in the southern United States, where almost all undergraduate students live on or near campus. Courses are offered in face-to-face, hybrid, and online formats. The university has zero fully online undergraduate degree programs, and 92% or more of undergraduate course sections each semester are offered in face-to-face formats. Since 2020, however, there has been a notable shift towards increased adoption of hybrid and online course formats. This change coincides with higher student expectations for technology use in face-to-face courses. Approximately 95 to 99% of undergraduate course sections at the university have a published LMS course site each semester, which is indicative of widespread adoption of educational technology. This pervasive use of digital resources within a primarily residential setting is characteristic of a residential hybrid model of education.

In this study, we define *residential hybrid* as a higher education model where students primarily reside on or near the physical campus, engaging in regular in-person classes and activities while simultaneously engaging with a substantial portion of their academic coursework through digital learning technologies. Technology is an integral extension of a campus experience in which both online and in-person educational activities are common. The learning process is a continuous interplay between physical and digital realms. In environments like these, where academic engagement spans both physical classrooms and digital platforms, coherent and supportive instructional design is critical for maximizing student engagement and success. As such, exploring how the design of LMS course sites impacts student success in this blended learning context is both relevant and timely.

The current residential hybrid model emerged from the COVID-19 pandemic, which accelerated pre-pandemic trends towards more digitally integrated learning environments. A recent study by Guppy et al. (2022) provides an overview of these changes from a global perspective. This multi-national research gathered insights from diverse educational stakeholders across four continents, revealing a consensus that trends towards increasing adoption of hybrid learning formats were real and would continue, which we have observed at the institution in this study.

Given the shift towards more hybrid higher education in residential contexts, there is a distinct need for research that examines how these models impact student learning and engagement. The current study enriches the academic discussion on post-pandemic higher education by addressing this gap. It serves as a practical guide for institutions aiming to refine their instructional designs to better suit a world where digital and physical learning environments are increasingly intertwined.

Purpose of the Study

This study aimed to examine the impact of various types of instructor-embedded content in LMS course sites on student withdrawal and failure rates (DFW) in university courses over a single semester. Predictor variables included numbers of announcements, assignments, files, quizzes, and a variable known as the Content Optimization Metric (COM), which was calculated based on the total number of pages in each Canvas course site. Additionally, the study controlled for the enrollment size of each course and the mean score from one item on the end-of-course student survey (ECS score) that is administered to every student near the end of every class. To this end, the following research question guided this study: *To what extent do enrollment size, end-of-course student survey scores (ECS), counts of instructor-embedded content (including announcements, assignments, files, quizzes), and COM account for variations in withdrawal and failure rates (DFW) among students in undergraduate courses in a single semester?*

Literature Review

The literature suggests that the quality of LMS course site design can directly affect student attitudes, engagement, and academic success (e.g., Baldwin, 2019; Fayer, 2014). For instance, Baldwin (2019) demonstrates how poorly structured courses can significantly hinder student engagement and lead to suboptimal learning outcomes. Similarly, Fayer (2014) presents evidence that well-designed courses enhance student satisfaction and academic achievement. As such, effective instructional design extends beyond content delivery, focusing heavily on course organization and navigability, which are crucial for fostering an effective learning environment.

Clear organizational structures, such as weekly folders and intuitive navigation paths, significantly boost student confidence and facilitate success (Larson & Lockee, 2014; Robertson & Doloc-Mihu, 2024). Moreover, employing instructional strategies such as "chunking," which involves breaking content into smaller, manageable units, can reduce cognitive overload and enhance the learning process (McGuire, 2017; Sankaranarayanan et al., 2024).

The design and usability of LMS course sites are crucial in shaping students' educational experiences. In hybrid courses, that design takes on added significance: consistent content organization and schedule flexibility directly determine how seamlessly a class can shift between in-person and online work, while also supporting the more active, student-centered learning role typical of hybrid environments (Álvarez-Chaves & Saborío-Taylor, 2025). Studies have shown that LMS course sites that lack clear navigational aids often result in poor student experiences (Demmans Epp et al., 2020). Similarly, research by Sung and Mayer (2012) suggests that online courses equipped with effective signaling aids can significantly boost student performance by improving memory retention and understanding. Furthermore, several studies found a connection between the usability and aesthetic appeal of LMS course sites and improved learning outcomes and student engagement (c.f. Ralston-Berg & Braatz, 2021; Sung & Mayer, 2012). Poor organization of LMS course sites can negatively impact students' perceptions of faculty commitment, affecting motivation, satisfaction, grades, and withdrawal rates (Placencia & Muljana, 2019).

While existing literature provides a robust foundation for understanding online course design, there is a notable gap concerning hybrid learning environments, particularly in the post-COVID context. Recent scholarship points to a substantial need for research that spans various instructional contexts and modalities (Bradley, 2021; Sochor, 2022), which is especially relevant for the residential hybrid contexts in which both in-person and online educational activities are important. Few scholars emphasize the complexity of conducting research in hybrid settings, advocating for studies that are tailored to specific institutional contexts and that explore the interplay between course elements and student success (e.g., Ali & Hanna, 2022; Robertson & Doloc-Mihu, 2024).

Community of Inquiry Framework

The present study employs the Community of Inquiry (CoI) framework to disaggregate the nuances of student engagement and learning in hybrid environments. The CoI framework, which distinguishes between social, cognitive, and teaching presences as central to effective educational experiences, provides a comprehensive approach to examining online and blended learning contexts. The CoI framework is foundational for digital learning research because it provides a model for investigating how social, cognitive, and teaching presences in a course enrich student's educational experience (Garrison et al., 2000). Social presence enables the students to project their individual characteristics to cultivate a sense of connectedness in limited physical interaction settings. Cognitive presence deals with the development of critical inquiry skills necessary for deep and meaningful learning experiences in online environments. Teaching presence involves course design, facilitation, and direction for students to achieve the course learning outcomes (Smith et al., 2017). The CoI framework has evolved over time to better address the complexities of digital learning in both asynchronous and synchronous formats (Garrison et al., 2000; Cleveland-Innes, 2019).

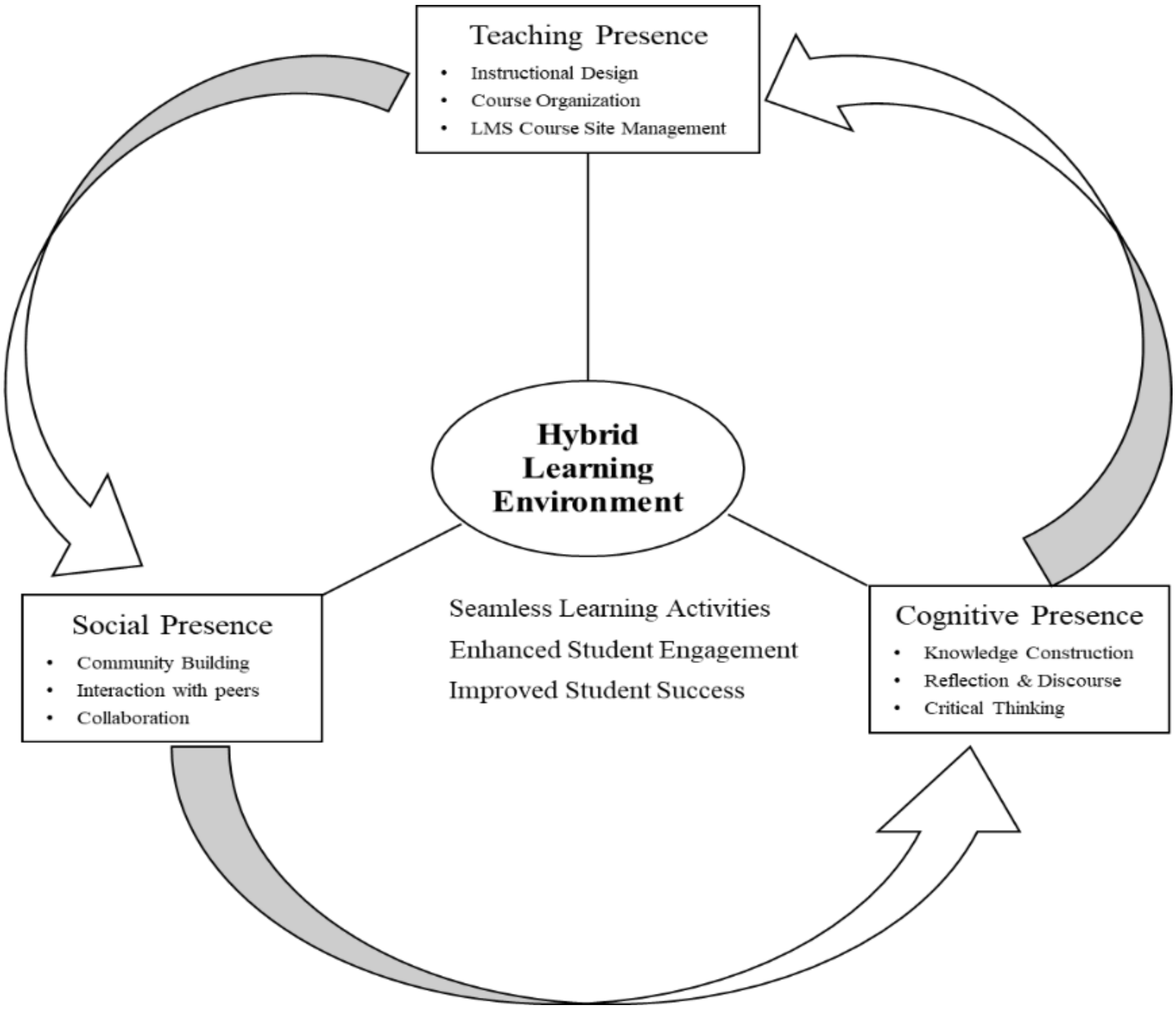
While the CoI framework posits that its three components—social, cognitive, and teaching presences—collectively enhance online learning, some researchers note that teaching presence, as expressed through instructional design, is crucial for social and cognitive presences to flourish (Smith et al., 2017). In hybrid learning environments, where educational delivery combines online and face-to-face interactions, the design and organization of learning activities in an LMS course site can be a critical factor that contributes to or inhibits student success. Good teaching presence leads to online and in-person learning activities that are seamless and complementary (Robertson & Doloc-Mihu, 2024).

The framework provides a useful tool for scrutinizing the impact of LMS course site design on student success in hybrid courses. For the purposes of this paper, we define teaching presence as "the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" (Anderson et al., 2001). In digital learning environments, that includes crafting learning outcomes, curating learning materials, sequencing lessons and activities, and creating assessments and evaluation criteria, much of which should take place before the class begins. In this context, instructors who effectively organize and present course content, establish clear navigation pathways, and provide comprehensive instructions exhibit strong and effective teaching presence. Thus, LMS course site design can be seen as a tangible manifestation of teaching presence, with significant implications for student success in hybrid learning environments.

Anchored in the CoI framework, this study foregrounds teaching presence as it unfolds in residential-hybrid courses. Guided by Beatty's (2019) HyFlex principles, we define teaching presence as the intentional orchestration of course organization, facilitation, and direct instruction inside the LMS shell. Recent scholarship shows that LMS sites with coherent content structures and flexible schedules—hallmarks of sound design—amplify student agency and engagement in hybrid settings (Álvarez-Chaves & Saborío-Taylor, 2025; Hodges & Lowenthal, 2020). Yet large-scale evidence that links objective design indicators—specifically, LMS course design features to concrete success metrics such as DFW rates is still scarce in the *Online Learning Journal* literature. To address this gap, the inquiry described in this paper seeks to consider the possibility that LMS course sites can be optimally designed to support student engagement and success. Figure 1 depicts the conceptual model guiding this inquiry, positioning optimal LMS design as the pivotal link between teaching presence and student success.

Figure 1

Community of Inquiry Framework for Hybrid Learning Environments



Methods

This section describes the study context, the study design, the measures, and the sampling procedure.

Study Context

In 2023, the university in this case study adopted Anthology Ally (Ally), an accessibility plug-in, in its Canvas LMS. Ally performs several functions, including scanning instructor-embedded content in Canvas course sites—announcements, assignments, discussions, files, pages, syllabus, and quizzes—and determining the degree to which each is accessible, expressed as a percentage, or “accessibility score.” It reports to instructors primarily to help them identify inaccessible learning materials in their LMS course sites, but it also provides counts of each type of content in every course in an institutional report available to administrators. We interpreted those counts of instructor-embedded content in LMS course sites as measurable indicators of teaching presence, the analysis of which can offer researchers a window on the intersection of design with student success.

As part of a preliminary analysis, we collected data from the Ally Institutional Report from a random sample of courses ($n = 70$) and merged it with additional measures. Those included data on enrollment, or the number of students who received a grade or withdrew from the course; student satisfaction, as measured by the mean result on a single item from end-of-course student surveys (ECS score); and the percentage of students who failed or withdrew from the course (DFW). Across the courses in the pilot sample, the mean student response rate on the ECS was 41% (range = 27% to 63%). Despite a relatively small sample size, a preliminary linear regression analysis suggested potential correlations between DFW and several types of instructor-created content in LMS course sites, including the number of pages, files, and quizzes. These initial findings provoked questions about the influence of LMS course site design on student success and prompted the research team to broaden the quantitative dataset and initiate qualitative research to delve deeper into these relationships.

Study Design

To answer our research question, we adopted a correlational research design (Fraenkel et al., 2023) to explore the relationship between the seven predictor variables and student outcomes, as measured by the DFW rate for each course section, or the percentage of students who withdrew or received failing grades. This approach was selected because it enables the examination of naturally occurring relationships in educational data without manipulations or controls, a typical characteristic of experimental designs (Fraenkel et al., 2023). The final dataset included data from 925 undergraduate course sections in one semester.

To be included in the sample, course sections had to have:

- One instructor and at least five students.
- A published Canvas course site with at least five files and two other types of instructor-embedded content (Announcements, Assignments, Discussions, Files, Pages, Quizzes, and Syllabus).
- Two or more D, F, or W grades or one DFW and 20 or fewer total students (5% DFW or higher).

Sampling Procedure

There were 5,002 undergraduate course sections with at least five students in the semester in which the study took place. A stratified random sample of 925 sections, representing 18.5% of the total, was selected from these 5,002 course sections through the following sampling procedure. First, all the course sections for each undergraduate college and department were listed in a Microsoft Excel file. Then, we used the Excel random number generator to select courses from each undergraduate college randomly. The course sections in the sample varied by enrollment size, modality (online, hybrid, and face-to-face), and academic level (both lower and upper levels). Given the subject of this research, the lack of control for instructional modality could be viewed as a validity threat. However, the research team did not view this as a serious concern given that more than 92% of the university's undergraduate course sections in the semester in question were classified as face-to-face courses. It is possible that hybrid and fully online course sections were in the sample, but they would have made up a small percentage of course sections overall. In the end, the sample encompassed course sections from every undergraduate college at the university, proportionately selected based on the number of degree programs within each college. The final sample included course sections from 120 academic departments.

Measures

The primary outcome, or dependent variable, was calculated per course section as the percentage of enrolled students who earned grades of D or F or withdrew from the course (DFW). Our study analyzed several independent variables. First, enrollment included the total number of students enrolled in each course section. Second, students' overall perception of the course was quantified through the mean score on one ECS item: "Overall, the course was ….." with responses provided on a five-point Likert scale (1 = Very Unsatisfactory to 5 = Excellent); for the 925-sections in the dataset, the mean ECS response rate was 41 % (SD = 9%, range = 24% to 68%). Then, we included counts of instructor-created content, which encompassed total counts of announcements, assignments, files, and quizzes uploaded to each Canvas course site by instructors or their proxies. Finally, the COM, a categorical variable, was derived from the number of pages reported by Ally within each section's course site.

Due to the skewed distribution of values in Pages across LMS course sites (see Table 1), we transformed the number of Pages in each course section to a categorical variable called COM. This transformation addressed the highly skewed nature of the Pages data in the sample (n = 925), which showed a mean of 10.2 pages, a mode of 0, a median of 1, and a maximum of 952 pages, a problematic degree of skewness for the linear regression analysis we set out to perform. This transformation aimed to reduce skewness and more accurately reflect our hypothesized construct for instructional design effectiveness. Each course section was grouped into one of three categories of COM as shown in Table 1. The rationale for these categories was based on the hypothesis that the suboptimal course site design, as reflected in the number of pages on the site, was bimodal. In other words, we considered it likely that course sites with very few and very many pages would be the course sites in most need of improvement from the standpoint of student engagement and success.

Table 1

Course Optimization Metric (COM) Calculation

Minimum pages	Maximum pages	COM score	Sample courses
0	1	1	531
2	9	2	177
10	45	3	165
46	89	2	24
	90+	1	28

Prior research and practice suggest that course sites with little organization (such as might be found in sites with 0 or 1 pages) may provide insufficient guidance for students, potentially leading to confusion about course navigation and expectations. On the other hand, course sites with a great deal of content (such as those with 90 pages or more) may overwhelm students to the point of disengagement. This bimodal conceptualization of suboptimal course design—characterized by either a paucity or an excess of content—formed the basis for our ongoing investigation into the relationship between LMS course site design and student outcomes. COM, then, was intended to diminish the skewness of the data and to group course sections by values of Pages thought to correspond with better or worse instructional design.

Initially, we collected data on Discussions and Syllabus from Ally for each of the sample course sections but subsequently removed the variables from the study. Discussions were excluded due to the unreliability of Ally counts of this feature, which did not account for external discussion tools used by many instructors at the university. Syllabus is reported by Ally as a binary variable that indicates whether the native Canvas Syllabus tool is being used in the course section. In practice, the Syllabus section of Canvas course sites often functions as a calendar of assignments rather than a true syllabus, unless the instructor loads the syllabus in some fashion to that section of the course site. The variable does not account for syllabi loaded elsewhere in the course site either. Thus, we did not believe the Ally variable, Syllabus, was an accurate indicator of the presence of a syllabus in the course site. For these reasons, we omitted both the discussions and syllabus counts from the final dataset and subsequent analysis.

Findings

To explore the factors influencing overall failure and withdrawal rates (DFW), we conducted a series of multiple linear regression analyses using IBM SPSS Statistics Version 25. Our analysis progressed through three models to gradually include a wider range of predictor variables, each designed to predict DFW rates, quantified as the percentage of students who failed or withdrew from a course section in one semester.

The initial model incorporated counts of four types of instructor-embedded content in Canvas course sites—announcements, assignments, files, and quizzes—and a metric, COM, derived from counts of pages in Canvas course sites. The second model built upon the first by adding enrollment size as an additional predictor to assess its impact alongside the other variables. In the third and most comprehensive model, we included all the predictors from the second model and introduced the ECS score as a predictor variable, aiming to control for the interaction between student satisfaction and grades. The standard assumptions of multiple linear regression analysis (i.e., linearity, homoskedasticity, independence of errors, normality, and independence of independent variables) were tested and sufficiently met to justify further analysis.

The first regression equation with the instructor-embedded content in Canvas course sites was found to be significant, $R2 = .015$, $F (5,919) = 2.80$, $p = .016$. The individual predictors were examined further, and the results showed that counts of some instructor-created content on Canvas sites, such as Announcements ($t = .16$, $p = .87$), Assignments ($t = 1.10$, $p = .27$), Files ($t = -1.51$, $p = .87$), and Quizzes ($t = 1.34$, $p = .18$), were not statistically significant predictors of the model. However, the model revealed a statistically significant association between COM ($t = -3.06$, $p = .02$) and DFW, suggesting that course sections with more optimal numbers of Canvas Pages were more likely to have lower DFW rates.

Enrollment was entered in the model in stage two, alongside counts of the four types of instructor-embedded content and COM. The results of this analysis indicated that COM ($t = -2.76$, $p = .006$) and enrollment size ($t = -3.03$, $p = .003$) accounted for a significant percentage of DFW rates, $R2 = .025$, $F (6,918) = 3.88$, $p = .001$, indicating that larger classes with more optimal numbers of pages tended to have lower DFW rates.

The third and final analysis was conducted to evaluate whether all seven predictors—announcements, assignments, COM, files, quizzes, enrollment size, and ECS score—were predictive of course section-level DFW rates. The multiple linear regression analysis resulted in a significant model, as indicated by an F-statistic of 10.64 with a p-value less than .001 ($F (7, 917) = 10.64$, $p < .01$), suggesting that the model explains some of the variance in DFW rates. The R2 value of .075 suggests that the model can account for approximately 7.5% of the variance in course section-level DFW rates, illustrating the included predictors' impact. In Table 2, we present our model for predicting DFW rates per course section. Five of seven bivariate correlations between the predictor variables and DFW rates (DFW) were negative, and three of the seven indices, COM ($t = -2.26$, $p = .024$), enrollment size ($t = -3.47$, $p = .001$), and ECS Score ($t = -7.07$, $p < .01$) were statistically significant ($p < .05$). These results suggest that courses with optimal numbers of Canvas pages, higher enrollment, and higher student satisfaction was associated with lower rates of course-level failure and withdrawal.

Table 2

Multiple Linear Regression Model Predicting DFW Rates

Variable	*B*	*SE*	95% CI	β	*p*
Constant	.25	.02	[0.212, 0.285]	-	< .001
Number of students	.00	.00	[0,0]	-.12	.001
Total Files	.00	.00	[0,0]	-.06	.139
Announcement	.00	.00	[0,0]	.00	.951
Assignment	.00	.04	[0,0]	.04	.217
COM	.00	.00	[-0.013, -0.001]	-.08	.024
Quiz	.00	.00	[0,0]	.06	.114
ECS Score	-.03	.00	[-0.038, -0.022]	-.23	< .001

Note. R^2 = .075, F (7, 917) = 10.64, p < .001.

Discussion and Implications

The findings from this study suggest that counts of certain types of content loaded in LMS course sites correlate with course-level DFW rates, although the effect size was not large in this case (we estimate 0.5%–1.2% fewer students with DFWs in the courses in the study sample if course site design was optimized in all of them). Our hypothesis that very small and very large numbers of Canvas Pages are suboptimal from the standpoint of student success is plausible. The correlation of our COM with course-level student success in this study suggests that educators and instructional designers should pay careful attention to the amount of content provided in their courses, as well as how it is delivered. LMS course sites can effectively host a great deal of content when they are well-organized and provide students with clear navigational and signaling aids.

We hypothesize that LMS course sites can be optimized through a learner-centered, design-driven approach. Optimally designed courses reduce the cognitive load required of students to navigate course sites, leaving them with more time and capacity to learn. This finding is well-established in prior research on student learning and success in online, asynchronous formats, but our research suggests it held for the residential hybrid students in this study. This should not be surprising in light of the degree to which many college students, especially traditionally aged cohorts (18–24), live their lives on their smartphones. Regardless of whether they attend a residential or online college or university, students today need digital learning experiences that connect to how they live. Organizing content in LMS course sites within an optimal range of material, as empirically defined, could enhance student engagement and success.

The impact of LMS course site design on student success extends beyond asynchronous online courses. While the factors influencing student performance are undoubtedly complex, recent research has highlighted the importance of effective LMS design across all modalities. For years prior, research had suggested a connection between LMS course site design and student success in fully online courses. However, the widespread adoption of digital learning tools during and after the COVID-19 pandemic has revealed that those findings are relevant to hybrid and face-to-face courses as well. Today, we have evidence that a thoughtfully constructed LMS site can enhance student engagement and success in hybrid and face-to-face courses, regardless of the course's primary mode of delivery. The CoI framework provides a structured approach to understand the implications of this phenomenon.

We argue that counts of instructor-embedded content in LMS course sites as reported by Ally represent measurable components of teaching presence as defined in the CoI framework. Only instructors or their proxies can create Canvas pages, announcements, and assignments. Students have to interact with that content to successfully complete their classes. In that context, content counts can provide an instructor-created map of the course-level digital student experience that can be analyzed for research and improvement. The number of pages in a Canvas course site is not, by itself, an important variable. Instead, it serves as a proxy for teaching presence by indicating the degree to which course instructors make their students interact with a structural component of the LMS. Given that teaching presence is likely to vary across institutional, instructional, and disciplinary contexts, the optimal range of Canvas Pages is probably different from one institution, instructor, or discipline to the next. We encourage institutional researchers and teaching and learning specialists to use our method to consider optimal design for their contexts.

Unfortunately, too few faculty members, at all types of institutions, lack training in or support for instructional design. If anything, we hope this research encourages institutions to invest in instructional design that works for students and faculty. In our opinion, that means teams of faculty members, designers, and assessment and accessibility specialists, working together to create an engaging and effective digital learning environment. After rollout, student feedback on LMS course sites should be elicited, and sites should undergo regular usability testing to iterate towards designs that better meet student needs. This is often too much for one faculty member to handle.

Study Limitations

This study offers valuable insights into online factors influencing student withdrawal and failure rates, but it also has several limitations that require careful consideration. First, although this study tested a large sample ($n = 925$), representing 18.5% of total courses in one semester, it was limited to courses at one university, which may affect the generalizability of the findings. We attempted to mitigate this limitation by collecting a stratified sample of courses from every undergraduate college and 120 academic departments.

Second, the study relied on a derived metric, Content Optimization Metric, or COM, that assumes a bimodal distribution of suboptimal counts of Canvas Pages as they relate to student outcomes. While useful, COM may not comprehensively capture all the nuances of course design quality. For example, the research team did not account for the substance of course content (e.g., announcements or pages that contained student-centered language), the use of third-party tools in the course, or possible manifestations of student presence. In theory, it is possible for an LMS course site to have suboptimal numbers of pages and still be robust and student-centered. Future iterations of COM should consider more carefully those types of confounding variables.

Third, the study's cross-sectional design limits our capacity to establish causality between course design and DFW rates. A longitudinal approach would be more suitable to explore the impacts of course design changes over time.

Fourth, the statistical model accounts for only 7.5% of the variance in DFW rates, suggesting the presence of other significant but unmeasured variables that influence student success. Some of those variables are mentioned above, including the substance of course content, the use of third-party tools, evidence of student presence, such as course modality, academic level, disciplinary area, and the degree to which instructors require that students use the LMS were not considered in the present study. In the case of this study, the undergraduate course sections at the university at which this study took place are overwhelmingly offered face-to-face, which suggests that the failure to control for modality was not a significant validity threat in this case. The inclusion of course modality and these other variables could boost the effect size significantly.

Fifth, Pages data from Ally were not accurate in some cases because unpublished Canvas pages, hidden from students, were counted. This was not a problem for the 57.4% of course sites in the sample that had zero or one page, since an inaccurate count of one page would indicate a course section with zero actual Pages. Beyond that, a review of the sample suggested that page counts were off by 10% or less in most cases. We estimate that a more accurate page count would have led to a COM category change for about 5% of overall cases in the model. In all those cases, the COM value would be off the real count by one.

Sixth, the ECS data were subject to potential non-response bias: the item we analyzed had an average response rate of roughly 40%, so students with strong positive or negative opinions may be over-represented despite a sensitivity check that showed no systematic link between response rate and DFW outcomes.

Lastly, the study findings revealed that some LMS course site components—i.e., announcements, assignments, and quizzes—did not significantly predict DFW rates, which might suggest that the presence of these components is less impactful on student engagement and success. Alternatively, the methods used in this study may not have been adequate to the task of measuring the impact of announcements, assignments, and quizzes on student engagement and success.

Study Implications and Future Research Directions

This study's findings have important implications for both academic research and educational practice by providing valuable insights into how certain online factors influence student success in residential hybrid courses. Given the potential impact that optimizing LMS course sites could have on reducing DFW rates, institutions should invest in instructional teams that support faculty in building engaging, effective, and accessible LMS course sites. Those teams should guide instructors towards simpler, well-organized LMS course sites that provide clear navigational and signaling aids that support student learning and success.

Future studies should adjust Canvas Pages counts from Ally to account for unpublished ones; control for course modality, discipline, and academic level, as the inclusion of any or all is likely to improve the overall model fit; analyze more comprehensive and reliable data from LMS course sites and the external tools integrated with them (learning tools interoperability, or LTIs) to include student engagement with the types of instructor-created content or student LTI launches; and seek a more sophisticated course design map that more accurately captures the LMS course site architecture and its interaction with student engagement, learning, and success. LMS course site maps could serve as a critical tool for course instructors, providing them with detailed information on the aspects of course design that most significantly affect student success and guiding targeted improvements in digital content delivery in learning management systems.

Given the observed impact of COM on DFW rates, future research should seek to refine and contextualize COM. As previously noted, the optimal range of Canvas Pages will vary by instructor, discipline, and institution. Faculty, institutional researchers, and instructional design staff should collaborate to experiment with LMS course site designs that seek optimization within contextually appropriate boundaries. Testing the effectiveness of different COM thresholds in varied disciplines and academic levels could provide deeper insights into how course content optimization affects learning outcomes under different instructional conditions. Future research should also integrate qualitative analysis on LMS course sites to account for the quality of content and clarity of delivery in their models.

Building on this study's findings, we are currently expanding the scope of our research in two ways. First, we are testing the model from this study with data from two different semesters with the aim of validating the current study findings. Next, we are ready to conduct qualitative evaluation of LMS course sites from a selected sample of course sections in this study using a rubric adapted from the State University of New York's Online Course Quality Review Rubric (OSCQR). Third, we plan to refine the COM to better capture the nuances of optimal design. Through these efforts, we hope to provide actionable insights that inform real enhancements in digital learning practices and further refine our understanding of how course design impacts student outcomes and engagement.

Conclusion

In conclusion, as higher education continues to evolve in response to technological advancements and changing student demographics, this study contributes valuable insights into how effectively designed LMS course sites can enhance student success. This current study has highlighted key aspects of LMS course site design and their relationships to student DFW in a residential hybrid educational setting. Our study findings indicate that while certain types of instructor-embedded content in LMS course sites do not significantly influence DFW rates, factors such as enrollment size, the COM, and ECS correlate significantly with it. The crucial role of COM in the model suggests that optimizing the amount and delivery of course content can effectively reduce the cognitive load on students, thereby enhancing their capacity to succeed. This aligns with existing literature that emphasizes the importance of thoughtful course design in improving student engagement and educational outcomes, particularly in an era where digital interaction plays a substantial role in the educational experience of traditionally aged college students. To build on these findings, future research should extend beyond the confines of this study to include data from additional semesters and different institutions. It should also refine the use of metrics like COM to more accurately reflect the effectiveness of course design across various educational contexts. Moreover, the integration of qualitative evaluations of LMS course sites using adapted instruments like the SUNY OSCQR rubric will provide deeper insights into the qualitative aspects of course design and its impact on student success. By continuing to refine our understanding of these relationships and adapting our educational practices accordingly, we can better support students in achieving their academic goals in any learning environment.

Declaration of Competing Interest

Authors have no competing interests to declare.

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Competing Hypotheses About Online Versus Face-To-Face Course Outcomes: Analysis Leveraging the Unique Circumstances of the COVID-19 Pandemic

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Abstract

Due to ethical and practical concerns, no large randomized controlled trials comparing outcomes in fully online versus face-to-face courses have occurred. However, circumstances presented by the COVID-19 pandemic created a unique opportunity to explore hypotheses about the relationship between online medium and course outcomes. The City University of New York (CUNY) was one of the first U.S. universities to shift courses completely online. This study used a dataset of all courses taken by students enrolled in fall 2019 or spring 2020 at any of the two or four-year colleges of CUNY to explore the relationship between course medium and completion rates. Findings from a quasi-experimental fixed effects approach show that at both two- and four-year colleges, students were significantly less likely to successfully complete fully online than in-person courses; however, this appeared to be driven more by the student's original choice of medium than the medium in which the course was actually taught. Results did not support hypotheses that the online medium itself causes lower completion; within the same term, students were less likely to successfully complete courses that they originally chose to take fully online than in-person, regardless of whether those courses were subsequently taught in-person or fully online after pandemic onset. Students also took different types of courses in different mediums, which made comparing outcomes across mediums problematic; results show students were significantly more likely to take elective courses fully online and less likely to take major requirements fully online. Findings indicate that elective courses had significantly lower rates of successful completion than major requirements, which may account for some of the differences in outcome by chosen (rather than enacted) medium.

Keywords: online versus traditional course completion, COVID-19 pandemic, elective versus major requirement course completion, online outcomes, fixed effects modeling

Wladis, C., Hachey, A.C., Manly, C.A. & Conway, K.M. (2025). Competing hypotheses about online versus face-to-face course outcomes: Analysis leveraging the unique circumstances of the COVID-19 pandemic. *Online Learning, 29*(3), 176-210. https://doi.org.10.24059/olj.v29i3.5018

Introduction

A correlation between online course medium and negative outcomes is often implicitly assumed in higher education discourse, with online viewed as inferior to face-to-face (Jaggars & Bailey, 2010; Protopsaltis & Baum, 2019). Some contend that the online medium itself causes worse outcomes (Altingdag et al., 2021; Baum & McPherson, 2019), while others argue that students who choose to take courses online take different courses (Bejerano, 2008; Fischer et al., 2021; Jaggars, 2014; Wladis et al., 2014, 2017) or have different characteristics than those who do not (Fischer et al., 2020; Hachey et al., 2022; Hyllegard et al., 2008; McDonough et al., 2014; Wladis et al., 2018, 2022). New knowledge is needed to shed light on the accuracy of each of these three hypotheses, as the connotations of each have important higher education policy implications for the efficacy of online learning in the post-COVID-19 era. However, large, representative randomized controlled trials comparing outcomes in fully online versus face-to-face courses are not feasible due to ethical and practical concerns.

With no large, randomized evidence available, the circumstances of the COVID-19 pandemic created a unique opportunity to explore hypotheses about the relationship between the online course medium and course outcomes. The City University of New York (CUNY) was one of the first U.S. public universities to shift all courses completely online due to the pandemic. This allowed for a within-student comparison of outcomes in courses that were forced to transition online to those courses that were originally online at the beginning of the spring 2020 semester. We know of no other large-scale *within-subjects* study that controls for the impact of self-selection into online courses by separating the *originally chosen mode* of the course from the *actual mode* of the course as subsequently implemented. To address this research gap, we compared such courses *within the same student* taking multiple courses originally chosen in different mediums *during the same term*, making this a novel study design.

Given the evolving higher educational landscape, where current data indicates that post-COVID-19 student preferences have shifted from a clear preference for in-person classes to a more equal distribution across modalities and wider exposure/experience of faculty to online learning (Bright & Vogler, 2024), a better understanding of the presumed relationships between the online course medium and course outcomes is critically needed for institutional decision-making and optimal utilization (Alarifi & Song, 2024). This study helps provide missing knowledge by leveraging the unique circumstances of the shift to fully online instruction during the COVID-19 pandemic, shedding new light on the patterns between online course taking and course outcomes. While this research is observational and not causal, it allows for exploration of the extent to which observed patterns are consistent with existing hypotheses about the online medium using a quasi-experimental fixed effects approach that is a stronger design than typical regression-based studies.

Literature Review

To put this study and its hypotheses in context, existing literature offers background for understanding patterns connecting completion outcomes to online course-taking, course characteristics, and student characteristics. This study draws from a long history of research on outcomes in online courses. First, we consider the research on online course outcomes, outside of the context of emergency remote teaching (ERT). Then, we discuss how student choices to take different types of courses online versus face-to-face may explain some of the patterns observed with course outcomes by medium. Next, we describe how students' characteristics may impact their choice of course medium, which may also explain some patterns observed in course outcome by medium. Finally, given the context of this study, we review research on outcomes during ERT, such as during the recent COVID-19 pandemic. All of this sets the stage for the subsequent conceptual framework that orients our study analysis.

Outcomes in Online Courses

Pre-pandemic, some studies indicate better retention/graduation rates for students who take online courses or no-difference between instruction mediums (Shea & Bidjerano, 2014; James et al., 2016; Johnson & Mejia, 2014). Others found lower retention/graduation rates for students taking online courses versus only face-to-face courses (Jaggars & Xu, 2010; Smith, 2016; Xu & Jaggars, 2014). Results are similarly mixed for analysis of course grades, with some studies reporting higher grades online, some no difference in grades between medium, and some worse grades online (for a review, see Hachey et al., 2022). It has been suggested that while proximal outcomes in online learning may be negative compared to face-to-face learning (i.e., course completion; course grades), benefit can be found in online course-taking more distally (i.e., time-to-degree; degree completion) (Castro & Tumibay, 2021; Fischer et al., 2021). Yet, there is a call for a more nuanced analysis of course outcomes, as the mixed findings in the literature are likely a result of significant contextual and methodological differences found between past empirical studies (Alarifi & Song, 2024; Hachey et al., 2022).

Somewhat consistent in the literature is that students are more likely to drop online than face-to-face (Hachey et al., 2022). This is problematic, as evidence strongly suggests that course completion impacts academic momentum, which is tied to persistence and degree completion (e.g., Chan & Wang, 2018). These findings have led to a perception that the online medium itself negatively impacts students (Altingdag et al., 2021; Baum & McPherson, 2019; Protopsaltis & Baum, 2019). A study comparing pre-pandemic dropout reasons found that students in both mediums were equally likely to cite course characteristics as a reason for dropout, but students in online courses were also more likely to cite reasons related to lack of time (Hachey et al., 2023). Research suggests that a lack of *time capital* (i.e., time as a resource for college) is a factor in online enrollment and outcomes (Hachey et al., 2023; Wladis et al., 2022). Students pressed for time may be more likely to drop because they are also more likely to take courses that are less important to their degree online than face-to-face (Jaggars, 2014; Wladis et al., 2014, 2017). This may be particularly salient for women and students of color who have on average lower time capital available for college (Wladis et al., 2022, 2024).

Course Characteristics and Online Outcomes

Students tend to choose to take different types of courses online than face-to-face. Bejerano (2008) and Jaggars (2014) report that students chose to enroll in more "interesting" or "important" courses face-to-face rather than online. Evidence also suggests that students prefer to take different subjects face-to-face versus online (Jaggars, 2014; Mann & Henneberry, 2014). Because outcomes may be different in different types of courses, correlation between online medium and course type could be confounding differences between online and face-to-face course outcomes in the literature. For example, online engagement has been found to be different in online courses across different subject areas (Young & Bruce, 2011) and research both during (e.g., Tsang et al., 2021) and before (e.g., Jaggars & Xu, 2014) the pandemic indicated that engagement can impact perceived and actual outcomes in online courses. In fact, Xu & Jaggars (2014) found variation in online versus face-to-face performance across subject areas, indicative of differences in the types of courses students chose to take online versus face-to-face driving some differences in online versus face-to-face course outcomes. Further, Wladis et al. (2014, 2017) found that electives in comparison to major requirements were more likely to have a larger gap in successful course completion rates online versus face-to-face. Taken together, the research suggests that the fact that students take different types of courses online than face-to-face may also impact their choices about which courses to prioritize academically. For example, when students find themselves pressed for time (a particularly common scenario given the higher prevalence of time poverty among online students [Wladis et al., 2022]), they may be more likely to invest less time (thus risking failure) in those courses or drop those courses that are least "interesting" or "important" to them, which some research suggests are more likely to be the courses that they chose to take online.

Student Characteristics and Online Outcomes

Differences in outcomes between online and face-to-face sections may also be the result of the characteristics of those who enroll in each medium (Hyllegard et al., 2008; McDonough et al., 2014). During typical enrollment (i.e., outside of pandemic conditions), students choose their course modality, such that students who take online courses have selected the online medium, and the specific courses to be taken in that medium online versus face-to-face, voluntarily. Students who enroll online often need flexibility or have less time to devote to college than those who do not (for example, because they have work and/or family responsibilities), and available time capital has been found to explain differences in outcomes by course medium (Daymont et al., 2011; Jaggars et al., 2013; Wladis et al., 2022). Students who enroll online have different demographic characteristics than those who enroll face-to-face; online students are more likely to be older, to be women, and to have non-traditional characteristics such as working full-time and single parent status (Johnson & Mejia, 2014; Pao, 2016; Xu & Jaggars, 2013; Wladis et al., 2018, 2022). Further, differences in academic preparation including remedial placement and GPA, race/ethnicity, gender and age have been linked to online course outcomes (see review in Hachey et al., 2022). Yet, much of the existing literature does not control for student characteristics (Smith, 2016), and those that do tend not to account for differences in course characteristics. Because student-level characteristics have been found to impact results (e.g., Alarifi & Song, 2024; Fischer et al., 2021), it is difficult to interpret the results of previous research that did not account for student characteristics; the present study specifically addresses this by employing a within-student design.

Outcomes in Online Courses in Emergency Remote Teaching (ERT)

ERT is online learning adopted in response to a disaster or crisis to maintain educational continuity; in this context, students find themselves in a modality that they did not select (Gelles et al., 2020; Hodges et al., 2020). While extensive research related to ERT during the COVID-19 pandemic has occurred, in a metareview of this type of research, Doo et al. (2023) report that only 4% of studies across 195 countries focused on student outcomes. Therefore, this study adds to the very little research that specifically investigates student outcomes during the COVID-19 pandemic.

The studies that have analyzed student outcomes during ERT have focused on the overall effects of ERT itself, rather than exploring how the unique circumstances of ERT can be leveraged to explore how course medium may relate to outcomes for those students who elect to take online courses during typical circumstances. McDougall et al. (2020) found that students at four research intensive institutions had significantly less achievement on standardized assessments during ERT versus pre-pandemic. Bird et al. (2020) reported a 6.7 percentage point decrease in course completion for two-year students in the Virginia Community College system who started out face-to-face and shifted online during the pandemic. Kofoed et al., (2021) found that West Point students randomly assigned to online courses during ERT had lower grades than those randomly assigned to face-to-face sections. However, in contrast, Altingdag et al. (2021) found that both online and face-to-face students had better course outcomes during spring 2020 compared to spring and fall 2019 (such findings are often attributed to institutional grading policy changes during the COVID-19 pandemic [see Chan, 2023]). What all of these studies have in common is that they focus on the impacts of ERT across the entire student population, including students who did and did not chose online courses voluntarily. That focus allows us to use these studies to make inferences about when and whether students might be harmed by ERT, or by being forced into online courses that they did not choose.

However, these studies are inappropriate for drawing inferences about students who *elect* to take courses online voluntarily, or for guiding policies and structures related to online course-taking outside of ERT. In prior work, we found that student course outcomes during ERT were highly dependent upon whether they had elected to take online courses before the pandemic started. For example, we (Wladis et al., 2023) found that students at two-year colleges, men, and Black and Hispanic students had worse outcomes during ERT, but only if they had *not* chosen to enroll in online courses pre-pandemic. In this study, a similar approach is taken: we use the unique circumstances of ERT during the pandemic *not* to compare outcomes in online courses for *all* students, but rather to compare course outcomes by delivered medium just for the subset of students who ordinarily *voluntarily* chose online courses. This means that outcomes from this study can inform policies most relevant to those students who actually chose to take online courses in college.

Different Target Populations for Online Outcome Research

Research on course outcomes during ERT points to a critical question about the target population when pursuing research on online course outcomes. Many studies leave the target population underspecified, but existing research on online course outcomes tends to point implicitly to one of two categories of target population: (a) the entire student population (i.e., where average effects across all students are measured under conditions where students are assigned to online courses involuntarily [e.g., during ERT or in Randomized Controlled Trial {RCT} study designs]); and (b) the population of students who chose to enroll in online courses (i.e., designs where only online course outcomes for students who selected them voluntarily are studied). Research results using different target populations provide very different inferences, leading to different practical implications from research outcomes. For example, a few studies have performed random assignment of students in online versus in-person courses (pre-pandemic: Alpert et al., 2016; Arias et al., 2018; Figlio et al., 2013; Stack, 2015; during pandemic: Kofoed et al., 2021), with mixed results. These studies are not sufficient for making inferences about whether online learning is good/bad for the subset of students who *choose* to take courses online, since this population has different characteristics than the general population, and student characteristics have been shown to matter, as online learning may be beneficial to some students yet harmful to others (Alarifi & Song, 2024; Wladis et al., 2022).

Course medium selection is not random; under normal circumstances, a subset of students *elect* to take courses online for compelling reasons, most often to address life or time factors that make attending college in-person difficult (i.e., scheduling conflicts with work and/or childcare responsibilities; long commutes; physical disability); the issues that often drive students to self-select into online courses may also make them more likely to dropout due to other life commitments taking resources away from their college studies (Bejerano, 2008, Jaggars, 2014; Wladis et al., 2014, 2015, 2022, 2023). A randomized-assignment study with this population would select students already enrolling in an online course and randomize the specific course section taken online versus face-to-face; this would eliminate course-characteristics-selection effects. However, this approach is not practical and as such, we could not find any such studies in the research literature. In the absence of randomized-assignment, one option (which we utilize here) is to use observational data from the switch to ERT during the COVID-19 pandemic to compare the within-student outcomes of courses that were originally online to those that were originally face-to-face, for students who had chosen to enroll in online courses prior to the start of the pandemic. Because of the within student comparison, this study design utilizes a quasi-experimental fixed effects approach and naturally controls for student-level, course-level and self-selection confounds; thus, it serves to provide a novel empirical contribution.

Conceptual Framework

Existing research is often used to drive higher education discourse. As an impetus for informing policies around online course-taking, the literature points to multiple hypotheses about factors that impact student outcomes in online versus face-to-face courses, each with different implications for practice:

Competing Hypotheses: *When observed, lower rates of successful course completion in online versus face-to-face courses are caused by:*

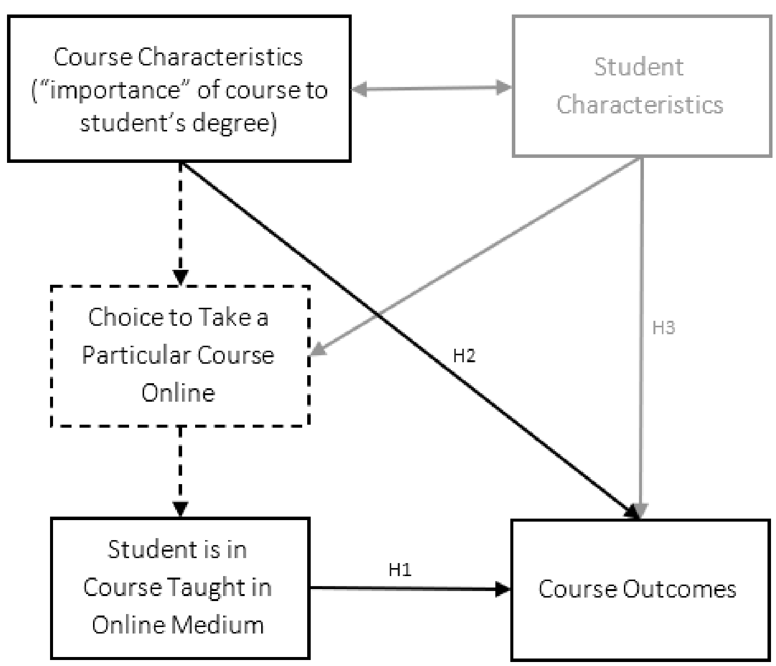
- ***H1.*** *The online medium itself (e.g., Altingdag et al., 2021; Baum & McPherson, 2019).*
- ***H2.*** *Differences in the types of courses that students choose to take online versus those that they take face-to-face (e.g., Bejerano, 2008; Jaggars, 2014; Wladis et al., 2014).*
- ***H3.*** *Differences in characteristics between students who choose to take courses online versus those who do not (e.g., Hyllegard et al., 2008; McDonough et al., 2014;*

Wladis et al., 2022).

Our population of interest is explicitly limited to the subset of students who choose to take courses online, so H3 is not relevant in this study (students who did not choose to take at least one online course were excluded from the sample). This is not to contend that H3 is not a real factor impacting online course outcomes, but rather to acknowledge its importance; indeed, mounting evidence both pre- and post-pandemic suggest that student characteristics and their life contexts likely impact both enrollment and dropout online (Alarifi & Song, 2024; Fischer et al., 2021; Hyllegard et al., 2008; Johnson & Mejia, 2014; McDonough et al., 2014; Pao, 2016; Xu & Jaggars, 2013; Wladis et al., 2018, 2022). However, what is missing in the literature (and thus the aim of this study) is an exploration of H1 and H2 while fully controlling for student characteristics and selection bias (H3). For this reason, we compare outcomes between courses taken by the same student in the same term, so the models explored here remove potential variation caused by H3. H1 and H2 may be possible mechanisms explaining the outcomes of students who elect to enroll in online courses outside of pandemic conditions, so in this study we leverage unique circumstances of ERT during the COVID-19 pandemic to explore the extent to which patterns in the data are consistent with each of these hypotheses. We take advantage of the fact that during ERT, the chosen medium and actual implemented medium of courses differed, allowing us to separate out potential impacts of how students choose online courses (and the subsequent impact that may have on outcomes) from potential impacts of the online medium itself. Looking at H1 and H2 together should aid in disentangling these factors' influence. This could help explain conflicting conclusions found in prior research (for a review, see Hachey et al., 2022). Figure 1 illustrates our conceptual model.

Figure 1

Model of How Course Characteristics, Student Characteristics, and the Online Medium Itself May Contribute to Course Outcomes



Notes. Grey lines represent characteristics that are controlled through fixed effects (comparing only courses within students in the same term) and by focusing only on outcomes for students who chose to enroll in online courses prior to pandemic onset.

Dotted lines represent the path by which course characteristics may influence student decisions to take a course online, which became separate from the medium in which the course was taught when all courses were moved fully online during ERT.

Path "H1" is the path denoting hypothesis 1 (the online medium itself lowers course outcomes).

Path "H2" is the path denoting hypothesis 2 (poorer outcomes in online courses are significantly related to the student's reasons for taking a course online—i.e., the course is less important to them).

Path "H3" is the path denoting hypothesis 3 (poorer outcomes in online courses are significantly related to the characteristics of the students who choose to take courses online; this hypothesis is controlled for in this study because all comparisons are within-students).

Considering these competing hypotheses together in a single conceptual model has not been previously described in the literature. This is largely because removing the effects of course medium choice is impractical and ethically problematic outside of ERT conditions. Students who take courses both online and face-to-face have been found to choose to take courses that are less "interesting" or "important" to them online (Bejerano, 2008; Jaggars, 2014; Mann & Henneberry, 2014); these courses are therefore already likely to have worse outcomes regardless of medium. Thus, outside of ERT, where students choose course medium themselves, it is impossible to disentangle the relationship between course characteristics and course outcomes from the relationship between course characteristics and course medium choice. In other words, during typical circumstances, the relationship between course medium and course outcomes is a combination of H1 pathway and the combined effects of the dotted and H2 pathways in Figure 1, and these two pathways (H1 and H2) cannot be teased apart.

However, the unique circumstances of the COVID-19 pandemic removed the relationship between chosen medium and actual medium, as all courses were moved fully online (regardless of the medium that the student had originally chosen for them). Pandemic conditions thus allowed us to disentangle the two paths H1 and H2. Comparing outcomes in courses that a student originally chose in the online versus face-to-face medium allowed us to explore H2 separately (since both of these types of courses were actually delivered in the same medium during the pandemic); hence, any remaining differences in outcomes between these two types of courses (taken by the same student in the same term) can be isolated to those course characteristics that drove the student to choose the online versus face-to-face mediums for particular courses over others. Because all courses were delivered in the same medium, differences in outcomes in this situation cannot be attributed to the online medium itself (H1).

We note that it is possible that both H1 and H2 play a role—we do not contend that these two hypotheses are necessarily mutually exclusive; existing research does not definitively suggest one may have precedence over the other or that they only may have individual impact. Here, we investigate the extent to which data obtained during the unique circumstances of the COVID-19 pandemic exhibits patterns that are or are not consistent with each hypothesis (H1 and H2), allowing for interpretation of our study results in light of each of these hypotheses. This conceptual framing enables us to begin to deconstruct the simplistic framing of some existing research that has considered course medium without other potentially relevant factors. Interpreting our results through this more nuanced lens serves to offer scholarly and practical insights that go beyond existing literature. The present study uses this conceptual model to frame several hypotheses for empirical investigation of within-student data through quasi-experimental methods designed to extend our understanding beyond what previous studies have achieved through cross-sectional or between-student designs. It also leverages pandemic data in a novel way to disentangle the relationship between course characteristics, course medium choice, and course outcomes, something that has not yet been attempted in existing research literature using a within-students design.

Method

Sample and Data Source

The dataset consisted of all courses taken by students enrolled in either fall 2019 or spring 2020 at CUNY, the largest urban university system in the U.S. (Boland, 2021).[1] The study sample is limited to students who were enrolled in at least one online and at least one traditional (face-to-face) course in fall 2019 and in spring 2020 ($n = 83{,}049$), allowing for comparison across medium and term within students. By analyzing fixed effects within students, we are able to assume characteristics of the individual, which might otherwise confound the results, are the same across comparisons made with the same individual. This allows us to make comparisons across medium and across term, all for the same individual, thus offering a stronger study design than the more typical design that makes comparisons across different individuals. This is particularly critical when comparing course outcomes by medium, since students who enroll in online courses have been found to differ significantly from students who take only face-to-face courses (e.g., Alarifi & Song, 2024; Fischer et al. 2021).

In fall 2019, CUNY undergraduates were 32% Hispanic; 26% Black, 22% Asian and Pacific Islander, and 20% White. About 44% were first-generation college students, 39% were non-native English speakers, 25% were older (>25 years) and 60% were Pell recipients. More than 60% of students worked and 33% attended part-time. While CUNY is not nationally-representative because of its large diverse student body and mix of two- and four-year colleges, it is a logical choice for exploring the relationship between online learning and outcomes for a diverse student population. When CUNY announced in March 2020 that all on-campus instruction was suspended, the majority of students had not enrolled in fully online courses, and most faculty had never taught online. During the forced pandemic transition, instructors were offered extra training and technical assistance, yet they had little time to prepare and varied levels of expertise in online pedagogy.[2]

[1] One of the CUNY community colleges recoded all classes that moved online in March 2020 as “fully online” retroactively. This made these classes indistinguishable in the data from classes that were online from the beginning of the semester. Therefore, we excluded data from that college from analysis.

[2] We note that the limited preparation of faculty during ERT may have influenced course outcomes. To address this, further investigation was conducted to investigate this potential confounding relationship (see subsequent section on Exploring Potential Confounding Relationships).

Measures

Online medium was operationalized as the format that was used to deliver instruction; this is the way that the online medium is operationalized in most studies that explore its relationship to academic outcomes (e.g., Shea & Bidjerano, 2014; Johnson & Mejia, 2014). The term ***online medium*** describes courses that are delivered 100% online; it does not indicate *quality* of instruction. (We discuss how varied quality of online instruction during ERT and other pandemic conditions may play a role in observed patterns in later sections.)

Outcomes were compared in courses based on the ***chosen medium***—the medium *originally selected by the student* (prior to the pandemic). In fall 2019, the chosen medium and the actual medium were the same for all courses; in spring 2020, the medium was online for most of the semester, often departing from the student's chosen medium. We call courses that students originally selected in the online medium ***fully online courses***, and those that they did *not* originally select in the online medium ***traditional courses***. Thus, traditional courses were not fully online in fall 2019 but they were fully online for most of the spring 2020 term.[3] We compared how gaps in course outcomes between fully online and traditional courses shifted from the fall 2019 ***pre-pandemic term*** to the spring 2020 ***pandemic term***. All face-to-face instruction was suspended at CUNY on March 11, 2020, with ERT enacted. In the spring 2020 term, students may have been subject to a number of direct and indirect effects from the pandemic. However, we compared only courses within students in the same term; thus, term is a proxy for student-level pandemic effects; in this way, it serves as a control for any potential impact of student-level pandemic effects on outcomes.

The outcome of interest was ***successful course completion***—completion with a C- or better[4]; this is typically necessary for transfer credit or credit in a major. Only students who were enrolled in at least one traditional and at least one fully online course in both terms were included; this allowed comparison of course outcomes across mediums within students within terms. Control variables included: gender, race/ethnicity, age, G.P.A., first-semester freshman status, the median household income of a student's zip code, and college level (two-year versus four-year). Some CUNY colleges were on a separate calendar, so in some cases we controlled for the semester start date.

The only variable with missing values was the median household income of a student's zip code (0.06% missing); students with missing data included data entry errors but were primarily a small subset of foreign students who did not have a local address on file. Because this population likely differs from those students with a zip code on file, the missingness was missing not at random (MNAR), which means that imputation would not be appropriate. Additionally, the small proportion of missing values in only a single variable meant that substantial bias was unlikely. Thus, listwise deletion was used, because it is a reasonable choice for handling missing

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[3] We compare originally chosen medium (rather than actual medium) because if students selected different types of courses online than face-to-face (e.g., by taking courses that are less important to them online as suggested by Bejerano [2008] and Jaggars [2014]), and this is correlated with differential course outcomes (H2), then this categorization allows us to disentangle H2 from H1.
[4] We include pass/fail designations in which a student was categorized as passing the course and receiving credit.

data under such circumstances, and other approaches such as imputation are only appropriate when data are reasonably assumed to be missing at random (MAR) or missing completely at random (MCAR) (Allison, 2002; Manly & Wells, 2015).[5]

For one sub-analysis to assess H2, we considered the relevance of course type to a student's major. This required hand-coding all courses taken during the 2019-2020 school year for each student in each major based on course type—whether the course counted as an elective, distributional, or major requirement. Major requirements were required courses in the major discipline or a closely related discipline (e.g., math and computer science were considered closely related)[6]; distributional requirements were courses that were required for the major, but not directly related to the major discipline (e.g., English requirements for the math major); and electives were courses that were not required by the major but fulfilled degree credit. Comparing outcomes across course type allowed us to observe patterns associated with H2.

Exploring Competing Hypotheses

We explored the following two hypotheses to determine the extent to which patterns observed in the data are consistent with H1 and/or H2 as explanatory mechanisms for differential outcomes observed in online versus face-to-face courses.

Hypothesis: *Lower rates of successful course completion in online courses are caused by:*	**Data patterns that would be consistent with each hypothesis:**
H1. *The online medium itself.*	• **Overall course outcome gap pattern expected:** Gap shrinks/closes during pandemic term (when ERT enacted). (If the online medium itself lowers successful course completion, when all courses move online, we would expect the gap in outcomes between online and face-to-face courses to disappear.) • **Robustness check:** Gap shrinks more at colleges where a greater proportion of the term occurred online. (If the online medium itself lowers successful course completion, we would expect course outcomes to be worse at colleges where there was less in-person instruction prior to the shift online; we would expect a significant interaction between time spent in in-person instruction before ERT and course medium in predicting course outcomes.)

[5] This limits generalizability of findings so that they may not apply to all first-semester foreign students, although the majority of students were still in the sample because they had a local address on file.
[6] The coding required interpretation of what disciplines were considered closely related-- faculty in those disciplines were consulted.

H2. *Students choosing to take "less important" courses in the online medium.*	• **Overall course outcome gap pattern expected:** Gap stays the same during the pandemic term (because course medium was selected prior to pandemic onset both terms). (If lower outcomes in online courses are due to differing characteristics of the courses students choose to take online versus face-to-face, then gaps in outcomes for these courses should stay the same, regardless of the actual medium in which they are delivered.) • **Robustness check:** Gap in both terms can be explained statistically by some measure of the "importance" of the course to the student's degree. (If characteristics like the "importance" of a course to a student's degree impacts both their likelihood of taking it online and the likelihood of poorer course outcomes, then mediation models should illustrate that a significant percentage of the gap in outcomes by medium is explained by measures of "importance" of the course to a student's degree plan.)

The "overall course outcome gap patterns" are intended to describe the expected trend if the corresponding hypotheses were the only factor at play. The robustness check for H1 would indicate support for H1 if there is a significant interaction such that colleges where more time was spent online saw more similar outcomes (i.e., a smaller gap) than other colleges, thereby supporting the idea instructional time in the online (rather than face-to-face) medium itself leads to lower course outcomes. The robustness check for H2 would indicate support for H2 if the "importance" of the course for the student's degree interacts significantly with course medium such that the gap was smaller for courses considered more "important," thereby supporting the idea that choosing lower "importance" courses online would lead to lower outcomes in those courses.

In subsequent analyses, we consider potential confounders and alternative hypotheses that may explain patterns observed in the data. One such confounder is ERT itself. Fully online courses and ERT are delivered similarly at a distance; however, ERT faculty have little time for planning or implementation and both faculty and students find themselves in a modality that they did not select (Gelles et al., 2020; Hodges et al., 2020). In contrast, non-ERT online courses are pre-planned and often follow research-based standards of instruction (Kebritchi et al., 2017). Thus, we might expect to see poorer outcomes in traditional courses during the pandemic term because of ERT, and not because of the online medium itself. This, and other potential confounding factors, are discussed later.

Analytical Approaches and Data Analyses

Linear probability multi-level models were used for all analyses reported here. Given the binary nature of the outcome, logistic regression models (using a logit link function) were also checked and results were compared for all analyses. Statistical analyses used Stata 17: *mixed* for multi-level logistic and linear probability models, and *melogit* for multi-level logistic regression models. As results of both approaches were similar, only linear probability models are presented here because: (a) our primary concern was estimating particular parameters and not forecasting a specific outcome; (b) due to rescaling, we could not compare coefficients across logistic regression models (Buis, 2010), however, this could be done with linear regression; and (c) the literature illustrates how commonly odds ratios are misinterpreted (Norton & Dowd, 2018) and readers are generally apt to better interpret the coefficients of linear probability models.

The multi-level models used include three levels: (a) the individual course record; (b) the individual student; and (c) the college at which that student took that course. This allowed for controlling of clustering by student and by college, to account for the tendency of grades in different classes for the same student, and grades given for different classes at the same college, to be similar to one another.

Using *i* to index course records and *j* to index students and *k* to index colleges, our multi-level model is:

Level 1:

(1) $$Y_{ijk} = \beta_{0jk} + \beta_{1jk}T_{1ijk} + \cdots + \beta_{njk}T_{nijk} + \varepsilon_{ijk}$$

Level 2. For each $\boldsymbol{l = 0, \ldots, n}$:

(2) $$\beta_{ljk} = \tau_{l0k} + \tau_{l1k}C_{l1k} + \cdots + \tau_{lmk}C_{lmk} + u_{ljk}$$

Level 3. For each $\boldsymbol{l = 0, \ldots, n}$ and $\boldsymbol{p = 0, \ldots, m}$:

(3) $$\tau_{lpk} = \mu_{lp0} + \mu_{lp1}L_{lp1} + \cdots + \mu_{lpq}L_{lpq} + r_{lpk}$$

Where β_{0jk} are the level-one intercepts, $\beta_{1jk}, \ldots, \beta_{njk}$ are the level-one slopes, and ε_{ijk} represents the random effect for course record *i*, student *j*, and college *k*; τ_{l0k}; for $l = 0, \ldots, n$, τ_{l0k} are the level-two intercepts, $\tau_{l1k}, \ldots, \tau_{lmk}$ are the level-two slopes, and u_{ljk} are the random effects for student *j* at college *k*; and for $l = 0, \ldots, n$ and $p = 0, \ldots, m$, μ_{lp0} are the level-three intercepts, $\mu_{lp1}, \ldots, \mu_{lpq}$ are the level-three slopes, and r_{lpk} are the random effects for college k.

For logit models, the same equations were used as in linear regression, but with a logit link employed to model the probability distribution. In other words, Y_{ijk} from the Level 1 equation is replaced with $\lambda(Y_{ijk})$ where $\lambda(Y_{ijk})$ represents the logit link:

$$\lambda(Y_{ijk}) = \frac{e^{Y_{ijk}}}{1 + e^{Y_{ijk}}}$$

Here $\lambda(Y_{ijk})$ represents the probability value of the dependent variable, and other variables are the same as in the linear regression models.

Separate models were run for students enrolled at two-year versus four-year colleges; there is research establishing that student outcomes at these different types of institutions are best modeled separately (e.g., Attewell, Heil, & Reisel, 2011).

For the robustness check for H2, KHB decomposition (Kohler et al., 2011) was used to calculate direct and indirect effects for mediation analysis. This model is preferable to others because it generates an indirect effect that is not distorted by the rescaling that occurs when a potential mediator variable that is correlated with the dependent variable is added to a nonlinear model. Monte Carlo studies have shown that the KHB method always performs as well or better than other methods that have been developed to address the problems of rescaling in terms of recovering the degree of mediation net of the impact of rescaling (Kohler et al., 2011). We recognize that the language of mediation may be associated by some with causation, and that this is an observational and not a causal study. However, attempts to reword seemed too inaccessible to many non-methodologists, so we compromised by putting the word “effect” (i.e., total “effect”) into quotes everywhere it appears and we remind readers throughout that these data do not support causal inferences. Our goal is to strike a reasonable balance between rigor of terminology and accessibility.

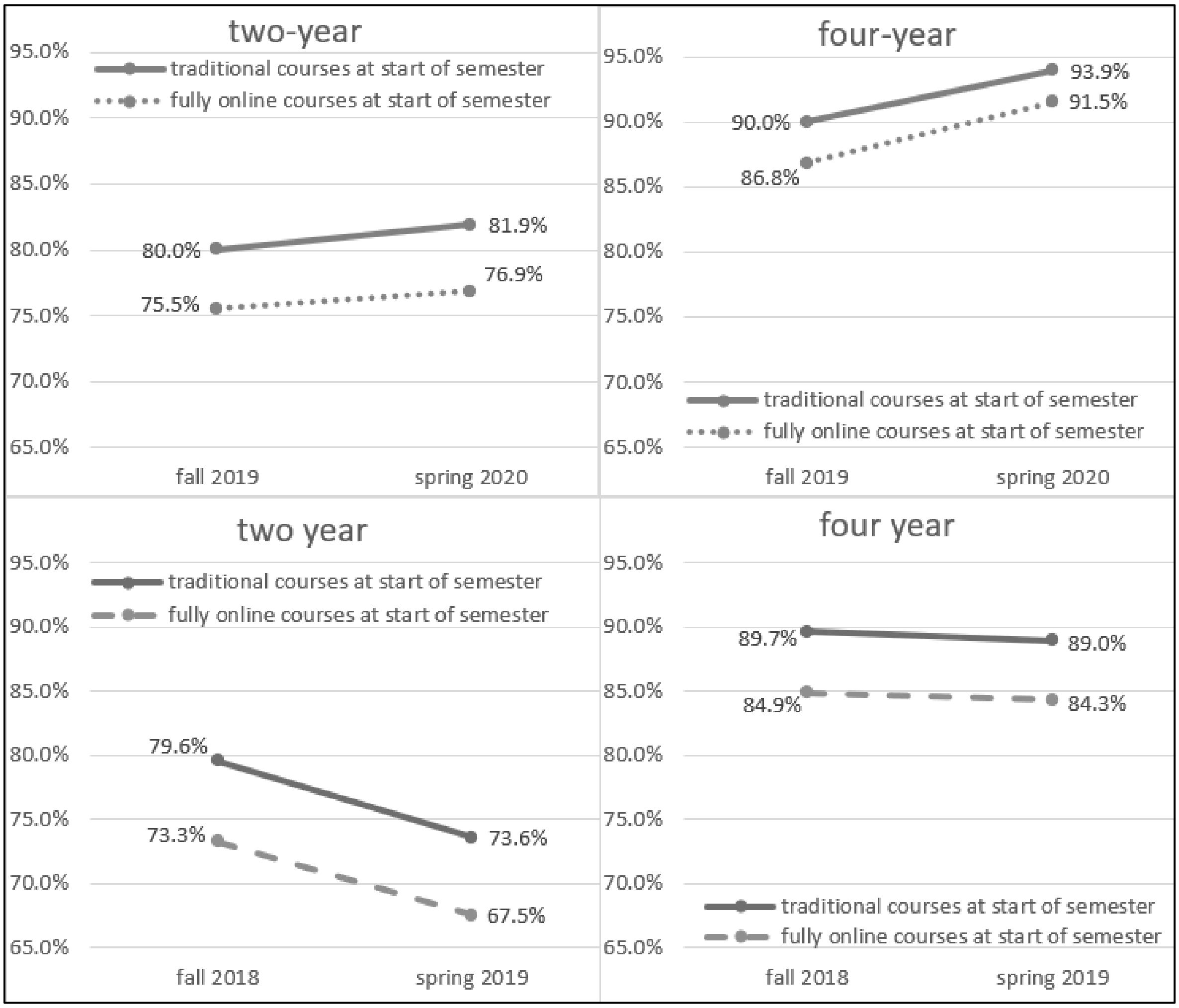
Results and Discussion

General Trends for the Gap in Successful Course Completion by Medium During the Pandemic

Outcomes were compared for fully online versus traditional courses for the same student in fall and spring terms. Figure 2 shows the mean successful course completion rate by student by term, by instructional medium at two- and four-year colleges (patterns from the year 2018–2019 are included for reference in the second row of Figure 2).

Figure 2

Mean Successful Course Completion Rates for Online Versus Traditional Courses Taken by Same Student During Pre-pandemic Fall Versus ERT Pandemic Spring Term



Note. Prior year included in bottom row for comparison.

Students[7] across colleges did significantly better ($p < 0.001$) in both fully online and traditional courses in the pandemic versus pre-pandemic term. The gap between fully online and traditional mode courses remained unchanged—in both terms, at both types of colleges, students were significantly less likely to successfully complete fully online than traditional mode courses ($p < 0.001$), even after traditional courses were moved fully online. The main difference between 2018–2019 and 2019–2020 is that students at both two- and four-year colleges, in both traditional and fully online courses, did better during the pandemic term than expected based on trends from 2018–2019. This may be because instructors were more flexible and lenient during

[7] When we use the term "students," we are referring students in this sample, or those who had enrolled in at least one fully online and one traditional course both terms.

the pandemic term (Altingdag et al., 2021; Chan, 2023; Gelles et al., 2020; Lederman, 2020). However, the *relative gaps* between student performance in fully online versus traditional courses did not change significantly during the pandemic; there was *no significant interaction* between term and course medium in 2019–2020 in multilevel linear probability fixed effects models (see Table 1).

Table 1

Difference in Successful Course Completion (w/C- or Better) within Students, by Term and Course Medium (with Interaction Term)

	Base Model (no covariates)				Full Model (with controls)[a]			
Two-year	Coeff.	SE	*p*	sig.	Coeff.	SE	*p*	sig.
pandemic term	0.026	0.007	0.000	***	0.027	0.007	0.000	***
fully online course	-0.045	0.008	0.000	***	-0.044	0.008	0.000	***
fully online x pandemic term	-0.004	0.012	0.725	*NS*	-0.005	0.012	0.672	*NS*
Four-year	Coeff.	SE	*p*	sig.	Coeff.	SE	*p*	sig.
pandemic term	0.041	0.002	0.000	***	0.037	0.002	0.000	***
fully online course	-0.028	0.003	0.000	***	-0.027	0.003	0.000	***
fully online x pandemic term	0.005	0.004	0.203	*NS*	0.004	0.004	0.271	*NS*

Note. * denotes $p < 0.05$; ** denotes $p < 0.01$; *** denotes $p < 0.001$
Multilevel linear probability fixed effects model coefficients (third level is college, second level is individual student, first level is individual course records); reference groups: pre-pandemic term, traditional mode; separate models were run for two- versus four-year colleges.
[a] Control variables include: gender, race/ethnicity, age, GPA category at the start of the semester, first-semester freshman, median household income of zip code

On average, both traditional and fully online courses had significantly better outcomes in the pandemic versus pre-pandemic term, and fully online courses had significantly worse outcomes than traditional courses both terms, even after traditional courses moved online. Students were less likely to successfully complete courses that they originally chose to take fully online than face-to-face, regardless of whether those courses were subsequently taught fully online or not. The lack of an interaction between course medium and term (i.e., a similar gap during both pre-pandemic and pandemic terms) is consistent with H2 rather than H1. This is because we would have expected the gap to shrink or disappear if H1 were true because regardless of the student's original chosen medium, *all* courses shifted fully online during the pandemic term. Whereas if H2 were true, the factors contributing to differences in course outcome would have been related only to the initially *chosen* medium of the course rather than the actual medium as implemented; thus, in this case we would expect the gap to remain regardless of whether courses were subsequently taught online or not. We now explore each of these hypotheses explicitly and in depth.

Exploring H1 (Course Medium Directly Influences Course Outcomes)

H1 hypothesizes that the online medium itself results in worse outcomes. However, the patterns observed in Figure 2 and Table 1 are not consistent with H1 (i.e., an observed lack of interaction between term and medium). If H1 were true, and the reason for the lower rates of successful course completion in fully online versus traditional courses pre-pandemic was the online course medium itself, then barring other potential confounding factors[8], we would expect the gap between fully online and traditional courses to shrink, close, or reverse during the pandemic term when traditional courses moved online. Yet, the gap stayed the same; higher education discourse that argues the online medium itself causes worse outcomes is not consistent with patterns observed in this study and bears further examination. This data is observational, and therefore we cannot make causal inferences. We can, however, use other features of the data to explore whether the lack of support for H1 observed in the patterns is or is not reinforced by other features of the data.

Robustness Check: Proportion of Term that was Fully Online as an Instrumental Variable

At CUNY, most colleges switched to ERT five weeks into the 15-week long spring 2020 term; however, three community colleges began the spring term about one week before the switch to ERT. We call the former *less-online* colleges, and the latter, *more-online* colleges. If the online medium itself were responsible for gaps in successful course completion between traditional and fully online courses (H1), then we would expect the gap between traditional and fully online courses to be larger in the less-online colleges (where traditional courses had more in-person instruction) than in the more-online colleges (where traditional courses had almost no in-person instruction). We chose one community college from the less-online colleges and one community college from the more-online colleges; these two colleges were chosen because they had a similar baseline pattern: they had patterns of course outcomes by medium (fully online versus traditional) that were not statistically different ($p = 0.852$) in the fall pre-pandemic semester. We ran a three-way interaction model to determine if there were differences in term-by-online interactions for more-online versus less-online colleges (see Table 2).

[8] To counteract this pattern (the gap between fully online and traditional courses remaining the same during the pandemic term), confounding factors would have to be factors that either: (a) lowered outcomes during the pandemic in fully online courses (those that were originally online) more than in traditional courses (those that were not originally online but moved online during ERT); or (b) raised outcomes during the pandemic in traditional courses (those that were not originally online but moved online during ERT) more than fully online courses (those that were originally online). We discuss potential confounding factors in the final section.

Table 2

Successful Course Completion (with a C- Grade or Better) for Students at Sample "Less-Online" and "More-Online" Colleges[a]

	Base Model (no covariates)				Full Model (with controls)[b]			
	Coeff.	SE	*p*	sig.	Coeff.	SE	*p*	sig.
pandemic term	0.160	0.045	0.000	**	0.148	0.048	0.002	**
fully online course	0.072	0.063	0.256	*NS*	0.074	0.063	0.240	*NS*
fully online x pandemic term	-0.167	0.091	0.065	·	-0.169	0.090	0.059	·
more-online college	0.051	0.058	0.382	*NS*	0.015	0.060	0.803	*NS*
pandemic term x more-online college	-0.077	0.055	0.164	*NS*	-0.071	0.057	0.210	*NS*
fully online x more-online college	-0.025	0.073	0.728	*NS*	-0.018	0.072	0.804	*NS*
fully online x pand. term x more-online	0.117	0.105	0.265	*NS*	0.111	0.104	0.286	*NS*

Notes. · denotes $p < 0.10$; * denotes $p < 0.05$; ** denotes $p < 0.01$; *** denotes $p < 0.001$
Multilevel linear probability model fixed effects model coefficients (second level is individual student, first level is individual course records; reference groups: pre-pandemic term, traditional mode course, less-online college), with three-way interaction by term, course medium, and more-online versus less-online college status.
[a] "More-online" colleges began their term at the end of January (five weeks of the fifteen-week term were taught in-person); "less-online" colleges began their term at the beginning of March (one week of the fifteen-week term was taught in-person).
[b] Control variables include: gender, race/ethnicity, age, GPA category at the start of the semester, first-semester freshman, median household income of zip code.

There was no significant three-way interaction between term, fully online medium, and whether the college was a more- or less-online college, suggesting that the proportion of instruction that was spent online during the pandemic term did not have a significant relationship to course outcomes in this sample.[9] As with prior analysis, results are not consistent with H1 (the online medium itself causes lower rates of successful course completion). If H1 were true, we would expect the proportion of time spent in online instruction during the spring pandemic term to be inversely related to successful course completion: i.e., outcomes in traditional courses at more-online colleges to go down more than at less-online colleges. However, the relationship

[9] We ran the same models with all of the more-online and less-online colleges and did not find significant three-way interactions in any models. We report the results from the model containing one college per group because there was significant variation among the community colleges in terms of baseline outcomes for fully online courses, and we felt that it was most appropriate to report coefficients for those colleges which were most similar at baseline.

between outcomes in traditional versus fully online courses was the same regardless of how many weeks of in-person instruction traditional courses had before the switch to fully online instruction. While these are not causal models and we therefore cannot definitively rule out H1, the patterns observed in this data using timing/duration of online onset as an instrumental variable are not consistent with this hypothesis. Using the difference in number of weeks of in-person instruction before the switch to online courses as a type of instrumental variable[10] is just a different but complementary way of separating out factors that simultaneously impact students' choice of course medium from time spent in the actual course medium (and thus another way of disentangling the mechanisms described by H1 from those described by H2).

Exploring H2 (Type of Course Students Choose to Take Online Predicts Outcomes)

We next considered H2 (differential outcomes online versus face-to-face can be explained in part by students choosing to take different courses online than face-to-face). If H2 were true, in the absence of other confounding factors, we would expect the gap between fully online and traditional courses to remain constant from the pre-pandemic to the pandemic term, since students selected the delivery mode prior to the onset of the pandemic. The chosen delivery mode is in this context a proxy for all the course characteristics that lead a student to choose the online medium for that course (and which may also subsequently drive outcomes in that course as well).

In Figure 2 and Table 1, the gap between fully online and traditional courses was practically identical in both terms, which is consistent with H2 (that gaps between online and face-to-face courses could be explained by students choosing to take different courses in each medium). The pattern observed here is thus consistent with higher education discourse that argues that differential outcomes in online courses are related to student choices to take different courses online versus face-to-face. We contemplate the potential impact of compounding factors in the final section, but first we considered an alternate analysis with different data that provides a robustness check to see if alternate data is also consistent with H2 or not.

Robustness Check: "Importance" of Courses to a Student's Degree Plan as A Predictor of Online Versus Traditional Course Outcomes During ERT

Courses may have various characteristics that make a student more likely to take them online versus face-to-face (or vice versa), and the particular characteristics that are salient may vary by student, making this a complex process. Thus, it is impossible to explicitly categorize all course characteristics that may impact student medium choice; however, we can focus on subsets of these characteristics that have a clear definition. Thus, for this robustness check we focused on one subcategory of characteristics that has been found in the literature to impact students' choice of course medium. There is evidence that students take less "important" courses online and more "important" courses face-to-face (Bejerano, 2008; Jaggars, 2014; Mann & Henneberry, 2014); to test whether this might explain the persistent gap in online versus traditional course outcomes even after traditional courses moved online, we conducted an additional analysis using a subset

[10] Whether a student spent more or less time in online instruction in traditional courses before the pandemic switched all instruction fully online was uncorrelated with either (a) confounding factors (i.e., course characteristics) that determined students' course medium selection or (b) with gaps in course outcomes between online and in-person conditions (outside of the measured potential relationship between time spent in online versus in-person instruction during the pandemic term).

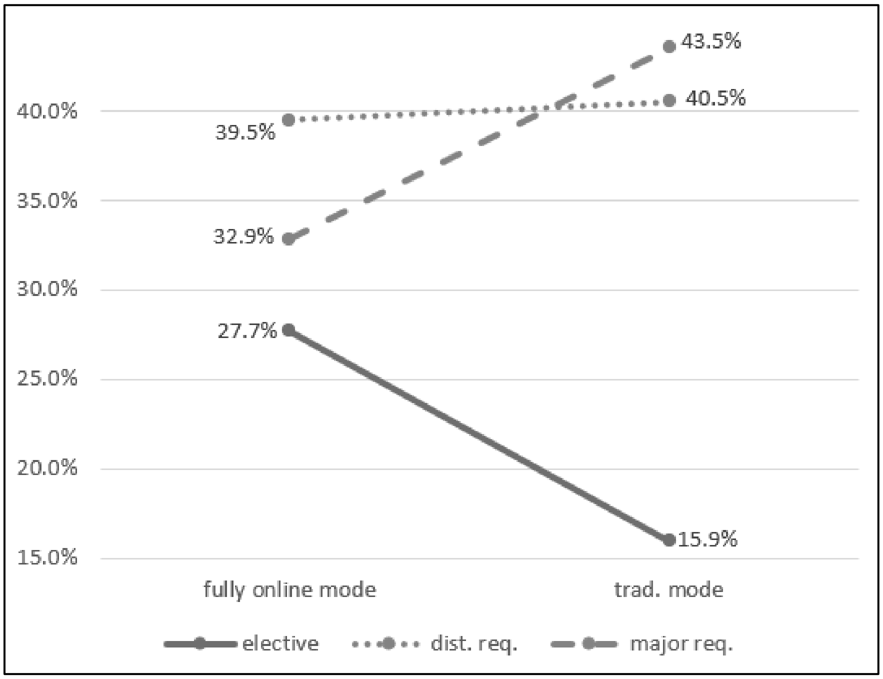
of the data. One measure of the “importance” of a student’s course to their degree is whether it counts as a major requirement, distributional requirement, or an elective. These categories have also been shown to explain variation in online versus face-to-face courses in prior research (Wladis et al., 2014, 2017).

For this robustness check, we studied only students enrolled at the largest CUNY community college because this analysis required hand-coding of all courses for each course-major combination in the dataset.[11] We examined the extent to which (a) the courses that students took in the fully online medium were more likely to be elective or distributional requirements rather than major requirements (Figure 3); and (b) the extent to which this distribution of course type by medium may explain the patterns found for course completion by medium by term (Tables 3 and 4).

[11] We excluded students majoring in “liberal arts,” which is a broad major not associated with any discipline, intended to help fulfill all distributional requirements for any four-year degree once students transfer to a four-year college.

Figure 3

Proportion of Courses by Type That Students Chose in Fully Online Versus Traditional Mode



Students were significantly more likely to take elective courses fully online ($p < 0.001$) and significantly more likely to take major requirements as traditional courses ($p < 0.001$)[12]; they were roughly equally likely to take distributional requirements as fully online or traditional courses. Courses that were either elective or distributional requirements had significantly lower rates of successful completion than major requirement courses (2.3 percentage points lower, $p = 0.01$; and 4.3 percentage points lower, $p < 0.001$, respectively); thus, we explored the extent to which this may explain the lower rates of completion for courses fully online during the pandemic term by using KHB analysis to run mediation models (Table 3).

Table 3

Mediation Analysis of How Elective Versus Major Requirement Course Type Might Mediate the Relationship Between Course Medium and Successful Course Completion (with a C- or Better)

	Base Model (no covariates)				Full Model (with controls)[a]			
	Coeff.	SE	*p*	sig.	Coeff.	SE	*p*	sig.
Total “effect”	-0.048	0.010	0.000	***	-0.051	0.010	0.000	***
Direct “effect”	-0.035	0.011	0.001	**	-0.040	0.010	0.000	***
Indirect “effect”	-0.014	0.003	0.000	***	-0.011	0.004	0.006	**

Note. * denotes $p < 0.05$; ** denotes $p < 0.01$; *** denotes $p < 0.001$

[12] Significance values come from linear probability models using course type to predict course medium; because of space constraints, we do not report model coefficients here.

In the spring pandemic term for students at the largest two-year college, using KHB method, clustering by student, with and without covariates.
[a] Control variables include gender, race/ethnicity, age, GPA category at the start of the semester, first-semester freshman, median household income of zip code.

Elective-vs-major-requirement-course-type significantly mediated the relationship between course medium and course outcomes during the pandemic term, explaining on average 28% of the difference in course outcomes by medium. In other words, 28% of the outcome gap by course medium can be explained by the fact that students were more likely to take electives than major requirements online and simultaneously had poorer outcomes in elective versus major requirement courses. Thus, the types of courses that students chose to take online explained a significant and substantial part of the difference in outcomes between fully online versus traditional courses during the pandemic (even though it was limited to just one narrow subset of course characteristics), further supporting H2.

This occurred even though the model in Table 3 is only a rough measure of the courses a student may consider "important." This categorization excludes nuanced distinctions that likely go into student decision-making; there are factors that make a course "important" that cannot be captured by our categorization of elective versus major requirement. For example, a student may take courses critical to future career plans but that are technically electives for their current major (e.g., students who plan to transfer to a specific major at a four-year college, or to a graduate program such as medical school, may take classes that are not required by their current major). Because of this, and evidence that students are more likely to take "important" courses in the traditional mode than online (Bejerano, 2008; Jaggars, 2014; Mann & Henneberry, 2014), the models in Table 3 likely *underestimate* the potential power of the "importance" of a course (and other course-level factors) in explaining differences in outcomes for courses that students elect to take online versus face-to-face.

We did not include distributional requirements in mediation models in Table 3. This is because there was an interaction "effect" between distributional requirement categorization and course medium in predicting outcomes (see Table 4). When an interaction term between course type and medium is included in the model, even more of the variation in course success rates are explained, because students successfully complete distributional requirements at significantly lower rates compared to major requirements in the fully online medium than in the traditional mode ($p < 0.001$). Though roughly the same proportion of fully online and traditional courses are distributional requirements, the outcomes in these courses are significantly worse when they are chosen to be taken fully online. One possible explanation is that students might have elected to take less "important" distributional requirements online rather than face-to-face; this is in line with existing research (Bejerano, 2008; Jaggars, 2014; Mann & Henneberry, 2014) and consistent with elective versus major requirement patterns observed in Table 3. The interaction patterns observed in Table 4 are consistent with this explanation. Because of this interaction "effect," we did not include mediation models for distributional versus major requirements in Table 3 (indirect "effect" estimates average over the substantial interaction between course medium and course type in terms of their relationship to outcomes). This provides further evidence that the mediation model in Table 3 likely underestimates the "effect" of course "importance" (and other course-level factors) on differential course outcomes by course medium.

The results in Tables 3 and 4 establish that the importance of a course to a student's degree plan may play a role in explaining differences in outcomes between courses that students elect to take online versus face-to-face. Even though this is not sufficient to make causal conclusions, this finding does reinforce prior research (Jaggars, 2014; Wladis et al., 2014, 2017).

Table 4

Successful Course Completion (with a C- or Better), by Course Medium and Type in the Spring Pandemic Term, for Students at the Largest Two-Year College

	Base Model (no covariates)				Full Model (with controls)[a]			
	Coeff.	SE	*p*	sig.	Coeff.	SE	*p*	sig.
fully online	-0.070	0.006	0.000	***	-0.071	0.006	0.000	***
course type								
elective	-0.023	0.009	0.010	*	-0.022	0.009	0.016	*
dist. req.	-0.043	0.007	0.000	***	-0.037	0.007	0.000	***
fully online	-0.047	0.011	0.000	***	-0.047	0.010	0.000	***
course type								
elective	-0.021	0.012	0.076	·	-0.018	0.012	0.125	·
dist. req.	-0.027	0.009	0.002	**	-0.021	0.009	0.018	*
fully x course type								
fully x elective	-0.016	0.018	0.391		-0.019	0.018	0.303	
fully x dist. req.	-0.051	0.016	0.001	**	-0.052	0.016	0.001	**

Note. · denotes $p < 0.10$; * denotes $p < 0.05$; ** denotes $p < 0.01$; *** denotes $p < 0.001$
Multilevel linear probability fixed effects model coefficients (second level is individual student, first level is individual course records); reference groups: traditional mode, major requirement; two separate models: with (top model) and without (bottom model) interaction term.
[a]Control variables include: gender, race/ethnicity, age, GPA category at the start of the semester, first-semester freshman, median household income of zip code.

Exploring Potential Confounding Relationships

Because this study compared course outcomes within students within terms, student-level variation and term-level variation has been controlled. While different students may have experienced differential impacts of the pandemic, we compared the outcomes in each student's fully online versus traditional courses during the pandemic term to each other, so these impacts would theoretically have influenced both online and traditional courses for that student similarly. Yet, ERT is different from online courses offered outside emergency conditions, so we next considered aspects of potential or theorized instructor/course-level differences during ERT that might have differentially impacted student outcomes in online versus traditional courses during the pandemic term:

C1) ERT courses might have lower quality than fully online courses, because the traditional course instructors had less time to prepare/less experience online (Legon et al., 2020; McDaniel et al., 2020; Stewart, 2021);
C2) Instructors might have been more lenient/flexible in ERT courses than fully online courses. Gelles et al. (2020) and Lederman (2020) found that instructors in general were more lenient during the pandemic without considering original course medium; Altingdag

et al. (2021) found the opposite of the theorized relationship needed to explain existing patterns—instructors teaching courses that were originally fully online were more lenient during the pandemic;

C3) ERT courses might have been more likely to have been offered synchronously (Legon et al., 2020; McDaniel et al., 2020), whereas fully online courses at CUNY (and elsewhere) tend to be asynchronous (Schaffhauser, 2017), and theoretically, outcomes in synchronous courses might be better than in asynchronous ones.

We outline what patterns in the data would be consistent with each hypothesis in isolation. Then, we consider how potential combinations of factors could theoretically lead to different data patterns, considering how these combinations could or could not result in the patterns observed at CUNY during the terms just before/after pandemic onset.

Hypothesis/confounder	**Overall course outcome gap pattern that would be consistent with this factor in isolation**	**Gap change direction**
H1. Lower rates of successful course completion online are caused by the online medium.	Gap *closes* during pandemic term (during ERT, when all courses moved online).	↓
H2. Lower rates of successful course completion online are caused by students selecting “less important” courses for the online medium.	Gap *stays the same* during the pandemic term (because course medium was selected prior to pandemic onset, and the factors that impact medium choice are also what explain poorer outcomes).	→
C1. Traditional courses were of lower quality during pandemic term because of ERT.	Gap *reverses* during pandemic term, as outcomes in traditional courses become worse than those in fully online courses.	↓
C2. Instructors were more flexible/lenient in ERT (traditional courses) than fully online courses during the pandemic term.	Gap *increases* during pandemic term, as students in ERT courses do even better than those in fully online courses due to increased flexibility/leniency.	↑
C3. ERT (traditional) courses were more likely to be synchronous than fully online courses; synchronous outcomes may be better than asynchronous ones.	Gap *stays the same* (or shrinks only slightly) during pandemic term (if synchronicity rather than medium is the reason for previously observed gaps in outcomes between online and face-to-face courses).	→

The gap in successful course completion between fully online and traditional courses stayed the same during the pandemic term, so the data is not consistent with H1, C1, or C2 alone; each would have increased or decreased the gap. For any of these factors to have played a role, they would have had to do so in combination with other factors that exerted an effect on the gap in the opposite direction. We consider each possible combination.

C1 (ERT courses were of lower quality) and H1 (the online course medium itself causes worse outcomes) are the two factors that would each, in isolation, *decrease* the gap between fully online and traditional course outcomes during the pandemic. Thus, for either of these to have played a role, another factor that *increased* the gap between fully online and traditional course outcomes during the pandemic would have to simultaneously have played a role—of the theorized confounders, only C2 is in the correct direction to produce that pattern. It is possible that the gap remained the same during the pandemic if ERT courses were of lower quality (C1) *and* instructors teaching these courses were *also* more flexible/lenient than instructors of fully online courses (C2); these two effects could “cancel” each other out, producing the patterns observed. Or H1 (the online course medium itself causes worse outcomes) could have played a role if C2 (instructors in ERT courses were more lenient/flexible than instructors of fully online courses)—was enough to override existing negative effects of ERT (C1) in addition to existing negative effects of the online medium itself (H1).

Thus, for C1 and/or H1 to be true, it seems likely that C2 would also have to have exerted an effect. Yet, what evidence exists suggests the opposite of C2—fully online instructors were shown to be more lenient than ERT instructors in spring 2020 (Altingdag et al., 2021; Chan, 2023; Gelles et al., 2020; Lederman, 2020). Thus, this scenario seems unlikely. It is possible that some as-yet unidentified confounding factor exists that increased the gap between courses that were originally fully online and those that were not but moved online during the pandemic, and therefore that C1 and/or H1 could have played some role in course outcomes, but current hypotheses can’t account for this.

Further, robustness checks of H1 using the proportion of instruction in traditional courses that occurred fully online during the spring 2020 term as a proxy for exposure to the online medium (the robustness check) were inconsistent with H1: the time that traditional courses spent in the fully online medium during the pandemic term was *not* correlated with significant change in the gap between traditional and fully online courses. While H1 cannot be definitively ruled out, it does not appear to be consistent with the data patterns observed.

The unchanged nature of the gap in successful course completion between traditional and fully online courses during the pandemic term is consistent with H2 (gaps between online and face-to-face courses can be at least partially explained by students taking less “important” courses online) and C3 (ERT courses were more likely to be synchronous; synchronous courses have better outcomes than asynchronous ones). While there is no concrete evidence, the literature does show a tentative connection between synchronous (versus asynchronous) instruction and engagement (e.g., McBrien et al., 2009) and there is research linking engagement to online course outcomes (e.g., Protopsaltis & Baum, 2019), so it is possible that C3 played a role. Since this would have left the gap unchanged, whether C3 played a role should have had no effect on whether or not the evidence supports H1 or H2.

Looking at changes to the gap in course outcomes between fully online and traditional courses from the pre-pandemic fall to pandemic spring terms is alone insufficient to determine if H2 (gaps between online and face-to-face courses can be at least partially explained by the fact that students take less “important” courses online) played a role, even though the data pattern is consistent with this hypothesis. We cannot rule out the possibility that this data pattern was caused by some combination of C2 working simultaneously with H1 and/or C1, even though there is no evidence (in existing research or the data here) that is consistent with that possibility.

None of those data patterns would rule out the potential effect of H2, as all could have occurred in tandem to produce the observed patterns.

Further, careful exploration of the "importance" of courses to students' majors was strongly consistent with H2, suggesting that H2 does play some role in explaining outcomes in fully online versus traditional courses for students who choose to enroll in both mediums. Because students did select more elective courses in the online medium and more major requirements as traditional courses, and because these differences in course type significantly explained differences in course outcomes both during and prior to the pandemic, this provides robust evidence that the kinds of courses that students select for the online medium likely explain, to some extent, differences in outcomes.

Limitations

The CUNY student population is more diverse and urban than the average U.S. college; therefore, while the study results are likely generalizable to a wider national student population, the dataset is not nationally representative. The CUNY data offers an excellent context in which to investigate the impact of the pandemic on traditionally underserved groups; however, it does limit the groups to which results can be generalized.

Given the complexity influencing student lives in spring 2020, we caution against simplistic causal interpretation of the relationships identified here. Rather, this work is useful for considering hypotheses about which factors may lead to student success in online environments in light of observed data. Future work using a research design more appropriate for causal inference is necessary, such as randomized controlled trials that focus on students who choose to take courses online but randomize *which* courses those students take fully online versus face-to-face. Such designs would be difficult to implement but would allow us to assess impacts of the online medium on the students who in practice actually enroll in these courses (while removing confounding effects of course characteristics on both choice of medium and course outcomes).

Researchers should also be prepared to take advantage of system shocks (like COVID-19) that allow data to be collected that are relevant for quasi-experimental analysis designs as have been employed in this study that get closer to investigation of causality than basic regression designs by eliminating various forms of confounding effects. It is important that such studies carefully consider the target population in particular—for example, by considering the impact of these system shocks not just on the whole student population—but on the subset of students who choose to take online courses, since this is the population who will be impacted by policies and structures regarding online course-taking. That this study is observational does not undermine the value of this research, however, it does impose limitations —assertion of causal relationships would be an inappropriate application of these results.

Conclusion and Implications

For students who took both fully online and traditional courses, fully online courses had lower course completion rates both terms, even after traditional courses moved online for ERT after pandemic onset. Differences in outcome by the originally selected course medium did not change even after face-to-face courses shifted fully online. Differences in face-to-face course outcomes also did not appear to be explained by the proportion of the term spent in in-person versus fully online instruction prior to pandemic onset; data in this study were not consistent with the often-cited hypotheses that the online medium itself leads to worse rates of successful course completion. Because this was not a causal study we cannot definitively rule out the possibility that the online medium itself still plays some role in outcomes, even if no such pattern was visible in these data.

This study also explored whether differences in online versus face-to-face courses could be explained by course characteristics, where the same characteristics that prompt students to take certain courses online also simultaneously result in poorer course outcomes. Courses that were originally fully online and those that were originally not fully online (but shifted fully online during the pandemic) had the same outcomes gap as observed prior to the pandemic, which is consistent with this hypothesis. Further evidence was observed using major requirement versus electives as a proxy of a course's "importance," which has been shown to be a factor in students' choice of medium in the research literature. The data showed that students take electives more often and major requirements less often online; these differences explained a significant portion of the gap between outcomes in courses that were originally fully online versus not-fully-online (before and during the pandemic). This suggests that when differences are observed in outcomes for online versus face-to-face courses, some portion of this difference is likely due to differences in the *types* of courses that students choose to take online versus face-to-face. When students choose to take course types that already have poorer outcomes online instead of face-to-face, the subsequent outcomes in those online courses appear worse on average, even though in these cases online versus in-person instruction has little to do with these differences in outcomes.

While this research is observational, there is currently a lack of causal studies. Thus, our findings may help institutions make policy decisions in the absence of better information. This study suggests that institutions should be cautious about enacting policies based on assumptions that the online medium itself produces worse outcomes for students who elect to take courses online. For instance, it is common practice to employ online readiness surveys (with no comparative for face-to-face courses), which may discourage students from enrolling online even when they are not at risk of dropout (Wladis & Samuels, 2016). Institutions may also enact other restrictions (i.e., who can register, how many online courses) that might reduce access to college for students who need online courses (women, parents, or students who are time-poor [Daymont et al., 2011; Jaggars et al., 2013; Wladis et al., 2018, 2022]) to progress. Additionally, institutions may have put pressure on students to return to taking courses face-to-face (e.g., Bauer-Wolf, 2020; Kumar, 2021); however, for students with disabilities/health issues, long commutes, and/or extensive work/family commitments, taking courses in person instead of online may have negative costs (Daymont et al., 2011; Jaggars et al., 2013; Wladis et al., 2018, 2022). Exerting such pressure can introduce negative stigma for those who need online accommodations. The patterns observed in this study suggest that restricting access to online courses may not produce any measurable benefit, and it has the potential of causing harm by limiting students' access to college, particularly for students who have already struggled historically to gain access to higher education.

Institutions may instead want to focus on supporting the needs of students who elect to take online courses. Policies focused on helping students to successfully complete courses that they consider to be less "important" to their degree may be a promising start. Students who enroll in online courses are more time-poor than their peers who take only courses face-to-face (Wladis et al., 2022), and it may be that when time-strapped students need to drop a class, the least "important" course is the first to be sacrificed (Hachey et al., 2023). Addressing students' time poverty may be one approach for improving outcomes in online courses (and in all their courses more generally). More research is also needed to determine which interventions would best support students in successfully completing elective courses; since students often choose to take these courses online, this could help boost online (as well as face-to-face) outcomes. It is critical to note that this study deliberately investigated students who had *chosen* to take courses online; implications cannot be extended to students who do *not* voluntarily select online courses (e.g., students who are forced online during an emergency). It is possible that forcing students who have *not* selected online courses into a fully online course could have a negative impact on their course outcomes; further research (e.g., well-designed RCT conducted outside of ERT conditions) is necessary to determine what kind of impact this might have. In the absence of such evidence, perhaps the best approach that institutions could take is to respect individual students' choices about which medium is best for them, making sure that there are enough online and face-to-face courses to accommodate all students' course-taking preferences. This includes offering enough sections across each medium to respond to student demand, and also de-stigmatizing student choices by recognizing students' agency and ability to assess what types of learning environments work best for them given their individual resources and constraints. Giving every student equal access to college may require honoring student choices about the particular course medium that works best for them.

Acknowledgements

This research was supported by a grant from the National Science Foundation (Grant No. 1920599). Opinions reflect those of the authors and do not necessarily reflect those of the granting agency.

We would also like to thank Zun Tang and the whole staff at the CUNY Institutional Research offices; Vivek Upadhyay and the staff at the CUNY Registrar's Office; Youngren Ponnuraj and the staff at CUNY Computer Information Services; and Zev Jeremias, CUNY's Executive Director of Technology, for their invaluable help in obtaining the data for this research. We would also like to thank Albert Sun and the *New York Times* for providing help obtaining data on COVID-19 case rates in New York City for this study. In addition, we would like to thank project managers Shristi Karim and Emma Wilson for their work on this project, and Chris Rhoads for his extensive and helpful feedback on the manuscript during its preparation.

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Section II

Introduction to Section II of the September Issue of the Online Learning Journal

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Abstract

In addition to the special section in this third quarterly volume, this issue also contains 8 articles from our regular submission process. These articles cover a broad range of related themes such as interaction, feedback, self-regulation, the COI framework, online STEM education and other topics.

We are very pleased to begin this section with a new article by Di Xu of the University of California, Irvine along with her colleagues, Qiujie Li of the National Institute of Education, Nanyang Technological University, Singapore; Gabe Avakian Orona of the University of Tübingen, Denmark; and Xuehan Zhou of the Institute of Economics of Education, Graduate School of Education, Peking University, China. In "Interaction-Oriented Instructional Practices Show Promise in Enhancing Overall Performance and Narrowing Racial Achievement Gaps in College Online Courses" these authors investigate the connection between six domains of interaction-oriented practices and student concurrent and distal success outcomes. Findings indicate a strong positive association between the overall usage of interaction-oriented practices and course completion rates, where instructor–student course managerial interactions play a particularly critical role in narrowing racial performance gaps. Dr. Xu, who has been a frequent co-author with OLJ's Senior Associate Editor Shanna Smith-Jaggar, regularly conducts important analyses intended to address racial disparities and the current paper reflects her commitment to taking on challenging studies that advance our understanding in this arena.

In "Feedback is Integral: Using a Revised ICAP Framework to Achieve Active Learning in an Asynchronous Online Course" authors Vikki Pollard and Christine Armatas of the Centre for Education and Innovation, at Australian Catholic University adapt Chi and Wylie's Interactive, Constructive, Active, Passive framework for use in asynchronous online settings. The authors introduce formative feedback to each ICAP level, concluding that the most active mode results in a student-produced artifact with evidence of having reflected on feedback. They use the revised framework to review a graduate level course of study consisting of eight asynchronous units recommending ways in which to apply the revised ICAP Framework to augment the level of active learning in the online mode.

In "Improving Community of Inquiry-Based Asynchronous Online Discussion through Improving Conceptual Knowledge by Information-Organizing Preparatory Activity with Kit-Build Concept Mapping" authors Lintang Matahari Hasani, Tsukasa Hirashima, and Yusuke Hayashi of the Graduate School of Advanced Science and Engineering, Hiroshima University, Japan, join colleagues Kasiyah Junus of the Faculty of Computer Science, Universitas Indonesia, Lia Sadita of Research Center for Data and Information Sciences, National Research and Innovation Agency (BRIN), Indonesia and Ayano Ohsaki of Shinshu University, Japan to investigate online discussion based on the community of inquiry (CoI) framework. Encouraging learners to actively perform the inquiry process in an online discussion is challenging, particularly among novice students. To prepare learners to engage in effective problem-solving discussions, preliminary activities that focus on training the learners on how to elaborate and express ideas is helpful. Asking students to engage in summarizing key concepts can serve as an information organizing activity that prepares them for dialogue that is more productive.

Alternatively kit-built concept mapping (KBCM) in which learners reconstruct teacher-created knowledge maps of key concepts from components and receive ongoing immediate feedback has been proposed. Previous research indicates that KBCM has the potential to improve upon summary writing in fostering cognitive presence, which includes triggering event, exploration, and integration, key indicators of advanced learning in the COI model. Results of the study indicate that KBCM is more effective for fostering exploration and encouraging transitions from integration to resolution compared to the traditional summary writing. This study does the hard work of advancing our understanding of a longstanding problem, how to promote significant learning through the lens of cognitive presence in the community of inquiry model.

The next paper in this section is “The Relationships Between Adolescents’ Academic Self-Regulation, Motivational Strategies, and Academic Achievement in Distance Education Process” by Tuğçe Gür of the Child Development and Education Department, Hacettepe University, and the Child Development Polyclinic, Turkey; and E. Helin Yaban of the Department of Learning, Motivation and Emotion at FernUniversität, Hagen, Germany. This study investigates a population gap in online education as most research is conducted on students in higher education settings, whereas this work examined self-regulated learning in a secondary educational context. Working with a sample of 311 adolescents attending public high schools from different socioeconomic levels in the Ankara, Turkey, the authors concluded that that the effect of self-regulation on adolescents’ academic achievement in distance education was mediated through motivational strategies. These findings highlight the significance of motivational processes in adolescent academic success, shedding light on critical skills for thriving in distance education for this age cohort.

In “Synchronous Online Learning: Why Some Students Don’t Actively Participate” authors Helen Donelan, Karen Kear, Jon Rosewell, Ale Okada, Kieron Sheehy, Kevin Amor, Carol Edwards, Allan Mooney, Paige Cuffe and Tracey Elder of The Open University, UK analyzed data from more than 600 students and nearly 200 faculty to investigate lack of activity in synchronous online learning sessions. Survey data indicated that lack of confidence is a significant factor affecting student participation and that more than a third of students indicated that they experience stress when expected to take part actively in “live” tutorials. The study recommends various tools to lower stress levels including those that take the spotlight off individual students.

In “Teacher—Student Relationships in an Online Graduate Program: A Phenomenological Analysis” authors Eric Belt of the University of Maryland, Baltimore, and Norm Friesen, Patrick R. Lowenthal, Chareen Snelson, State University of Boise State University argue that that students who perceive a sense of connectedness or closeness with teachers are more confident, less anxious, and perform better academically. However, less is known about how closeness develops in online environments, though the importance of relationships between faculty and students, especially at the doctoral level, can be crucial to student success. Consequently, the principal research question of this phenomenological study was: How do doctoral students experience the teacher–student relationship in a fully online doctoral program? Data for the study included transcripts from seven semi-structured interviews that revealed four categories that characterize the nature of faculty-student relationships. The paper provides thick description of the lived experience in detailing these four aspects including direct and indirect communication, student self-relational understanding, and teacher persona. The study explored how the emotional context of teaching interactions shapes the dynamics of teacher–student relationships in a fully online doctoral program, including moments of closeness, ambiguity, and perceived distance, adding crucial detail to our understanding of connections between online faculty and their doctoral students.

In the next paper in this issue is "Enhancing Online STEM Education: Impacts of Pre-Released Exam Materials and Remote Proctoring" by Mėta M. Landys of Oregon State University, the author provides evidence to suggest that online STEM environments can result in higher levels of attrition, especially among historically underrepresented classes of students in higher education. High-stakes timed testing situations can be partly to blame for this situation, leading the author to conclude that remedies found effective in used in classroom learning (i.e. pre-release of exam materials) might have similar benefits online. The author also investigates the use of remote proctors. The paper therefore seeks to answer three related research questions, "Do pre-released exams improve exam performance and socio-psychological factors relevant to the success of online STEM students?" and: "Do pre-released exams help reduce disparities in educational outcomes for students historically underrepresented in STEM?" and: "How do remote online proctors influence exam performance and key socio-psychological factors in online STEM students?" The answers to these questions are somewhat surprising and add nuanced insight into our knowledge of online assessment.

The final paper in this issue is "Revisiting the Interrelationships Between Social and Cognitive Presences in Asynchronous Online Courses: Insights from Epistemic Network Analysis" by Liu Dong, Chi-Jia Hsieh, Sunnie Lee Watson and Victoria L. Lowell of Purdue University, and Ji Hyun Yu of the University of North Texas. The authors note that learning in online environments is dependent on the effectiveness of asynchronous online discussions (AODs) and that analysis of online learning in AODs through the lens of the popular Community of Inquiry framework is somewhat methodologically limited. While many studies have investigated the interrelationships among the three presences in Community of Inquiry (CoI) studies, most rely on self-report CoI surveys and quantitative content analysis of discussion posts. However, these methods do not capture detailed information related to the dynamic interrelationships and the variations in interaction patterns. The purpose of this study is therefore to apply Epistemic Network Analysis (ENA) to investigate the dynamic interrelationships among CoI presences, especially social and cognitive presences, in AODs across classes with varying levels of activity and different instructional strategies. Accordingly, this study contributes to the growing body of CoI research that uses advanced learning analytics and offers practical insights for enhancing the design and facilitation of online discussions.

Special thanks to Dr. Patsy Moskal of the University of Central Florida for her work in identifying and curating papers in the OLC Conferences section. Also, big thanks to our new Managing Editor Carrie Miller, and post-doctoral Editor extraordinaire, Dara Tafazoli who provided invaluable support in advancing both the special issue as well as the wider work of the journal more generally. We also thank the authors, reviewers, and the entire OLC/OLJ editorial team for their myriad contributions to this issue.

Interaction-Oriented Instructional Practices Show Promise in Enhancing Overall Performance and Narrowing Racial Achievement Gaps in College Online Courses

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Abstract

This study examines the impact of interaction-oriented instructional practices on student performance and racial achievement gaps in college online courses. By linking survey data from almost 400 online instructors with student-level transcript records at a state community college system, we examine the relationship between six domains of interaction-oriented practices and student concurrent and downstream success outcomes. Our results reveal a strong positive association between the overall usage of interaction-oriented practices and course completion rates, where instructor–student course managerial interactions play a particularly critical role in narrowing racial performance gaps. These results highlight the potential for targeted instructional strategies to foster equitable outcomes in online education and provide actionable insights for practitioners to enhance engagement and inclusivity in digital learning environments.

Keywords: online learning, evidence-based teaching, course completion, higher education

Xu, D., Li, Q., Orona, G. A., & Zhou, X. (2025). Interaction–oriented instructional practices show promise in enhancing overall performance and narrowing racial achievement gaps in college online courses. *Online Learning, 29*(3), 211-235. https://doi.org.10.24059/olj.v29i3.4626

Introduction

Notable theories of online teaching and learning have converged on the crucial role effective interactions play in promoting student engagement, satisfaction, and success in a virtual learning environment (Anderson, 2004; Bolliger & Martin, 2018; Garrison et al., 2003; Moore, 1989). Mounting evidence consistently suggests that in semester-length online courses, where physical separation can lead to feelings of isolation and disengagement, effective interactions foster a sense of community and belonging among students, which is essential for maintaining motivation and engagement (e.g., Bork & Rucks–Ahidiana, 2013; Dixson, 2015; Garrison & Cleveland-Innes, 2005; Gherghel et al., 2023; Martin & Bolliger, 2018; Jaggars & Xu, 2016). Moreover, success in online learning requires a high level of self-regulation, time management, and digital literacy. Yet, students from under-resourced educational backgrounds may have had fewer opportunities to develop these skills (Jaggars & Xu, 2016; Martin et al., 2019). These students can particularly benefit from the structure and guidance provided through frequent and meaningful interactions with instructors (Glazier, 2016; Ladson-Billings, 1995; Bolliger & Martin, 2018), as well as collaborative activities through peer interactions (Alqurashi, 2019; Richardson et al., 2017). As a result, effective interactions have the potential to serve as a crucial mechanism for addressing equity gaps in online learning at open-access institutions, such as community colleges, which serve a large proportion of students from historically underrepresented groups (Jenkins & Fink, 2015; Ramos & Sifuentez, 2021).

Can interaction-oriented teaching practices lead to better student outcomes and reduce racial achievement gaps at open-access institutions? If so, are practices that promote certain types of interaction more helpful than others? Answers to these questions are fundamental to improving online learning and reducing equity gaps at scale. While a growing number of studies have explored and shown positive effects of interaction-oriented practices on student performance and engagement outcomes (e.g., Glazier, 2016; Johnson & Mejia, 2014; Wei et al., 2015), much of the existing evidence comes from small-scale studies conducted at four-year universities, which limits the applicability to open-access institutions. Nor does the current literature explicitly examine the potential of interaction-oriented practices to address learning gaps among historically marginalized groups.

This paper addresses these research gaps by collecting online instructors' use of interaction-oriented teaching practices through an NSF-funded survey of 369 online instructors in fall 2019 at a state community college system that includes almost two dozen institutions. The survey draws on a comprehensive person-purpose framework developed by Orona et al. (2022), which categorizes interaction-oriented practices in online learning into six sub-domains defined by the intersections between two dimensions: (i) the type of interaction that the instructional practice aims to promote (e.g., between peers or between instructors and students), as well as (ii) the pedagogical purpose of a given interaction (academic, social, managerial). We further link these practices with student course performance data that include close to 10,000 student course enrollment records to directly examine the empirical association between interaction-oriented practices and student course outcomes. Drawing on this unique dataset, we address the following research questions:

1. Can interaction-oriented teaching practices lead to better student course outcomes and reduce racial achievement gaps in community colleges?

2. Are interaction-oriented teaching practices associated with student subsequent college enrollment?

3. Are certain types of interaction-oriented practices more effective than others in promoting student course performance and subsequent college enrollment?

Our results reveal a strong positive correlation between overall usage of interaction-oriented practices and student course outcomes. Additional analyses that further break down practices into different domains based on the purpose of the interaction indicate that practices that aim to foster instructor–student course management interactions, student–student academic interactions, and student–student social interactions are particularly effective in promoting online course success. Additionally, instructor–student interactions regarding course management have a significant impact on reducing achievement gaps between underrepresented minority (URM) and non-URM students in the concurrent course and promote subsequent college persistence for both groups. While our sample includes courses prior to the COVID-19 pandemic and the online learning landscape may have evolved post-COVID-19, the foundational strategies for effective interaction identified in this study remain highly relevant. These findings provide a baseline for understanding and improving online teaching practices, offering evidence-based strategies that can be adapted to current and future online learning environments. As online education continues to be a significant component of higher education, these insights help educators develop and refine their approaches to enhance student engagement and success in the post-pandemic era.

Literature Review

Challenges Associated with Online Learning and Racial Achievement Gaps

Online learning has grown rapidly in higher education over the past two decades (Xu & Xu, 2020). Despite its expansion, there remains a strong need to improve its effectiveness. Research indicates that fully online courses often result in lower success rates compared to face-to-face courses at open-access institutions, including lower course completion, reduced likelihood of passing, and lower overall grades (Bettinger et al., 2017; Hart et al., 2018; Johnson & Mejia, 2014; Streich, 2014), as well as compromised downstream outcomes, such as increased course repetition and decreased college persistence (Bettinger et al., 2017; Hart et al., 2018; Huntington-Klein et al., 2017; Krieg & Henson, 2016; Shea & Bidjerano, 2018).

Several factors could contribute to the lower performance associated with online learning. One primary challenge is the greater difficulty in achieving effective interactions, which are crucial for student engagement and success (Moore et al., 2011). Researchers and practitioners consistently point out that effective interactions have a critical impact on student online learning process, satisfaction, and performance (Jaggars & Xu, 2016; Jung et al., 2002; Orona et al., 2022; Swan, 2002; Wanstreet, 2006). However, the physical separation inherent in online learning makes spontaneous interaction with peers and instructors difficult. This may not only hinder students' ability to keep up with course requirements, but can also lead to feelings of isolation and disengagement (Bolliger & Martin, 2018).

While creating meaningful and effective interactions is beneficial to all online students, it is especially important for students from marginalized groups. These students often have limited opportunities to develop their time management skills. Thus, they can benefit greatly from the structure and guidance provided through frequent and meaningful interactions with instructors, which help them stay organized, understand expectations, and keep up with coursework (Bolliger & Martin, 2018; Glazier, 2016; Ladson-Billings, 1995). Moreover, students from marginalized groups often rely more heavily on a sense of community and peer support to navigate the academic challenges they face. Accordingly, insufficient opportunities to interact with peers and the lack of a sense of community in online learning environments can exacerbate feelings of loneliness and isolation among students from marginalized groups (Garrison & Cleveland-Innes, 2005; Tinto, 1993), which can lead to poorer academic outcomes (Garrison & Cleveland-Innes, 2005).

Indeed, current research consistently reveals that the performance gaps between students of different racial and socioeconomic backgrounds have widened in online learning environments (e.g., Johnson & Mejia, 2014; Xu & Jaggars, 2014). The performance decrements and exacerbated equity gaps associated with online learning were also commonly reported during the pandemic, suggesting that the challenges of fully online courses are likely to persist in the post-COVID era (e.g., Adnan & Anwar, 2020). A number of interview- and survey-based studies found that students who struggle in online courses consistently attribute a lack of connection with the instructor and peers as an important barrier to success (Bambara et al., 2009; Jaggars & Xu, 2016).

A Conceptual Framework for Interaction-oriented Practices in Online Instruction

In view of the critical role of interaction, much effort has been devoted to defining and understanding the various forms of interaction in an online learning environment. The literature has pointed out that online interaction is not unidimensional. In particular, existing research has described interaction in an online learning environment from two perspectives: the participants involved in the interaction and the instructional purpose served by the interaction. Below, we first summarize the literature for each perspective and then explain how they both contribute to the framework for capturing interaction-oriented practices in our study.

The first strand of research differentiates three types of interaction based on the participants involved in it, including student–instructor interaction, student–student interaction, and student–content interaction (e.g., Anderson, 2004; Bolliger & Martin, 2018; Moore, 1989; Wagner, 1998). For example, Moore's theory of online interaction, which is a predominant framework in distance education, suggests that student intellectual interaction with course content is a defining characteristic of education, as it results in changes in students' knowledge, perceptions, and skills. In addition, student–instructor interaction is essential for instructors to deliver course content, facilitate knowledge and skill acquisition, and provide additional support based on student needs. Finally, student–student interaction provides a valuable source of learning by promoting critical thinking and deepening students' understanding (Moore, 1989).

The second strand of literature, exemplified by the widely known community of inquiry (CoI) model, focuses on instructional goals served by interaction. Specifically, these frameworks suggest that online interaction serves three primary goals: academic, social, and managerial (Berge, 1995; Quality Matters, 2014; 2018). Academic interaction refers to activities where students construct meaning of the course content, which is critical for student learning of knowledge and skills. Social interaction refers to social exchanges among participants in the learning community, which allow them to be projected as “real people” and socially connected with each other. Managerial interaction refers to the organization and management of course expectations, policies, and details (e.g., deadlines).

Both strands of literature capture critical aspects of interaction in online learning, and prior studies have integrated both perspectives into more nuanced frameworks. For example, drawing on both lines of literature, Orona et al. (2022) proposed a person–purpose framework that categorizes interaction into six sub-domains defined by the intersections between the entities involved and the instructional goal. We draw on this framework and therefore explain each of the components in more detail below:

First, *instructor–student academic interaction (ISAI)* refers to instances where instructors communicate with students regarding the knowledge or skills to be learned in a course. Examples include an instructor answering content-related questions in synchronous sessions, discussion boards, and/or providing feedback on assignments. Second, *instructor–student social interaction (ISSI)* also happens between the instructor and the students, but instead focuses on social connections rather than the academic content. Third, *instructor–student course managerial interaction (ISCMI)* is when instructors communicate with students about course policy, schedule, and other logistical issues, as well as to help students stay on track. Examples include instructors using various strategies to keep students on track, such as posting a “due date checklist” regularly, sending regular announcements and reminders, or reaching out to individual students who are missing assignments or show signs of risk, such as a lack of activities or low grades. The fourth type of interaction is *student–student academic interaction (SSAI), which* happens between students and is related to the content of the course. An example of student–student academic interaction would be collaborative work, such as group assignments or peer review. The fifth type of interaction is *student–student social interaction (SSSI),* which also happens between students but is not directly related to the course content. Examples include asking students to add personal profiles to the learning management system (LMS) or inviting students to introduce themselves in an engaging way. The last type of interaction is *student–content academic interaction (SCAI)* and typically pivots on improving student meaningful engagement with course materials and thus their understanding of the course content. Some example strategies to promote student–content academic interaction include providing lectures through video in addition to PowerPoints, encouraging students to do self-testing, and encouraging students to reflect on their learning.

Interaction and Student Outcomes

Several studies have shed light on the positive correlation between various forms of interaction and online student outcomes. For instance, Wei et al. (2015) found that increased student interaction with both course content and management tools led to improved performance on exams, discussion boards, and group projects. Glazier (2016) found that students who engaged in interpersonal rapport-building exercises with their instructors, such as personalized communication, earned higher grades and were less likely to drop out. Additionally, Lee and Recker (2021) conducted a comprehensive analysis of data from 72 online university math courses and concluded that instructor presence in discussion boards positively impacted student grades.

Similar benefits were also reported for peer interactions. For example, Kurucay and Inan (2017) found that students who interacted more with their peers achieved higher grades than those with limited peer interaction. Shelton et al. (2017) demonstrated that the frequency of interaction between peers strongly predicted student persistence in online courses. Using a quasi-experimental design, Bettinger et al. (2016) found that personalized communication between students, such as responding specifically to another student's discussion board posts and addressing them by name, enhances student grades.

Research has also provided insights into the potential mechanisms through which interaction is critical to students' academic performance. For example, student engagement is widely recognized as a key determinant of success in college (Bowden et al., 2019; Chen et al., 2010; Marti, 2008; Soffer & Cohen, 2019), and survey-based research indicates that student–student and instructor–student interactions are critical to promoting student engagement in online courses (Cole et al., 2021; Dixson, 2010; Kordrostami & Seitz, 2022; Miao et al., 2022; Van Wart et al., 2020; Wang et al., 2022). For instance, in a large-scale psychometric analysis, Van Wart et al. (2020) found that students valued several key interaction practices that promote teaching presence, online social comfort, interactive modality, and social presence. In a similar vein, Martin et al. (2018) found that students perceived instructors' timely responses and personal introductions as helpful practices to support their learning engagement.

A number of studies have conducted formal mediation analysis to explore how interaction indirectly influences key student outcomes, such as learning, grades, and satisfaction, through engagement as an important mediator. For instance, Gray and DiLoreto (2016) utilized structural equation modeling to assess how learner interaction and instructor presence impact students' perceived learning. They found that both types of interaction directly predicted student engagement, which, in turn, significantly improved perceived learning. Additionally, they found statistically significant indirect effects, which indicates that interaction types and instructor presence affected these outcomes by enhancing engagement. Kucuk and Richardson (2019) adopted a similar approach and explored the effects of various interactive practices, including teaching presence, social presence, and cognitive presence, on student satisfaction while explicitly examining engagement as a mediator. Their study provided additional support that interactive practices indirectly shape student satisfaction by enhancing engagement.

Limitations of the Existing Studies and the Unique Contribution of the Present Study

While an extensive body of research has highlighted the importance of interaction-oriented practices in online courses, there are still substantial research gaps that warrant further investigation. First, much of the current research has been small-scale studies conducted at four–year research university settings, and it is unclear to what extent these findings may speak to online courses at community colleges that serve a diverse student body with varying levels of digital literacy. Furthermore, existing research has predominantly focused on the overall relationship between interaction-oriented teaching practices and student outcomes, while there is limited knowledge of how these practices might address learning gaps among historically marginalized groups. Additionally, previous studies seldom incorporate a comprehensive framework that includes the diverse types of interactions and distinguish them by their pedagogical goals. Consequently, while it is widely acknowledged that interaction contributes to the educational experience in online courses, there is limited understanding of the relative importance of specific practices. For instance, student–student interactions aimed at social engagement, such as discussion forums or peer group chats, may have different effects on student performance compared to those focused on academic collaboration, such as problem-solving tasks or group projects. Accordingly, a framework that incorporates and considers the nuanced distinctions between practices targeting different types of interactions will be able to provide more practical insights.

Our study aims to address several critical gaps in the existing literature on online education. First, our investigation focuses on community college online courses, a setting that has been relatively understudied despite its increasing importance in higher education. To achieve a comprehensive understanding of interaction-oriented teaching practices, we draw on the person–purpose framework by Orona et al. (2022) that integrates the diverse types of interaction that take place in online courses. Furthermore, different from previous studies that typically focus on a handful of online courses, we collected instructional practices through a large-scale survey that involves nearly 400 instructors linked with around 10,000 student course enrollment records from almost two dozen community colleges. To our knowledge, this unique dataset makes our study one of the most extensive investigations into the associations between interaction-oriented teaching practices and student outcomes in higher education research. Finally, our study goes beyond merely assessing the overall impact of these practices on student concurrent course outcomes, but also explores how these practices influence critical downstream outcomes, such as college persistence, as well as the role of these practices in mitigating equity gaps among historically marginalized groups.

Methods

Setting, Sample, and Data Sources

Our study was conducted at a state community college system (SCCS) in the southeastern United States that includes more than 20 institutions. Altogether, these institutions serve more than 200,000 students. In the fall term of 2019, all instructors who taught at least one online course at SCCS in the last three years were invited to respond to a survey that collects information on instructors' use of interaction-oriented teaching practices and their perceptions related to the use of these practices. The survey includes a total of 34 questions on instructional practices. It was developed based on predominant theoretical frameworks of effective online instruction (e.g., Anderson, 2004; Berge, 1995; Moore, 1989) and was further refined drawing on the authors' prior work (Orona et al., 2022).

Participants were asked at the beginning of the survey to specify the course they would be referencing when answering subsequent questions regarding their teaching practices. All the questions were framed to retrospectively elicit instructors' frequency of using each type of interaction-oriented practices in the specified online course. At the end of the term, SCCS provided information on student demographic characteristics as well as their college transcript records, which were linked to the survey data.

Among the roughly 2,000 instructors contacted, a total of 369 instructors completed the survey and were successfully matched with the college administrative data, yielding an approximately 15% response rate. These instructors taught 88 different courses which enrolled 9,478 unique students. Table 1 provides the characteristics of these instructors (e.g., 71 percent were female, 91 percent identified as White, and 54 percent were employed full-time), their students (e.g., 67% were female and 31% identified as URM), and their courses (e.g., 20% were Math courses). Some students were enrolled in multiple courses taught by this sample of instructors, resulting in N = 10,107 enrollment records with an overall pass rate of 70%. In analyses focusing on letter grades, we excluded withdrawal, incomplete, and pass/fail grades, resulting in N = 8,959 enrollment records.

Table 1

Sample Summary Statistics

	N	M	SD
Panel A: Instructor characteristics			
Female instructor	369	0.71	0.46
White instructor	369	0.91	0.28
Instructor is full time	369	0.54	0.50
OL course built from scratch	369	0.31	0.46
OL course built from F2F	369	0.43	0.50
OL course built from other	369	0.02	0.15
Taught F2F version	369	0.82	0.38
PhD/Professional Degree	369	0.29	0.45
Masters	369	0.66	0.47
Years teaching in system	369	11.83	7.64
Overall years teaching	369	14.64	9.06
Taught 1 online course	369	0.13	0.33
Taught 2 to 5 online courses	369	0.51	0.50
Taught 6 to 10 online courses	369	0.13	0.33
Primarily teaches OL courses	369	0.27	0.44
Teaching is primary career	369	0.75	0.43
Panel B: Student characteristics			
Female	9450	0.67	0.47
Age during term	9478	25.42	8.21
Full-time	9478	0.44	0.49
First-Generation	9478	0.27	0.44

First-Term in college	9478	0.17	0.38
URM	9478	0.31	0.46
Grade in class	8411	2.72	1.42
Pass C or above	9468	0.70	0.45
Panel C: Course characteristics			
Natural Science	88	0.06	0.19
Humanities	88	0.08	0.25
Social Science	88	0.13	0.29
Math	88	0.20	0.39
English	88	0.11	0.29
Interdisciplinary Studies	88	0.04	0.19
Physical Education	88	0.02	0.11
Foreign language	88	0.01	0.04
Art	88	0.02	0.10
Occupation field 1	88	0.09	0.25
Occupation field 2	88	0.06	0.21
Occupation field 3	88	0.08	0.23
Occupation field 4	88	0.03	0.14
Occupation field 5	88	0.02	0.10
Occupation field 6	88	0.06	0.19

Notes. Examples of occupational fields include healthcare, information technology (IT), and manufacturing.

Data Collection and Analysis

Instructional Practices

The survey collected information on six categories of practices depending on the pedagogical purpose of the interactions: (i) instructor–student academic interaction (ISAI), (ii) instructor–student social interaction (ISSI), (iii) instructor–student course managerial interaction (ISCMI), (iv) student–student academic interaction (SSAI), (v) student–student social interaction (SSSI), and (vi) student–content academic interaction (SCAI). Table 2 provides specific survey items for each category of practice, the sample average for each item, and the average across items within each category ("subdomain scores"). To capture an overall interaction-oriented practice (IOP) score across all six categories, we standardized the six subdomain scores, summed them together, and standardized them again, resulting in an index with a mean of 0 and a standard deviation of 1.

Student Course Performance Outcomes

We focused on two course performance measures: (i) course completion was a dichotomous variable, measuring whether a student successfully completed a course with a grade that was C or higher, as opposed to either receiving a grade that was below C or withdrawing from the course; (ii) course grade was measured on a 0 to 4 grading scale among students who persisted through the end of the course and had a valid course grade.

Downstream Outcomes

Considering that learning experiences in a course may influence a student's overall engagement with a college and subsequent enrollment decisions, we also examined students' college persistence as a downstream outcome, measured as students' persistence into the following term in college, as opposed to dropping out of college or stopping out. College persistence is imperative when it comes to economic opportunity, especially among disadvantaged populations. Methodologically, downstream outcomes also help to address the concern that course outcome measures, such as course grades, may be subject to instructor leniency in grading criteria.

Model Specification

In view of the hierarchical structure of the data where students were nested within courses, we used multilevel regression analyses that included both student-level and class-level controls to examine the relationship between interaction-oriented teaching practices and student outcomes. Taking the overall interaction-oriented practice (IOP) score as an example, the model writes as follows:

$$Y_{ij} = \beta_{0j} + \beta_{1j}URM_{ij} + std_{ij} + \xi_{ij} \qquad (1)$$

$$Where\ \beta_{0j} = \gamma_{01}IOP_j + tch_j + crs_j + sub_s + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10} \qquad (2)$$

$$Y_{ij} = \gamma_{00} + \gamma_{01}IOP_j + \gamma_{10}URM_{ij} + \gamma_{11}IOP_j * URM_{ij} + tch_j + crs_j + std_{ij} + \mu_{0j} + \xi_{ij} \qquad (3)$$

The student-level regression (Equation 1) examines whether the course performance Y_{ij} of student *i* in course *j* is associated with URM status (URM_{ij}), while controlling for other student-level variables (std_{ij}), such as age and first-generation student status. The course-level regression (Equation 2) further models the intercept β_{0j} of Equation 1 (i.e., the average course performance) as a function of observable course-level characteristics, including the overall interaction-oriented practice score (IOP_j), teacher characteristics (tch_j), course characteristics (crs_j), and subject fixed effects (sub_s). The vector of course characteristics (crs_j) includes all course-level variables listed in Table 1. In addition, we further constructed a "course difficulty measure" that was calculated as the average student course grades in face-to-face sections of a given course taught by any instructor in the past three years to address the possibility that courses in the same subject area may still vary in the level of difficulty. Substituting Equation 2 into Equation 1 yields the multilevel model. We further included an interaction term between the IOP score and student URM status to allow the relationship between IOP and student outcomes to vary by URM status in Equation 3. Accordingly, the coefficient r_{01} captures the relationship between IOP score and performance outcomes for non–URM students, while r_{11} captures the interaction effect — the difference in this relationship between URM and non-URM students. Thus, the sum of r_{01} and r_{11} captures the relationship between the IOP score and performance outcomes for URM students.

Results

How Are Instructors Engaged in Interaction-Oriented Teaching Practices?

We first describe the extent to which instructors were engaged in various interaction-oriented teaching practices. Table 2 suggests instructors prioritize instructor–student interactions over student–student interaction. For example, both the ISAI and SSAI use the 5-point Likert scale of 1 = "Never" and 5 = "Every Week." An ISAI of 3.66 suggests that, on average, instructors in our sample engage in instructional practices involving instructor–student academic interactions approximately between once and every two weeks, while an SSAI of 1.80 implies that instructional practices focused on student–student academic interactions between never and only once during a semester.

Within a specific domain, there are substantial variations in instructors' engagement with specific practices. For example, in the domain of instructor–student academic interaction (ISAI), the most widely implemented practice is "Providing feedback (beyond a grade) on student work" (M = 4.57, or every week or two), while the least is "Interacting with students using synchronous media (e.g., Skype or other video conference tools)" (M = 2.06, or about once a semester).

Table 2

Summary Statistics of Interaction-Oriented Practices

Practice	Full Item	M	SD
Panel A: Instructor–Student Interaction-oriented Practices			
ISAI	**Instructor–Student Academic Interaction (5 = Every Week)**	3.66	0.77
ISAI_1	Providing face–to–face office hours for students to ask academic–related questions	3.47	1.82
ISAI_2	Providing feedback beyond a grade on student work	4.57	0.84
ISAI_3	Directly responding to student postings regarding academic content on discussion forums	4.27	1.23
ISAI_4	Interacting with students using synchronous media e.g., Skype or other video conference tools	2.06	1.45
ISAI_5	Interacting with students using asynchronous media discussion boards, etc.	4.27	1.21
ISSI	**Instructor–Student Social Interaction (1 = Yes)**	0.83	0.25
ISSI_1	I introduced myself to my students via audio, video, or images excluding emails only.	0.79	0.41
ISSI_2	I tried to make my personality come through in my communication with students.	0.97	0.17
ISSI_3	I shared aspects of my hobbies, interests, pets, and other aspects of my life with my students.	0.85	0.35
ISCMI	**Instructor–Student Course Managerial Interaction (5 = Very Frequently)**	3.59	0.40
ISCMI_1	Sending announcements or reminders to students about course content and assignments e.g., weekly check–ins	4.84	0.47

ISCMI_2	When I gave a course assignment, I provided explicit grading criteria e.g., rubric.	4.36	0.91
ISCMI_3	When I recognized struggling students, I offered additional support e.g., study tips, resources, and advice.	4.02	0.84
ISCMI_4	When a student asked a question about logistics and course requirements, I quickly responded within 24 hours.	4.70	0.50
ISCMI_5	Provide opportunities for students to give feedback about the course	2.85	1.22
ISCMI_6	provided explicit grading criteria e.g., rubric for discussion forum assignments.	0.88	0.33
Panel B: Student–Student Interaction-oriented Practices			
SSAI	**Student–Student Academic Interaction (5 = Every Week)**	1.80	0.90
SSAI_1	How often did you require students to rate the individual performance of team members on projects?	1.44	0.93
SSAI_2	How often did you provide collaborative work e.g., group assignments, reports	1.83	1.19
SSAI_3	How often did you assign students to interact with peers through student presentations asynchronously or synchronously?	2.22	1.51
SSSI	**Student–Student Social Interaction (1 = Yes)**	0.64	0.33
SSSI_1	I encouraged my online students to get to know each other more than what is required for assignments or tasks.	0.63	0.48
SSSI_2	I asked my students to introduce themselves using an icebreaker discussion.	0.88	0.33
SSSI_3	I provide a virtual lounge where students can meet informally to share common interests.	0.49	0.50
Panel C: Student–Content Interaction-oriented Practices			
SCAI	**Items 1–7 (5 = “Very Frequently”) and 8–13 (5 = “Weekly”)**	2.70	0.40
SCAI_1	Explicitly connected new lessons with prior content	4.13	0.78
SCAI_2	Summarized the big ideas in the course	4.25	0.81
SCAI_3	Emphasized important information/exam content	4.39	0.72
SCAI_4	Emphasized application of facts, theories, or methods to practical problems or new situations	4.16	0.80
SCAI_5	Emphasized analysis of an idea, experience, or line of reasoning in depth by examining its parts	3.95	0.95
SCAI_6	Emphasized evaluation of a point of view, decision, or information source	3.82	1.02
SCAI_7	Emphasized the formation of a new idea or understanding from various pieces of information	3.92	0.89
SCAI_8	Provided quizzes or problem sets	4.14	1.31
SCAI_9	I encouraged my students to do self–testing.	0.66	0.47
SCAI_10	encouraged my students to make outlines.	0.54	0.50
SCAI_11	I encouraged my students to make diagrams.	0.31	0.46
SCAI_12	encouraged my students to use flashcards.	0.38	0.49
SCAI_13	I encouraged my students to reflect on their learning.	0.78	0.41

Note. ISAI, SSAI, and SCAI 8–13 items used a 5–point scale of 1 = "Never," 2= "Once," 3 = "Three times in total during the semester," 4 = "Every two weeks," and 5 = "Every Week." ISSI and SSSI items were binary, with 0 = "No" and 1 = "Yes." ISCMI and SCAI 1–7 items used a 5–point scale of 1 = "Never," 2= "Rarely," 3 = "Occasionally," 4 = "Frequently," and 5 = "Very Frequently."

Are Courses with Higher Overall IOP Scores Associated with Better Student Course Performance Outcomes and Smaller Racial Gaps?

To contextualize the role of interaction-oriented practices in shaping student outcomes, we first used our hierarchical regression models (Equation 3) to predict course grades, completion rates, and subsequent enrollment with different values of IOP indices. Figure 1 visualizes these relationships and indicates that higher IOP scores are generally associated with better student outcomes. In addition, although there is a consistent performance gap between URM and non-URM students, URM students seem to show a steeper increase in predicted course completion and subsequent enrollment as the level of IOP increases.

Figure 1

Predicted Student Outcomes by Different IOP (Interaction-oriented Practice) Scores and URM Status

To formally test whether these observed patterns reflect statistically significant effects, Table 3 presents estimates based on Equation 3. The results indicate that there were significant gaps between URM and non-URM students across all three outcome measures. Specifically, URM students, on average, had lower grade points by 0.36 standard deviations ($p < .001$), had a reduced probability of passing the course with a grade of C or higher by 13 percentage points ($p < .001$), and were 3 percentage points less likely to stay enrolled in college subsequently ($p < .05$). Students taking a course with high practice instructors showed improved course outcomes.

For each unit increase in the IOP index, students, on average, experienced a 0.05 standard deviation boost in course grades (*p* < *.05*) and were more likely to pass a course with C or above by 2 percentage points (*b* = *.02, p* < *.05*). Yet, the interaction terms are consistently non-significant, indicating that URM and non-URM benefit similarly from higher levels of interaction practices.

Table 3

Estimated Effects of IOP (Interaction-Oriented Practice) on Student Outcomes by URM Status

	Grade Points	Pass (C or above)	Subsequent Enrollment
URM	-0.36 (0.02)***	-0.13 (0.01)***	-0.03 (0.01)*
IOP Index	0.05 (0.02)*	0.02 (0.01)*	0.01 (0.01)
URM*IOP Index	0.01 (0.02)	0.01(0.01)	0.00 (0.01)
N	8,854	9,993	10,054

Note. Grade points are z–score standardized. Pass (C or above) is coded 0/1. IOP = Interaction-oriented Practice. URM = Underrepresented minority. Standard errors in parentheses. + p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Are Specific Subdomains of IOP Related to Course Outcomes and Racial Gaps More Strongly?

Table 4 further displays the associations between each subdomain of IOP and student outcomes. The table also presents interaction terms between each subdomain and URM status to assess whether the effects of a given subdomain vary by student URM status. Student–student social interaction (SSSI, *b* = .02, *p* < .05) and student–student academic interaction (SSAI, *b* = *.02, p* < *.05*) show modest but significant benefits for students' probability of passing a course with a C or higher. In addition, ISCMI shows a positive relationship with subsequent term enrollment (*b* = *.02, p* < *.05*), indicating that when instructors were engaged more actively in instructor–student course managerial interactions, students, on average, were more likely to persist into the following term.

The interaction terms between URM status and IOP subdomains generally remain non–significant. This suggests that students benefited from higher engagement in interaction-oriented practices in a similar way regardless of their URM status. However, one notable exception is the interaction between ISCMI (instructor–student course managerial interaction) and URM status, which is positively and significantly related to both course grades (*b* = *.07, p* < *.05*) and course completion (*b* = *.03, p* < *.05*). This suggests that, compared to non-URM students, URM students benefited significantly more from instructor–student course managerial interactions. Accordingly, when instructors were engaged with higher levels of ISCMI, such as sending regular check-ins to keep students on track or proactively identifying students who were struggling and reaching out to them, the performance gaps between URM and non-URM students became narrower.

Table 4

Estimated Effects of Subdomains of IOP (Interaction-Oriented Practice) on Student Outcomes by URM Status

	Grade Points	Pass (C or above)	Subsequent Enrollment
URM	-0.35 (0.02)***	-0.13 (0.01)***	-0.02 (0.01)*
ISAI	0.01 (0.02)	-0.01 (0.01)	-0.00 (0.01)
ISCMI	0.00 (0.02)	-0.00 (0.01)	0.02 (0.01)*
ISSI	0.02 (0.02)	0.00 (0.01)	-0.00 (0.01)
SSAI	0.01 (0.02)	0.02 (0.01)*	0.02 (0.01)
SSSI	0.04 (0.02)	0.02 (0.01)*	-0.00 (0.01)
SCAI	0.01 (0.02)	0.00 (0.01)	-0.02 (0.01)+
URM*ISAI	-0.04 (0.03)	-0.01 (0.01)	0.01 (0.01)
URM*ISCMI	0.07 (0.03)*	0.03 (0.01)*	-0.00 (0.01)
URM*ISSI	-0.03 (0.03)	-0.01 (0.01)	-0.03 (0.01)*
URM*SSAI	0.03 (0.02)	0.01 (0.01)	0.00 (0.01)
URM*SSSI	–0.00 (0.03)	–0.00 (0.01)	0.00 (0.01)
URM*SCAI	–0.02 (0.03)	–0.00 (0.01)	0.02 (0.01)
N	8,854	9,993	10,054

Note. Grade points are z–score standardized. Pass (C or above) is coded 0/1. ISAI = instructor–student academic interaction; ISSI = instructor–student social interaction; ISCMI = instructor–student course managerial interaction. SSAI = student–student academic interaction; SSSI = student–student social interaction. SCAI = student–content academic interaction. URM = Underrepresented minority. Standard errors in parentheses. + p<0.1 * p<0.05 ** p<0.010 *** p<0.001

To further contextualize the interactional effects of instructor–student course managerial interactions on course outcomes, we used our model to predict course grades and completion rates across different values of ISCMI for URM and non–URM students, respectively. Results presented in Figure 2 visually demonstrate how increased use of ISCMI reduced the racial gaps in course performance. Specifically, as instructors engaged more in ISCMI practices, non–URM students' course performance remained relatively stable. In contrast, URM students experienced strong improvement in both course grades and completion rates. As a result, the racial gaps in course outcomes progressively narrowed. At high levels of ISCMI (two standard deviations above the mean), the model predicts that the racial performance gap is nearly closed.

Figure 2

Predicted Student Outcomes by Different ISCMI (Instructor–Student Course Managerial Interactions) Scores and URM Status

In view of the potential of Instructor–Student Course Managerial Interaction (ISCMI) practices in reducing racial equity gaps, we further disentangle which specific ISCMI practices drive these effects. To achieve this goal, we replaced the ISCMI index score with a vector of six individual ISCMI practices listed in Table 2. We then included these six variables and their interactions with URM status in the model. Importantly, the model retains all prior control variables, other subdomains of IOP, and their interactions with URM. Accordingly, the new model teases out the effects of each of the ISCMI practices from potential influences of other interaction-oriented practices.

The results presented in Table 5 show that not all ISCMI practices contributed equally to reducing equity gaps between URM and non–URM students. Notably, ISCMI_3 (active outreach to struggling students) shows significant positive interaction with URM status for both grade points ($b = .12, p < .001$) and course completion ($b = .04, p < .01$). These results suggest that URM students disproportionately benefited from proactive outreach to struggling students. In addition, ISCMI_4 (responding to student questions about logistics and course requirements quickly) also shows marginally significant interaction with URM on course completion ($b = .04, p < .1$). This suggests that URM students benefited particularly strongly from timely and responsive communication regarding course logistics and expectations.

Table 5

Estimated Effects of Specific ISCMI Practices by URM Status

	Grade Points	Pass (C or above)	Subsequent Enrollment
ISCMI_1	0.03 (0.05)	–0.01 (0.02)	–0.00 (0.02)
ISCMI_2	–0.01 (0.02)	–0.00 (0.01)	0.01 (0.01)
ISCMI_3	–0.02 (0.03)	–0.01 (0.01)	0.00 (0.01)
ISCMI_4	–0.01 (0.04)	0.00 (0.02)	–0.00 (0.02)
ISCMI_5	0.02 (0.02)	0.00 (0.01)	0.01 (0.01)
ISCMI_6	–0.01 (0.06)	0.02 (0.03)	0.06 (0.03)*
URM=1 # ISCMI_1	–0.02 (0.06)	–0.01 (0.02)	0.02 (0.03)

URM=1 # ISCMI_2	–0.00 (0.03)	0.01 (0.01)	–0.01 (0.01)
URM=1 # ISCMI_3	0.12 (0.03)***	0.04 (0.01)**	0.01 (0.01)
URM=1 # ISCMI_4	0.06 (0.05)	0.04 (0.02)+	0.02 (0.02)
URM=1 # ISCMI_5	0.00 (0.02)	0.01 (0.01)	–0.01 (0.01)
URM=1 # ISCMI_6	0.10 (0.08)	–0.03 (0.03)	–0.01 (0.04)
N	8,854	9,993	10,054

Note. Grade points are z–score standardized. Pass (C or above) is coded 0/1. For ISCMI items, see Table 2. URM = Underrepresented minority. Standard errors in parentheses. + p<0.1 * p<0.05 ** p<0.010 *** p<0.001

Discussion and Conclusion

Summary of Key Findings and Implications

Distance learning through online coursework is playing an increasingly important role in higher education, especially at open-access institutions that enroll a large proportion of adult learners who benefit from the flexibility of distance learning. Yet, students' low performance in these courses has been a persistent concern, and colleges have been actively seeking evidence-based practices that can help colleges and instructors design and implement high-quality online courses that could fundamentally improve student learning outcomes. Drawing on a unique dataset that links instructors' use of practices aimed at promoting interaction, our study provides empirical evidence on the benefits of various interaction-oriented practices on student online learning outcomes.

Overall, our results support the theoretical conjecture that interaction-oriented practices play an important role in facilitating learning and engagement in college online courses. Even after accounting for a rich set of student and instructor characteristics, course subject areas, overall course difficulty, and average student grades in face-to-face sessions, we find positive relationships between higher levels of engagement in interaction-oriented practices and student performance outcomes. These findings underscore the value of fostering interactivity in online education. The positive impacts on course completion rates are particularly noteworthy for community colleges, where failure to complete a course, especially introductory courses, can substantially increase the probability of early college withdrawal and decrease the probability of earning a postsecondary credential (Calcagno et al., 2007). Unsuccessful learning experiences can be particularly consequential for URM students: A Black student who withdraws or fails his/her introductory course has a 67% chance of not earning any postsecondary credential, compared with a 48% chance for a White student (Chen & Soldner, 2013).

Our results also indicate that the benefits of interaction-oriented practices are not uniform across all domains of interaction. Among the six domains examined, practices that promote peer social interaction are the strongest predictor of higher course performance for all students. This finding aligns with prior research showing that students in online courses frequently report feelings of isolation and a lack of "social presence"—the perception of being connected to others in a computer–mediated environment (e.g., Richardson et al., 2017; Shearer, 2013). While the current literature has consistently highlighted the importance of enhancing meaningful peer interactions, most of these studies focus on collaborative learning opportunities that facilitate academic interactions between students. While we also identify a positive coefficient for SSAI (student–student academic interaction) on course performance, the size of the effect is only about half of the effect of SSSI (student–student social interaction). While we are not able to draw any definitive conclusion regarding the comparison between SSAI and SSSI based on the sample of the current study, our results suggest that fostering opportunities for purely social connections, such as encouraging students to add personal profiles to the learning management system (LMS) or participate in engaging introductions, can have a substantial impact on student outcomes. This highlights the importance of designing online courses to address the social dimensions of learning.

Contrary to our expectations, instructor–student interactions (ISSI & ISAI) were not significantly associated with student online performance outcomes. The specific reason why instructor–student interactions did not matter in this specific context is beyond the scope of the present study. It is possible that the effect of the student–faculty interactions may largely depend on qualitative features of the interaction, such as the content of the interaction or tone used by the faculty, which cannot be captured by our survey items. Future research that has access to richer data on course interaction dialogues may wish to explore these possibilities.

Finally, among the six domains examined, practices targeting instructor–student course management interaction (ISCMI) emerged as a promising way to reduce equity gaps by disproportionately improving the course performance of racial minority students. This finding aligns with prior research suggesting that learners may not be equally predisposed to succeed in online learning due to different levels of self-directed learning skills (e.g., Hart et al., 2018). Indeed, existing literature on learning autonomy suggests that White students and individuals with high prior educational attainment, on average, exhibit higher levels of self–directed learning skills than URM students and individuals with lower educational attainment (e.g., Hoskins & Van Hooff, 2005; Muse, 2003; Stewart et al., 2010; Wiggam, 2004). Consequently, practices that provide structure, monitor progress, and help students stay on track are especially beneficial for URM students. Indeed, our subsequent analyses that examine the specific managerial practices indicate that URM students disproportionately benefited from proactive outreach to struggling students and timely guidance about course expectations. Considering that course management-related communications are often addressing the whole class rather than messages tailored to personal needs, it should be relatively easy for instructors to incorporate these practices into their online instruction. Institutions seeking to improve online teaching and learning outcomes may also consider incorporating these practices into the professional training curriculum for online instructors.

Limitations and Future Research

There are several limitations to this study. First, our reliance on self-reported survey data introduces potential validity issues (Maul, 2017). For instance, instructors could respond to interaction-oriented practice questions in socially desirable ways. Although we believe this risk is minimal, given that the survey was designed for research rather than evaluation, future research could validate our findings through more objective measures of teaching practices. In addition, it is important to note that the benefits of specific types of interaction may vary depending on the local contexts and student population. Accordingly, institutions and researchers may wish to tailor the survey to the local context and examine the relationship between interaction-oriented practices and student outcomes using local data.

Acknowledgment

This study was approved by the Institutional Review Board (IRB) at the University of California Irvine under protocol number #20184354. All participants provided informed consent before participation. This work was supported by the National Science Foundation 17–537 DRL #1750386.

Conflict of Interest

The authors declare no conflicts of interest with respect to the authorship or publication of this manuscript.

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Feedback is Integral: Using a Revised ICAP Framework to Achieve Active Learning in an Asynchronous Online Course

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Abstract
The Interactive, Constructive, Active, Passive (ICAP) Framework (Chi & Wylie, 2014) is used to review and develop active learning in higher education. It is a hierarchical model based on overt behaviours seen by the teacher in the classroom. This principle is acknowledged as a limitation, especially in the case of online modes of study. In this paper, we revise the ICAP Framework to fit an asynchronous mode of online learning by introducing formative feedback to each ICAP mode, arguing the most active mode results in a student-produced output with evidence of having reflected on feedback. We then use the revised framework to review a course of study consisting of eight units of an asynchronous online post-graduate degree and then recommend ways in which to apply the revised ICAP Framework more generally to enhance the level of active learning in the asynchronous, online mode.

Keywords: Active learning; asynchronous online learning; ICAP Framework

Pollard, V., Armatas, C., & Pepe, A. (2025). Feedback is integral: Using a revised ICAP Framework to achieve active learning in an asynchronous online course. *Online Learning 29*(3), 236-253. https://doi.org/10.24059/olj.v29i3.4555

Introduction

Active learning is essential in higher education as students need to be "active agents in the process of knowledge acquisition" (Bada, 2015, p. 66). Considerable effort is spent designing and reviewing university courses (i.e., sequences of study that are completed to obtain a specific award), to ensure there are active learning opportunities. This is done best at a course level to provide an understanding of the student experience (Meyers & Nulty, 2009) and allowing alignment across units (i.e., discrete, standalone components of a course with prescribed learning outcomes), at the same level and between units at different levels. The design and review of active learning often occurs at the level of learning activities, which are specifically designed to enable knowledge acquisition (Chi & Wylie, 2014). The Interactive, Constructive, Active, Passive (ICAP) Framework, as developed by Chi and Wiley (2014), is useful for reviewing learning activities and designing more active ones. The framework was designed for face-to-face learning and includes a focus on behaviours as literally "seen" by teachers (p. 22). In this paper, we revise the ICAP Framework to understand how "seen" can be interpreted in the asynchronous online mode.

Our revision recognises the importance of interaction to online learning (Cho & Kim, 2013; Moore, 1989; Su et al., 2005). We incorporate the element of feedback as integral to higher modes of active learning in delivery of asynchronous online learning, then report on an audit of eight units of a post-graduate course designed for asynchronous, online delivery using the revised ICAP Framework (Chi & Wylie, 2014) to show what the "cumulative experience" (Meyers & Nulty, 2009) is for the students who take units in this course. We also discuss how the learning activities could be revised to shift them towards higher modes of active learning. Finally, we explore how to revise the course to achieve a higher level of interaction to which feedback is integral.

In conducting the course audit using the ICAP Framework (Chi & Wylie, 2014), our aim was to address these research questions:

1. How effective is the ICAP Framework for assessing the potential for students to exhibit active learning in an online, asynchronous learning environment?

2. In what ways can using the ICAP Framework to categorise the level of active learning in an activity help improve learning design and student engagement?

3. What value does the adding of feedback to the ICAP Framework have for enhancing active learning in asynchronous, online learning?

Literature Review

Online Active Learning

An important aim of teaching and learning in higher education is "to guide students to create increasingly complex knowledge structures [and this] requires us to progressively scaffold their thinking" (Meyers & Nulty, 2009. p. 565). The scaffolding of thinking includes the construction of carefully considered learning outcomes (Armatas & Spratt, 2019), the development of considered curriculum (Meyers & Nulty, 2009), and the design of learning activities that result in students engaging in particular behaviours, with the latter considered essential. "It seems central […] that it is only by ensuring that students engage in behaviours (cognitively) that the quality of their learning outcomes can be guaranteed" (Meyers & Nulty, 2009, p. 567). Rather than simply soaking up knowledge, learners need to actively "confront their understanding in light of what they encounter in the new learning situation" (Bada, 2015, p. 67). Students need to be active and engaged to learn, hence the focus on what is known as "active learning" which has "gained widespread attention and acceptance in the last few decades" (Prince, Felder & Brent, 2020, p. 4).

Active learning is as important in online learning as it is in other learning modes and activities must be specifically tailored to the online context (Garratt-Reed, Roberts & Heritage, 2016). The key to online learning for students is interaction (Su et al., 2005) which is important to student retention (Cho & Kim, 2013) and knowledge acquisition. Interaction is essential in designing engaging learning activities and, in the online environment, "interactions may be either synchronous (the instructor and all students are gathered at two or more sites simultaneously for class sessions) or asynchronous (instructional materials reside online and are accessed by students at times convenient to them)" (Prince et al., 2020, p. 5).

An active online experience requires the design and delivery of learning activities tailored to that mode which encourage and facilitate students' interactions, "such as inquiry, collaboration, and reflection" (Shi, Hur, Tang & Dennen, 2023, p. 272). These types of activities allow students to gradually increase their abilities to think in complex ways. The review of the types of learning activities present in an online course can therefore be used as one measure of course quality.

A course approach to understanding how active learning is, or is not present across the units that make up the course, is preferable to a unit-by-unit one because a whole-of-course approach allows for an understanding of "the cumulative nature of the students' experience of the course" (Meyers & Nulty, 2009, p. 569). A comparative approach, unit-by-unit across a course of study, allows for targeted revision. It can help to make "decisions about what subjects need revision and how to prioritize these revisions" (Armatas & Spratt, 2019, p. 247). In the next section we examine the ICAP Framework (Chi & Wylie, 2014) as a highly useful tool towards this type of course review.

The ICAP Framework

It is important to understand what constitutes active learning in order to enable educators to develop active modes of learning. The ICAP Framework (Chi & Wylie, 2014) is an important and often used (Farrow, Moore & Gašević, 2022) system of categorisation used to rate and design learning activities according to the type of activity required by the student. In the Framework, active learning has been defined as "overt behaviors *seen* either during instruction or while students are undertaking specific instructor-designed learning activities" (Chi & Wylie, p. 220, emphasis added). The Framework is used as an "independent quality measure" (Farrow et al., 2022) to review courses, as well as for "guiding instructional design" (Chi & Wylie, 2014). It has a taxonomy of four modes of engagement with each mode eliciting different cognitive processes and behaviors; these are Passive, Active, Constructive, and Interactive (Chi & Wylie, 2014, pp. 221-223), summarised by Prince et al. (2020, p. 19) as

> in increasing order of effectiveness, student engagement may be passive (the student is a passive recipient of information), active (the student does something with the information but does not generate new material from it), constructive (new material is generated), or interactive (new material is generated interactively with other students).

The ICAP Framework is based on the proposition that active learning is best understood as part of a set of knowledge change processes that can predict the amount of learning and that higher modes of engagement lead to more learning occurring with a deeper understanding and comprehension. Learning activities are defined by Chi and Wylie (2014, p. 219) as "the large collection of instructional or learning tasks from which teachers or educational designers can choose for students to do (e.g., reading, solving problems, learning to understand charts and diagrams, etc.)." Such activities aim at increased engagement, which is defined "in terms of overt behaviors that students can undertake, and teachers can *see*" (Chi & Wylie, 2014, p. 220, emphasis added). Further, "overt behaviors are '*seen*' either during instruction or while students are undertaking specific instructor-designed learning activities" (Chi and Wylie 2014, p. 220, emphasis added). The behaviours that can be seen include reading, taking notes, underlining, drawing concept maps, rotating an object, defending a decision, and debating.

The focus on "seen" in the ICAP Framework is due to the emphasis on teacher practices in the classroom, which Chi and Wylie (2014) acknowledged is a limited context but nonetheless useful. "Although far from perfect, overt [seen] behaviors are a good proxy to reflect different modes of engagement that teachers can use to ascertain whether a student is in fact engaged in a specific mode for a given activity" (Chi & Wylie, 2014, p. 220). The framework was developed based on laboratory and classroom studies (Rakovic, et al., 2020; Atapattu, Thilakaratne, Vivian & Falkner, 2019) hence the focus on observable activities. This, for us, raises the important issue of how educators can observe behaviours in the online mode where they are not present to "see" what students do. While there is some research that has addressed online learning and the ICAP Framework, we believe there is a gap in the literature around the problem of "seen." We argue that the ICAP Framework is not as effective for assessing the potential for students to exhibit active learning in an asynchronous online learning environment as it relies too heavily on the notion of "seen." We propose a way for what students do asynchronously online to be "seen" so activities can be designed specifically for this mode.

Farrow et al. (2022) argue that Chi and Wylie's (2014) ICAP Framework can be applied to both in-person and online learning. Their research focused on coding online asynchronous discussion threads in a fully online distance-learning course in real time applying a "label indicating the relevant mode of cognitive engagement from the ICAP framework" (Farrow et al., 2022, p. 46). Their findings aimed to support instructors to change behaviours during a course. In their case, "seen" refers to comments in discussions in an online course. While their work adds to understanding what "seen" can mean, we argue there is a need to move beyond discussion posts as "a major concern about asynchronous interactions such as discussion boards is the difficulty of getting students to participate in them" (Prince et al., 2020, p. 8). Our work addresses these issues, allowing a greater appreciation of different types of learning activities specifically within the asynchronous online mode. Following Johnson, Seaman, and Poulin (2022, p. 104) we define asynchronous online learning as where "all classes or instructional activities happen online; there is no on campus requirement […] instruction is available for students to access at a time that works best for them." We are interested in this specific mode of online learning because it has exponentially increased and because active learning is as important to learners in the asynchronous online mode as it is in all others (Baker & Tukhvatulina, 2023). Further, there is a research gap in active asynchronous online learning (Lim & Lim, 2021), to which our work aims to contribute.

Interpreting "Seen" in Previous ICAP and Asynchronous Research

Online learning elicits the same level of student satisfaction and academic performance as other modes (Prince, et al. 2020). However, when online learning does not include synchronous learning opportunities, e.g., video classes, there is a risk of "lack of learning engagement" (Hefter, Kubik & Berthold, 2023, p. 2). Returning to our research question, a problem faced when implementing active learning to the asynchronous online mode, is how to "see" behaviours. Learning analytics can provide evidence of what students have done but not necessarily what else they have done (Vale & Falloon, 2024). For example, we can tell they have watched a video for a certain number of minutes, but we cannot always know what other activities were performed as they watched, e.g., did the student take notes or pose questions to be answered (Dodson et al., 2018; Vale & Falloon, 2024). The challenge then is how to "see" students in such an environment; i.e., to see both the student actions and to evaluate any output from learning activities.

Next, we review previous research on the use of the ICAP Framework (Chi & Wylie, 2014) in online study modes to further understand how we can "see" students' engagement. Previous research of reviewing and designing active learning activities has interpreted "seen" to mean primarily engagement in asynchronous discussion boards (Ahmad, Junis & Santoso, 2022; Atapattu et al., 2019; Farrow et al., 2022). In this sense "seen" means posting comments and responding to others and the Framework has been used to gauge "depth and quality" through labelling (Farrow et al., 2022, p. 129). Atapattu and colleagues (2019) applied the ICAP Framework to classify online discussions in a Massive Open Online Course (MOOC). While their work is limited to online discussions, in respect to the issue we have described above, they advanced the use of the Framework by automating the data collection, noting that previous studies relied on manual analysis. Ahmad et al. (2022) conducted a literature review of 54 articles to measure learner engagement in discussion boards arguing that these support students to interact, engage with content and for teachers to monitor, direct, and encourage deeper learning.

Some research has moved beyond discussion boards to understand "seen." For example, Galatsopoulou, Kenterelidou, Kotsakis, and Matsiola (2022, p. 13) analysed asynchronous viewing of videos followed by "peer discussions and collaborative analysis." The work by Hefter et al. (2023) focused on university students' engagement with recorded video lectures and then took a quiz or wrote a self-explanation. Vale and Falloon (2024) used a modified version of the ICAP Framework (Chi & Wylie, 2014) with the modifications focused on differing activities related to watching videos. This allowed them a more nuanced understanding, but they did not specifically mention the problem of "seen." Findings from their study included that the ICAP Framework was valuable in evaluating data collected as part of learning analytics. In particular, learning analytics data alone were more effective at identifying lower level forms of engagement, such as Active, but not the higher order levels of Constructive and Interactive. They concluded that a more accurate picture of student engagement with video-based learning objects could be obtained by using the ICAP Framework to determine active learning. While these authors concluded that learning analytics is generally effective for identifying active learning behaviours when viewing videos, it is "greatly strengthened when mapped to a well-researched pedagogical model like the ICAP framework" (Vale & Falloon, 2024, p. 62).

Common to this "seen" research are interactions involving teachers and fellow students. It is argued that such interactions are key to online learning, "and there should be an interaction between students, students with instructors, and students with the course content" (Galatsopoulou et al. 2022, p. 4). While we agree, we also align with Garrison and Cleveland-Innes (2005) who argue that interactions per se are not enough and that they "must be more structured and systematic" (p. 134) and further, there is a need for "a qualitative dimension […] where interaction is seen as communication with the intent to influence thinking in a critical and reflective manner." (p. 134). Thus our work aims to encourage structured and systematic activities that influence thinking to higher modes. To this end, in the next section, we have identified that an important qualitative dimension is formative feedback, from teachers and peers, and accordingly apply this to our revised version of Chi and Wylie's (2014) ICAP Framework.

Revising the ICAP to Embed Formative Feedback as "Seen"

Formative feedback, either from self (i.e., reflection), peers, or from the teacher is an essential element in our revised ICAP Framework (Chi & Wylie, 2014). Feedback is included in the original framework where there is discussion of a classroom-based study that found students who self-explained but did not receive feedback (Constructive) did not perform as well as those who self-explained and did receive feedback (Interactive). However, feedback is not explicitly described as part of the four ICAP modes, except in Interactive where students who engage in dialogue provide feedback. The importance of feedback in designing

ICAP-aligned synchronous and asynchronous activities is recognised by Prince et al., (2020, p. 8) who argue, "the point is not to require activity for its own sake, but rather to provide guidance, practice, and *feedback* in your targeted skills" (emphasis added). Revisions such as ours are expected when the framework is applied to different modes of delivery (Farrow et al., 2022).

Shute (2008, p. 152) defines formative feedback as "information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning." Specifically, we are interested in "task-level feedback [which] typically provides more specific and timely (often real-time) information to the student about a particular response to a problem or task." There are different types of formative feedback and we use the term *feedback* to indicate that task-based formative feedback needs to be designed into learning activities. Our second research question relates to the ways in which use of the ICAP Framework (Chi & Wylie, 2014) to categorise the level of active learning in an activity can help improve learning design and student engagement, and we argue that it can be used to improve design and engagement by explicitly designing in the element of feedback.

In revising the ICAP Framework (Chi & Wylie, 2014), we add the element of feedback, or the lack of feedback, to each mode. This ranges from Passive, with no feedback, to Interactive, which is a collaborative activity in which the incorporation of feedback on an external output to a new external output, or double-loop learning, is essential. Double-loop learning "involves reflection" (Greenwood, 1998, p. 1048), therefore evidence of reflection on feedback received on an external output is afforded the highest ICAP mode. Our revision to Chi and Wylie's (2014) ICAP Framework for asynchronous, online learning is as follows, with our additions in bold:

> *Passive* refers to "a passive mode of engagement [such] as learners being oriented toward and receiving information from the instructional materials without overtly doing anything else related to learning (Chi & Wiley, 2014, p. 221)." **No feedback.**
>
> *Active* refers to "if some form of overt motoric action or physical manipulation is undertaken" (Chi & Wiley, 2014, p. 221). **No feedback from others/ some self-feedback.**
>
> *Constructive* refers to "constructive behaviors [such] as those in which learners generate or produce additional externalized outputs or products beyond what was provided in the learning materials" (Chi & Wiley, 2014, p. 222). **Feedback provided on external output by either peers, teacher or other external party.**
>
> *Interactive* refers to "interactive behaviors to dialogues that meet two criteria: (a) both partners' utterances must be primarily constructive, and (b) a sufficient degree of turn-taking must occur" (Chi & Wiley, 2014, p. 223). **Feedback on an external output from peers etc. that is then incorporated in the development of another output (Double-loop learning).**

We adapted the table of typical examples of activities in Chi and Wylie's paper (2014, p. 22) to our revised version of the ICAP Framework (see Table 1). Looking at our third research question regarding the value that adding feedback to the Framework has for enhancing active learning in asynchronous online learning, we can see that adding in feedback allows each mode to have an output (or no output) that is then used for moving thinking to a higher level. That is, it is not simply an output that counts but how that output is used and the term "feedback" determines usage.

Table 1

Modes of Engagement in Asynchronous Online Learning Mapped to ICAP Modes

Mode	Behaviour	Feedback provided
Passive-Receiving	Watching a video/narrated PowerPoint.	None
Active-Manipulating	Taking notes following prompts, manipulating the videos.	Student may reflect on their own work (self-feedback).
Constructive-Generating	Reflecting/note-taking and producing evidence for feedback following prompts, posting in discussion boards, explaining concepts in a video.	Feedback designed—either a fellow student or a teacher provides feedback, or it is part of an interactive element.
Interactive-Dialoguing	Joining a small group for asynchronous idea sharing/formation/defending. Posting in a discussion board, receiving feedback and responding to it. Developing collaborative artifacts, such as concept maps that evidence feedback.	Receiving feedback and responding, evidenced through a new external output. Double-loop learning.

Aims

Our aim was to use our revised version of Chi and Wylie's (2014) ICAP Framework to delineate the cumulative nature of the learning activities upon the student experience across a course, as opposed to individual units of study. To do this we used the Framework to rate and label the learning activities on the assumption that "good" educational design aims for "more" engagement from students, therefore activities in the Constructive and Interactive modes are of more educational benefit than the two lower modes. To address our research questions, we were specifically interested in what types of activities are most common in the asynchronous online course we audited and how this impacts the student experience.

Data

The data we analysed were all the learning activities in one asynchronous online course. We had access to the course, and permission to use it for this purpose, from the Director of the program. Ethics permission was not required as we did not use any data from students and no human participants were involved in the research. Instead, we reviewed the learning activities, assessing each of them using our revised ICAP Framework. The course was very similar to the one described by O'Connor (2022, p. 103):

> Subjects were offered asynchronously and were based around weekly learning objectives and *targeted activities* which scaffolded toward the assessment. Each week, students were expected to engage in related discussion activities via discussion forums. These discussions were supported by online tutors who were required to guide the student interactions based upon the weekly activities and additional instructions from the lecturers (emphasis added).

Method

A Case Study of an Audit

We used our revised ICAP Framework (Chi & Wylie, 2014) as an auditing tool. This work was influenced by the work of Farrow et al. (2022), who labeled learning activities according to the Framework. They argue that this is a common approach to understand the content of discussion forums and we found that it is readily adapted to other forms of learning activities. We acknowledge that this type of labeling is time-intensive, but we found getting close to the activities in this manner allowed us to fully appreciate the look and feel of a course. We used the audit to suggest how the course currently stands in terms of being Constructive and Interactive and to show changes that can be implemented. The audit was undertaken on the latest, archived version of the unit; in some cases, the unit had been delivered three times. We had access to archived versions of all the units (subjects) that had been offered in the course. This course was chosen because it had run several times and was due for a review.

Unit design was done using a template to help achieve a similarity of learning design patterns across all units and courses (Bearman, Lambert & O'Donnell, 2021). This includes the labeling of activities with icons and headings such as "Watch," "Read," and "Reflect." For our audit we took a course-level approach, meaning we reviewed all eight units which make up the course, each of which consists of eight weekly modules. The number of pages in each module varied, with some having as few as six pages per module and some having as many as 20. We reviewed each page looking for learning activities as there was no automated way to find these activities. Instead, we clicked through each page of every module looking for "activities." For most of the activities identified, the templated labels had been used and their use (e.g., Watch, Read, Reflect) assisted in identifying other learning activities that were not labeled but still met Chi and Wylie's (2014) definition of a learning activity.

Two of the authors undertook the unit audits and met twice to ensure reliability and consistency of each other's audits. An audit consisted of four steps, the identification of learning activities being the first. In defining a learning activity, we checked that it satisfied the ICAP (Chi & Wylie, 2014) description of a learning activity. All the units audited had been developed using a template, providing some regularity in the sign posting of learning activities by "calls to action," making identification of learning activities easier. Once a learning "activity" was identified in a module, following Farrow et al. (2022, p. 129), we "annotated each message [activity] with a label indicating the relevant cognitive engagement mode from the ICAP framework." We also used the framework to categorise the activity in respect to the scaffolding of tasks via use of prompts, external output as a result of completing the learning activity and presence of feedback, each of which are described in more detail next.

Categorising the Learning Activities

There were three elements to the categorisation of learning activities:

Prompts

As well as defining an activity, we looked at the prompts associated with the "call to action" or equivalent to see what students were asked to do for the activity. In a classroom, teachers will provide students with scaffolding such as directions, prompts, questions, and feedback to help them undertake a learning activity. Scaffolding "enables learners to do more advanced activities and to engage in more advanced thinking and problem solving than they could without such help" (Shute, 2008, p. 162). In the asynchronous online mode, this sort of scaffolding can "encourage students to deeply process the material" (Hefter et al., 2023, p. 2) and to produce self-explanations that contribute greatly to knowledge acquisition. Thus, directions and prompts contributed to the categorisation of the activity according to its level on the ICAP Framework (Chi & Wylie, 2014); for example, directions such as "answer these questions while watching" were considered at a higher mode of ICAP than simply "watch."

Creation of an External Output

Units were reviewed for external output from learning activities, and if present, we analysed what type of output it was, who was involved in developing it, what students were asked to do with the output and evidence of the knowledge thus generated being useful towards other ends. For example, students were often asked to "Reflect" using their own notes. This was considered at the lowest level of the ICAP Framework (Chi & Wylie, 2014).

Presence of Feedback

Finally, we looked for feedback. Was there feedback available for the activity? Who gave it? Was there feedback on an external output? What type of feedback? What happened to the output once feedback was received? The answers to these questions assisted in determining whether the learning activity could be categorised as Constructive or Interactive according to the ICAP Framework (Chi & Wylie, 2014).

Once all of the units in the course had been audited, the results were collated to show the number and type of learning activities for each unit and their categorisation to provide a picture of the level of active learning across the course as a whole.

Results

Number and Types of Activities

Overall, we categorised 619 learning activities in the eight units. On average, each unit had 40 learning activities across the eight weeks of teaching, however, the number did vary with some units having 60 and one having 218, most of those being passive video watching. We found only a small number of types of learning activities and the majority were categorized as Passive (*n* = 289, 47%), with the next most frequent category being Active (*n* = 250, 40%). Only 61 (10%) and 19 (3%) were categorised as Constructive and Interactive respectively. Categorisation of the types of learning activities using the ICAP Framework (Chi & Wylie, 2014) is shown in Table 2 below.

Table 2

Examples of Activities Categorised Using the Revised ICAP Framework

ICAP mode	Activity	Scaffolding and Feedback	Examples from units
Passive	Watch - Video – YouTube, PowerPoint	No prompts, questions or directions and no feedback.	Watch this video.
Active	Take notes /reflect/ watch	Prompts/questions and some self-feedback incorporated.	Refer to X article and identify Y and Z as part of your own study notes. Reflect on your notes.
	Click and reveal /Multimedia assets	Prompts, questions or both provided but no feedback.	Information placed into a "click and reveal" or a multimedia asset - no feedback, no external output.
	Quiz	Prompts, questions or both provided but no feedback.	Quiz, no answers provided.
Constructive	Quiz	Prompts or questions and feedback on answers.	Quiz, answers provided allowing for feedback.
	Discussion board post with possible feedback	Prompts/questions but feedback not given (i.e., peers/teacher might respond, they might not).	Post in the discussion board answer to the following question(s).
	Calculations with solutions	Prompts/questions with feedback (e.g., answers).	Students given calculations to complete, and answers provided on next page or in click and reveal.
	Click and reveal	Prompts/questions with feedback on answers.	Students write an answer in their personal notebooks which are not seen by the teacher, then check using a click and reveal.

	Multimedia interactive asset	Prompts and feedback but no external output.	Multi-media assets made by the university interactive development team that require student input and provide feedback upon input but no external output results e.g., drag and drop.
Interactive	Discussion board post with feedback	Prompts and questions with output shared and feedback provided.	Post a response to questions then comment on a fellow student's post (may or may not be an assessment).
	Multimedia interactive asset	Prompts and feedback in response to what student has done.	Multi-media assets made by the university interactive development team or a private company (e.g., simulation) that require students to input, with an external output or feedback on choices/input.

Types of Passive Activities

Many activities were categorized as Passive. In Table 2, we have described these as engaging students in the mode of "Watch" without any scaffolding to direct attention or support knowledge acquisition while watching. However, it should be noted that these results were somewhat skewed as one unit had over 100 "Watch" activities in the passive mode. Similarly, reading a paper or other text without scaffolding would be categorised as Passive.

Types of Active Activities

The second highest mode was Active activities and consisted primarily of activities that invited students to "Reflect" or "Take notes" for their own use. There were questions or prompts but no feedback on the notes and only occasional directions as to how the notes might prove useful to knowledge acquisition or assessments. Also included as an Active activity were several multimedia assets, developed by the central design team, that required students to click on icons to reveal further information. We counted these as Active, as opposed to Constructive as they were simply "click and reveals" and students were not required to further integrate the information obtained and no feedback, such as "Wrong answer, try again," was part of the asset. As such, these activities were simply a way to provide information in a more active manner than reading it on a screen.

Types of Constructive Activities

There was a relatively low number of Constructive activities and these consisted primarily of discussion board posts, with questions and prompts, that required students to respond to other students' comments. A standard discussion board post description for the course was "Post a response to this question and respond to one of your peers." What happened after the posts and response was not made clear as students were not asked to collate their posts and responses for further feedback.

Other Constructive activities included quizzes, calculations with answers provided, and multi-media assets that produced an external output, e.g. a “drag and drop” concept check where students were asked to put the correct term in the correct place. The wrong answer was rejected. The completed asset comprised a new external output that could be downloaded. However, nothing else was done with the output, such as receiving feedback which would have placed it in the highest mode.

Types of Interactive Activities

There were relatively few Interactive activities. An example of one was a multimedia asset developed by the university learning design team that required students to undertake a branching scenario from which an external text was developed that students were required to post and discuss in a discussion board for feedback. Another example was an externally developed simulation that students undertook for the whole term, with weekly activities and posting to discussion boards. It was also part of the assessment.

Opportunities for Feedback on External Outputs

As can been seen in the types of Constructive and Interactive activities found in these units, there is a limited type of external output to which feedback is assigned, this being external output from a university-developed multimedia asset that students posted in a discussion board and a simulation that involved, again, output that was posted and discussed. In terms of the simulation, these discussions were developed in the assessment tasks.

Discussion

There were three research questions of interest in our study. The first related to the effectiveness of the ICAP Framework (Chi & Wylie, 2014) for assessing the potential for students to exhibit active learning in an asynchronous online learning environment. We found the Framework to be very effective in this regard as it provided a codified and objective way of assessing the level of active learning required for the activities in the audited course. The audit demonstrated that overall, the course tends to the Active mode of engagement as defined by the ICAP Framework. This is similar to Vale and Falloon (2024) in their analysis of videos in learning activities wherein they found that students tended towards the Active mode. They found that when codifying activities using the Framework, their interviews with students uncovered more of the higher level modes. Our finding thus agrees with their study and we suggest that ways other than codifying activities are necessary to more fully understand nuances.

We found that across the course, students experience a limited variety of activities and there were many passive activities in some units. Su et al. (2005), in their review of interactivity in an online course, found a similar lack of variety of activities, with online discussion, instructor feedback, and summaries of key points dominating. Activities that could be considered at a higher mode such as peer evaluation and inter-team feedback were used sparingly, despite students interviewed asking for more such interactions. Su et al.(2005) argue instructors are less skillful in providing student-led interactions which “suggests the importance of faculty training and support when it comes to online education” (p. 10). It is interesting that given their work was almost twenty years ago, we have found a similar pattern of passive activities.

Additionally, an uneven distribution of modes was found, with some units rated as Interactive and some entirely Passive. The small variety of activities may partly be due to the template used to develop the units which has icons and verbs to be used when signposting an activity; this “shorthand” may make it more difficult to develop active learning tasks that are outside the template. To address this difficulty may require further development of the template. There is also a need to consider how to make activities such as those labelled “Watch” more constructive or interactive and less passive as there were far more passive activities, primarily—“Watch”—than any other activity. While this may partly be due to the template, it could also be due to the time pressures associated with the development of activities for these units, with lower level activities being easier and quicker to design. In addition, the transition to asynchronous delivery can be challenging and may require a longer period of development time and professional support to help teachers design learning activities that are at the higher end of the ICAP Framework (Chi & Wylie, 2014).

Our second research question related to the ways that using the ICAP Framework (Chi & Wylie, 2014) to categorise the level of active learning in an activity could help improve learning design and student engagement. We found the ICAP Framework very useful for working out how active a course is and where improvements can be made. This is a similar finding to other research in the field such as Atapattu et al. (2019), who applied the ICAP Framework to identify cognitive engagement by MOOC participants. We found it particularly useful for identifying which units needed more active learning activities to promote student engagement, activities that could be modified to shift them to a more active mode according to the Framework, and the distribution of active learning across the course. We suggest that the Framework must be adapted to the online mode in order to explicitly address what is meant by “seen.” We also suggest that the work needs to take a whole-of-course approach and must move beyond discussion boards.

Some units in the course we audited did have learning activities we categorised at the higher modes of active learning. This was encouraging but one unit had considerably more interactive learning activities than the other units as this unit had an externally produced simulation as well as several university-produced multimedia assets and the requirement to post and respond to peers. Limited opportunities for feedback on external outputs was also identified as an area requiring attention to produce higher modes of activity and feedback. Simulations and multimedia assets that produce an external output that can be reviewed by peers and then used in assessments is present in two units. Further development of such learning activities, particularly multi-media assets bespoke to the unit and the course, is warranted. Overall, a whole-of-course approach to the placement and building of such learning activities could be undertaken to ensure that effort is used to develop higher modes of activity and a more consistent distribution of types of activities across units. While there is a place for simpler learning activities, such as click and reveals, there needs to be a coherent approach to ensure variety and higher modes with feedback.

Another area where enhancements can be made to promote higher levels of active learning is in the template and the use of prompts for consistency. The design template allowed for clear and consistent signposting of activities using icons. However, we found that the template was used inconsistently at times. For example, the Activity icon might signal a passive reflect/take notes or an activity in the Interactive mode of the ICAP Framework (Chi & Wylie, 2014). We argue that lower levels of activities should be signaled differently thus alerting students to the amount of time and knowledge acquisition that might be expected. An improvement would be to develop prompts using the ICAP Framework. Hefter et al., (2023) argue that carefully constructing prompts based on the ICAP Framework can increase active learning, in their case self-explaining. They argue that instructors should spend time constructing such prompts.

These findings point to a need for professional development for those designing online courses. Chi and Wylie (2014, p. 238) note that their "framework, on the other hand, can provide specific guidelines for how to create lessons that incorporate overt behaviors that are associated with higher levels of engagement and their associated knowledge-change processes." Such guidelines need to be developed in specific contexts. These guidelines would be useful for both academic staff and learning designers in conceptualising units and for course coordinators who can work with their teams in a whole-of-course approach. Professional development will also allow for an understanding of the constraints to the template and the possibilities for teams to develop different types of activities using the template. Like Chi and Wylie (2014, p. 238), we have "developed an online module containing information about ICAP" for academic staff undertaking unit development with the learning design team. Although too soon to evaluate, there has been some uptake, but the challenge is for academic staff to do this professional development given time constraints. Professional development with learning design teams may not face this constraint as it could be scheduled as part of their workload. Another strategy for raising awareness of how to design active learning using ICAP is to pilot an exemplary course. This would include the use of the guidelines and professional development for the staff involved.

Our third research question concerns the value of adding feedback to the ICAP Framework (Chi & Wylie, 2014) for enhancing active learning in asynchronous online learning. Based on our audit results, we believe feedback to be a critical to allow students' behaviour to be "seen" in a learning mode where the teacher is not physically present. For many of the activities in the course, without an output that received feedback, the information about what the student did would be limited. By including feedback in a learning activity, analysis of learner behaviour through learning analytics will be greatly enhanced as it will provide outputs that help to show what the student has done.

Limitations and Future Research

A limitation to our methodology relates to the manual categorisation of all the units, the time this took, and the opportunity for differences in categorisation between coders. We had to actively look for activities in the units. Sometimes, following the template, these were obviously labelled, sometimes not.] There is a margin of error in activities not being identified, especially due to the amount of time it took to audit each unit. The meeting of the researchers to check each other's categorisation twice helped to address any differences, but the argument can be made that activities were missed or mis-labelled. Our suggestion to support this type of auditing and to make activities stand out more is to keep a record of every activity in every unit and store these as part of the design process. Further, we suggest that labels for activities in templates are regularly reviewed and updated where necessary to help the design of more cognitively challenging activities.

Our study applied the ICAP Framework (Chi & Wylie, 2014) to course design, demonstrating it to be an effective and valuable tool for this purpose. Further studies validating and refining our audit methodology would provide clarity and guidance on its application when conducting course reviews. In addition, we categorized learning activities and not students' behaviour when completing those activities. Validation of our revisions to the Framework to add feedback so what students do in an online, asynchronous learning environment can be "seen" is a logical and fruitful area for future research. As the work of Vale and Falloon (2024) has shown, the use of learning analytics in combination with the ICAP Framework provides valuable insights into what students do and what they have learnt. This requires learning design that includes a digital footprint of learning activity and outputs that feedback is provided on to evaluate the extent of active learning occurring and what students did and learnt.

Conclusion

The ICAP Framework (Chi & Wylie, 2014) is used to review and design learning activities. In this paper, we revised the Framework for use with the asynchronous online learning mode, arguing that formative feedback and an external student output is the highest mode as it allows what students do to be "seen" when completing a learning activity. Feedback is also expected at the lower modes but need not involve an external output. The audit of the course revealed a large amount of activity required by students across all ICAP Framework levels. However, the nature of the learning activities is such that modifying them so that they move to a higher mode of the Framework is not onerous, particularly for passive activities. To support designing more active learning activities, we argue there is a need to develop guidelines for specific instances, which would be useful for improvements to learning activities, introduction of more authentic tasks, and professional development opportunities that can be included to support academic staff. The challenge is one of developing a course that has well distributed examples of learning activities at the various levels of the (revised) ICAP Framework. Based on the work presented here, we believe that the production of course-specific guidelines for the application of the ICAP Framework—including the revised version presented here—would be beneficial. However, more work is needed to validate the revised version of the Framework, particularly in respect to its efficacy in revealing what students do in online, asynchronous learning environments where teachers are not there to "see" them.

Declaration of Competing Interests
The authors declare that they have no competing interests.

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Improving Community of Inquiry-Based Asynchronous Online Discussion through Improving Conceptual Knowledge by Information-Organizing Preparatory Activity with Kit-Build Concept Mapping

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Abstract

Online discussion based on the community of inquiry (CoI) framework has received considerable popularity due to its potential benefits for enhancing problem-solving skills and achieving deep understanding in the long term. However, it is challenging to make learners actively conduct a discussion using typical environments (e.g., asynchronous online forums). Information-organizing activity (IOA) has been proposed as one of the preparatory activities for preparing learners to actively discuss topics. Compared to the typical structured summary writing (SW), kit-build concept mapping (KBCM) has been proposed in past studies as an alternative IOA with the potential of fostering more cognitive presence and higher-level inquiry messages. However, such potentials were yet to be confirmed by a comparative study with a balanced sample size. Additionally, conceptual knowledge was hypothesized as influential in affecting learners' inquiry. This follow-up study aims to confirm the potential of KBCM as an alternative IOA for achieving better discussion. Moreover, this study contributes to investigating the relationship between conceptual knowledge and inquiry stages performed by learners to explain the effect of KBCM. By analyzing the discussion transcripts of 75 undergraduate computer science students from a public university who engaged in CoI-based discussions on linear algebra, this study found further evidence that KBCM is effective for fostering exploration, the evidence that a higher conceptual knowledge level after KBCM contributed to more exploration, and a tendency

to perform integration→exploration and integration→resolution transitions among KBCM learners.

Keywords: Community of inquiry, online discussion, conceptual knowledge, information-organizing activity, kit-build concept map, summary

Hasani, L. M., Junus, K., Sadita, L., Ohsaki, A., Hirashima, T., & Hayashi, Y. (2025). Improving community of inquiry-based asynchronous online discussion through improving conceptual knowledge by information-organizing preparatory activity with kit-build concept mapping. *Online Learning, 29*(3), 256-284. https://doi.org.10.24059/olj.v29i3.4754

Introduction

Asynchronous online discussions have been adopted in educational contexts due to their potential to encourage critical thinking and deeper learning (Garrison, 2016; Garrison et al., 2003). Deepening understanding of a learning content is one of the potential benefits of asynchronous online discussions (Torres & Satti, 2024). However, despite its potential, providing an online discussion can be effective only if the participants actively contribute to the inquiry (Gasmi, 2022; Swan et al., 2000; Yang et al., 2007). Low participation and shallow discussions have been reported as issues that persist in many online discussions, which may hinder learners from gaining the potential benefits of online discussion (Fung, 2004; Garrison & Cleveland-Innes, 2005; Hew et al., 2010; Mazzolini & Maddison, 2003; Pawan et al., 2003). Such issues lead to the need for learning environments and activities that encourage active participation.

One of the frameworks that have been widely adopted to design and implement asynchronous online discussions (e.g., online forums, social media, etc.) is the community of inquiry (CoI) framework (Garrison et al., 1999; Popescu & Badea, 2020; Valverde-Berrocoso et al., 2020). The CoI framework describes how three presences (i.e., cognitive, social, and teaching) are needed to achieve a meaningful learning experience through problem-solving and inquiry (Garrison, 2016). Cognitive, social, and teaching presence focus on the process of learning, facilitation of the inquiry, and facilitation of collaboration among the participants, respectively (Sadaf et al., 2021).

Cognitive presence is operationalized by four inquiry stages that learners need to perform: triggering event, exploration, integration, and resolution (Garrison et al., 1999). During the triggering event, learners try to understand the problem and how to engage with it. In the exploration stage, they explore possible solutions and share relevant resources to work on. In the integration stage, they elaborate ideas into a coherent solution or conclusion. Finally, if they can think more critically, they may try to defend the solution, show its application in different contexts, and reach resolution. Cognitive presence is one of the elements that determine the quality of the discussion (Garrison, 2017). A high number of messages indicating the inquiry stages being performed (triggering event, exploration, integration, and resolution) may characterize a successful discussion because cognitive presence is central to the success of learning activity and influences learning outcomes (Akyol & Garrison, 2011; R. L. Moore &

Miller, 2022). Experiencing a meaningful discussion fosters necessary collaborative skills to develop deep understanding (Torres & Satti, 2024).

However, research suggests that it is challenging for online discussions to go through all stages of inquiry (Garrison & Arbaugh, 2007; Rourke & Kanuka, 2009). Merely providing an online discussion forum does not result in a high amount of cognitive presence (Garrison et al., 2001; R. L. Moore & Miller, 2022). Regarding this issue, many factors may affect the learners' cognitive presence during online discussions, such as the awareness of commonly referred terms and concepts within the discussion topic, i.e., familiarity and fluency in using relevant terms during the discussion (Hasani et al., 2023). Learners' conceptual knowledge, especially the basic knowledge related to the topics (e.g., how relevant concepts are interrelated), may play a role in influencing their interactions in the discussion. Several past studies emphasized the importance of conceptual knowledge for solving problems (Bereiter, 2014; Braithwaite & Sprague, 2021; Cracolice et al., 2008; Surif et al., 2012). Thus, having sufficient and well-organized basic conceptual knowledge related to a discussion is an important prerequisite for engaging in an effective and meaningful problem-solving discussion.

Nevertheless, most learners usually lack conceptual understanding (Surif et al., 2012). Some studies suggested that learners, in particular novice learners, may experience difficulty in conducting a deep discussion about a topic due to their unfamiliarity with the terms and concepts within the relevant basic knowledge, inability to facilitate discussion effectively, heavy reliance on recalling facts, and tendency to follow rules without reasoned judgments (Persky & Robinson, 2017; Weinberger et al., 2005). Unfamiliarity with the terms used in the knowledge domain among novice learners may also hinder them from solving problems effectively (Martin & Evans, 2018).

To prepare learners, especially novice learners, to engage in an effective problem-solving discussion, preparatory activities that focus on training the learners on how to elaborate and express ideas may be provided before the discussion (Junus et al., 2019; Sadita et al., 2020). A prior study suggested that increasing engagement with the learning content, e.g., the materials related to the discussion topic, may increase the quality of the discussion (Saadatmand et al., 2017).

Information-organizing activity (IOA) is one of the alternatives for increasing engagement with the discussion-related topics and preparing the learners to conduct a good CoI discussion by making them aware of the terms and concepts related to the topics as well as having a well-organized understanding of the topics, i.e., aware of the relationships between important concepts. A well-organized understanding is one of the characteristics of an expert knowledge base and one of the prerequisites of meaningful learning (Kalyuga, 2007; Novak & Cañas, 2006); thus, having one may help solve problems or engage in an inquiry about a particular topic.

IOA can be done by writing a summary of the learning materials, which is an activity that has been widely integrated as a part of the instruction in many educational contexts. In summary writing, learners are expected to select important concepts and organize them into coherent propositions through paraphrases (Pilegard & Fiorella, 2016). Another alternative is making a concept map from scratch (scratch concept mapping/SCM), which involves a visual representation of knowledge structure (Novak & Cañas, 2006). In SCM, learners extract propositions from learning materials and express them in concept-link-concept structures. Both alternatives require learners to extract and express the knowledge structure in the form of propositions, in complete sentences within a summary or concept-link-concept visually represented as nodes and links in a concept map.

Nevertheless, both summary writing and SCM may be difficult for novice learners because both activities require them to extract the knowledge structure by themselves, which poses a high cognitive load (Hasani et al., 2023). There is a possibility that learners might produce a low-quality representation of the knowledge structure, e.g., incorrect terms, incorrect propositions, etc. In the case of summary writing, the learners may experience difficulties in selecting important ideas from the materials and do not wish to exert sufficient efforts due to a high cognitive load and end up copying and pasting verbatim sentences for writing their summary, which is detrimental to their effort in achieving well-organized knowledge (Chuenchaichon, 2022; Pilegard & Fiorella, 2016; Spirgel & Delaney, 2016).

To address this issue, another alternative called kit-build concept mapping (KBCM) may be implemented. In KBCM, learners reconstruct teacher-created maps from components and receive immediate feedback during the attempt (Hirashima et al., 2011; Yamasaki et al., 2010). This may help learners catch the knowledge structure and confirm their understanding. It may also help them develop a well-organized understanding of the discussion topic without making them extract the structure of the knowledge domain from zero, i.e., reducing their cognitive load.

Related prior studies showed that KBCM *has the potential* to be better than summary writing in fostering cognitive presence, which includes triggering event, exploration, and integration, and to follow transitions that resemble a scientific inquiry process: triggering event-exploration-integration (Hasani et al., 2023; Hasani, Junus, Sadita, Ayano, et al., 2025; Hasani, Junus, Sadita, Hirashima, et al., 2025). However, the previously mentioned related studies were limited by an unbalanced sample size, making it difficult to generalize the results. In addition, despite prior studies suggesting that having conceptual knowledge is important for effective problem-solving (e.g., Braithwaite & Sprague, 2021; Surif et al., 2012), there is a lack of studies that investigate its role in shaping learners' behavior in a problem-solving discussion. In other words, whether the conceptual knowledge about the discussion-related topics affects learners' cognitive presence during the discussion is not well understood.

Therefore, a follow-up study involving a balanced sample size is needed to *confirm* the effectiveness of KBCM for fostering the inquiry stages in online discussion and *investigate* the role of learners' conceptual understanding. This study provides further evidence of KBCM's effect as pre-discussion IOA and proposes KBCM as an alternative IOA. This study aims to realize a better CoI-based discussion experience for learners by answering the following research questions.

- (RQ1) To what extent did the occurrence of inquiry stages in the discussion differ?
- (RQ2) To what extent did the pattern of transitions between inquiry stages in the discussion differ?

- (RQ3) Is there a relationship between the learners' conceptual understanding after the treatment and the occurrence of each inquiry stage in the discussion?

RQ1 and RQ2 are posed to confirm, under a balanced sample size, whether KBCM could be the better alternative for: (a) fostering one or more inquiry stages compared to the traditional summary writing method (e.g., through calculating the rate of messages containing an inquiry stage) and (b) encouraging learners to perform transitions between inquiry stages that resemble a scientific inquiry (triggering event-exploration-integration-resolution); thus, informing teachers regarding further evidence of KBCM's effectiveness as pre-discussion IOA and regarding some practical implications on the use of KBCM. RQ3 is posed to investigate whether learners' conceptual understanding after the treatment is related to the learners' discussion performance in showing the inquiry stages (e.g., by performing correlation analysis involving conceptual knowledge test score after the treatment and the type of the treatment); thus, explaining the effect of KBCM on the discussion process.

Theoretical Framework

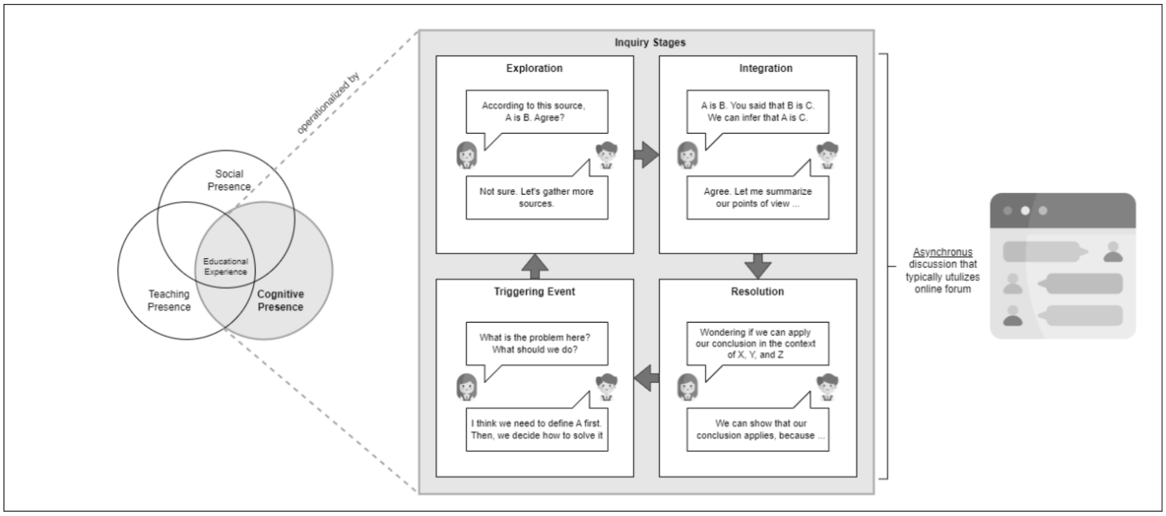
Community of Inquiry Framework for Meaningful Collaborative Learning

The CoI framework defines three presences that make up meaningful educational experience within the mentioned community of inquiry in a collaborative learning environment: social, cognitive, and teaching presence (Garrison et al., 1999). Social presence refers to the ability of the participants in the CoI to project their individual personalities through the medium of communication being used (Garrison et al., 1999). Cognitive presence is the extent of the learners' ability to construct and confirm meaning through active participation in the transaction of ideas (Garrison et al., 2001). Teaching presence, on the other hand, refers to the design, facilitation, and direction of social and cognitive processes within the collaborative learning activity to achieve its educational goals (Garrison et al., 2001).

In addition, the practical inquiry model further describes four inquiry stages that operationalize cognitive presence in the community of inquiry: triggering event, exploration, integration, and resolution (Garrison et al., 2001). Figure 1 illustrates how inquiry stages could be performed by a community of inquiry in an asynchronous online discussion forum.

Figure 1

The Community of Inquiry Framework and the Practical Inquiry Model



Note. This figure is designed using images made by Freepik from Flaticon (https://flaticon.com). Parts of the illustration were adapted from "About the Framework: An Introduction to the Community of Inquiry," by Centre for Distance Education at Athabasca University, 2021 (http://thecommunityofinquiry.org/coi). CC BY-SA 4.0.

Information-Organizing Activities as Discussion Preparatory Activity

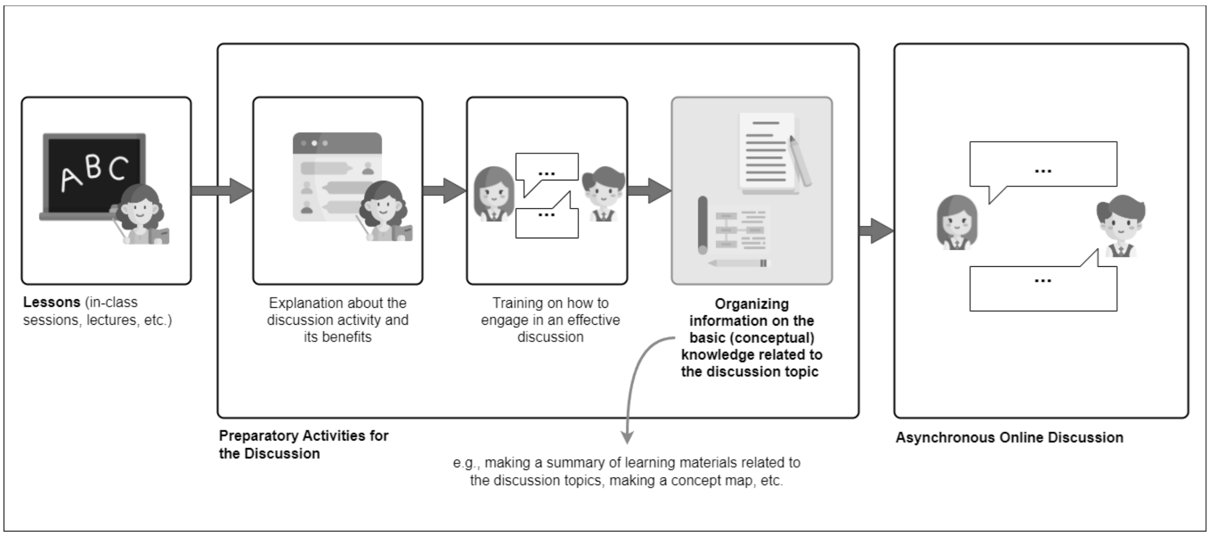
A number of studies suggested the importance of conceptual knowledge in addition to procedural knowledge for problem solving across educational contexts (Bereiter, 2014; Braithwaite & Sprague, 2021; Cracolice et al., 2008; Surif et al., 2012). Possessing a well-organized understanding about the conceptual knowledge related to the discussion topics may help learners to conduct an effective and productive inquiry in addition to achieving a more refined conceptual understanding throughout the activity.

The activity of organizing information (e.g., writing a summary or making concept maps) has been integrated into instructions in many educational contexts to help learners retain information, improve critical comprehension of text material, and achieve meaningful learning (Novak & Cañas, 2006; Shokrpour et al., 2013; Spirgel & Delaney, 2016). Additionally, achieving meaningful learning requires well-organized knowledge structure and commitment to integrate with existing knowledge (Novak & Cañas, 2006).

A prior study suggested that activities that increase learners' engagement with content of the discussion topics may be provided to improve their discussion (Saadatmand et al., 2017). As a form of content-engaging activity, the activity of organizing information can be provided prior to the discussion activity in addition to other necessary preparations (see Figure 2). Prior studies suggested the importance of providing discussion guides and training on how to engage meaningfully in a discussion (Junus et al., 2019; Sadita et al., 2020). By adding information-organizing activities in complement to the mentioned preparatory activities, learners are expected to organize information related to discussion topics, such as general facts or principles related to the problems or procedures for solving the problems that will be focused in the discussion later on.

Figure 2

Information-Organizing Activities as One of the Preparatory Activities for Engaging in Collaborative Learning



Note. This figure is designed using images made by Mihimihi, Freepik, and justicon from Flaticon (https://flaticon.com).

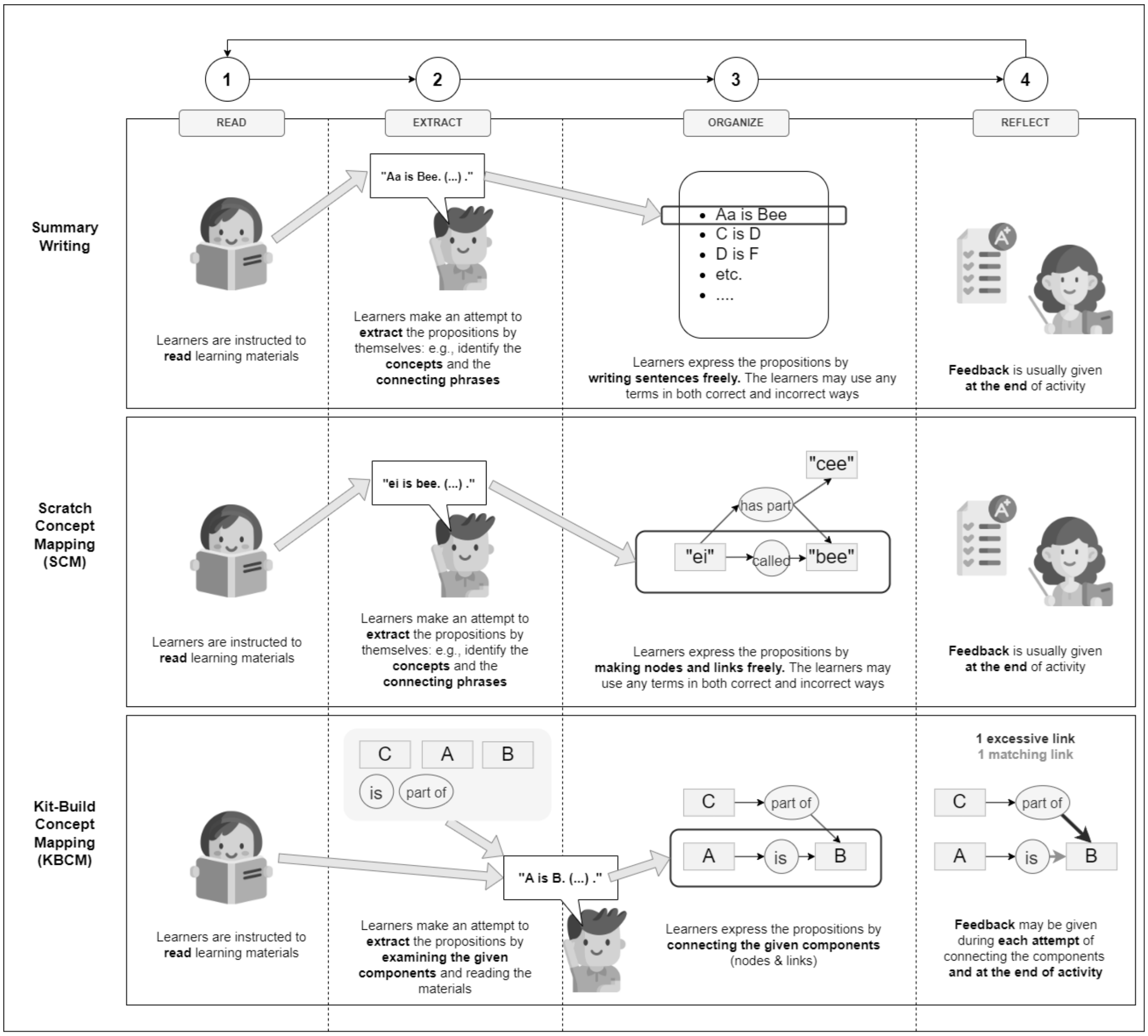
Information-organizing activities can be provided in various assignments, such as writing a summary and making a concept map. In summary writing, learners organize their understanding of the learning materials by paraphrasing them in their own words through the process of extracting the structure of the knowledge included in the materials, which may involve adding personal reflections on the materials (Pilegard & Fiorella, 2016). Despite some limitations, various studies reported the benefits of summary writing (Franzke et al., 2005; Lenhard et al., 2013; Sung et al., 2016).

Concept mapping is another alternative that can be provided for organizing information. Pioneered by Novak (1990) based on Ausubel's theory of meaningful learning (Ausubel, 2000), concept mapping is an activity that involves the use of a graphic organizer (the concept map) to enable learners to achieve meaningful learning by becoming aware of the structure of the knowledge domain, i.e., the relationships between concepts within a topic (Novak & Cañas, 2006).

There are various approaches to concept mapping, such as constructing a concept map from scratch (the traditional scratch concept mapping/SCM) and reconstructing a teacher-constructed concept map from components (kit-build concept mapping/KBCM) (Yamasaki et al., 2010). Figure 3 illustrates the differences between the mentioned approaches.

Figure 3

Summary Writing, Scratch-Concept Mapping, and Kit-Build Concept Mapping



Note. This figure is designed using images made by Freepik from Flaticon (https://flaticon.com).

Methods

Participants

This study involved 75 students from two linear algebra classes at a public university in Indonesia. One class was assigned as the experimental group (KBCM class; $n = 42$), while the other was assigned as the control group (summary writing class; $n = 33$). Note that this arrangement involved a more balanced sample size in comparison to the sample size used in the related prior study (Hasani et al., 2023). The participants' informed consent was collected prior to the study, and the data collected from the participants were anonymized. In addition, this study was approved by the teaching team of the involved classes due to the fact that the institutional review board was still in the process of being established. The demographics of the participants are shown in Table 1.

Table 1

Demographics of the Participants

	KBCM ($n = 42$)	Summary Writing ($n = 33$)
Gender		
Male	28	18
Female	14	15
Batch		
2022	42	33

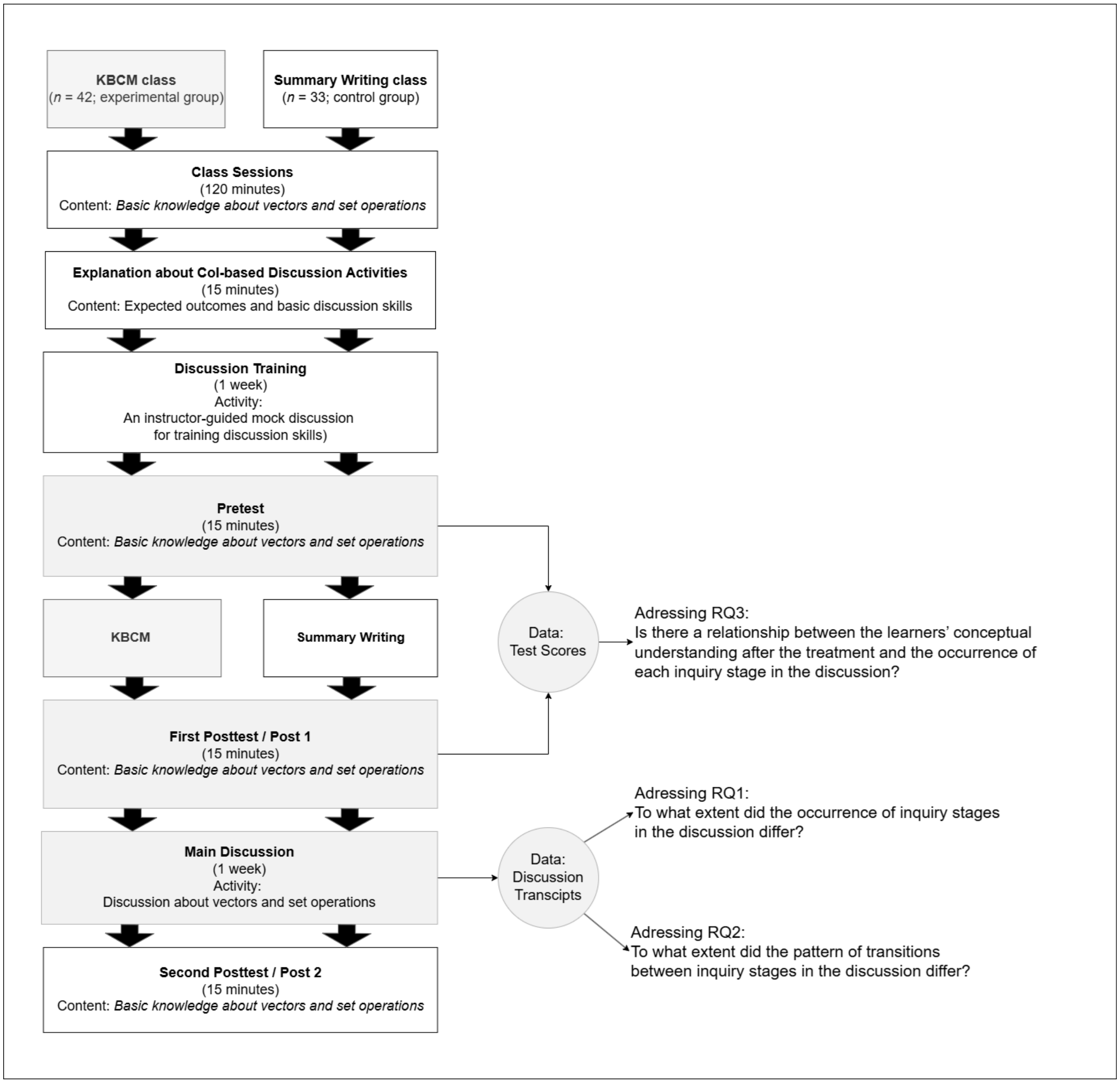
Learning Context and Procedures

The goal of the learning activity was similar to the one reported in the related prior study, which is being able to present a proof whether a set of given mathematical objects (e.g., functions, matrices, and polynomials) satisfies all vector space axioms (Hasani et al., 2023). To achieve the mentioned goals, learners were instructed to: (a) attend lecture sessions about the basics of algebraic vectors and binary set operations, which are the necessary conceptual knowledge for engaging in the discussion about vector axioms; (b) attend pre-discussion training (explanation on the basics of CoI-based discussion, best practices, and participation in a mock discussion); and (c) organize information related to the mentioned conceptual knowledge using different methods (KBCM for the experimental group and summary writing for the control group). Figure 4 illustrates the procedures conducted in this study.

After attending class sessions, learners in both experimental group (KBCM class) and control group (summary writing class) were divided into smaller discussion groups during the discussion training (1 week). The same discussion group arrangement was used for the main discussion activity (1 week). In this study, only the data from learners from 2022 batch were included for the analysis. There were three to seven learners in each discussion group (KBCM class: 9 discussion groups; summary writing class: 6 discussion groups). Figure 4 shows in detail the order and the duration of each activity.

Figure 4

Procedures and Data Collection



As displayed in Figure 4, learners' conceptual understanding was captured three times: before the information-organizing activities, before the discussion, and after the discussion. The conceptual knowledge test consisted of eight questions measuring the understanding of the conceptual knowledge about vector space axioms, which is related to the discussion topic.

Coding Process of the Discussion Transcript

The discussion transcript from the KBCM and the summary writing classes were retrieved from the Moodle forum and coded using a coding frame based on the works of Junus (2023) and Shea et al. (2010). Two coders independently coded the transcript, and then a reliability analysis was performed to check the discrepancies between the coding results and establish reliability as suggested by Campbell et al. (2013). To begin, the first coder coded the transcript. The meaning unit was one message, which might contain one or more descriptors of inquiry stages. The coding scheme and sample codes (excerpt) are shown in the Appendix. The second coder then coded a randomized sample of the transcript (30% of the messages). Both coding results were compared, and the Brennan-Prediger Kappa value (the reliability coefficient) was calculated using MAXQDA (https://www.maxqda.com/). The Kappa value of 0.98 was obtained, which is considered as almost perfect agreement according to Landis and Koch (1977). After the coders then discussed and reached a consensus regarding the discrepancies, the agreed coded transcripts were used for the analysis.

Data Analysis

In this study, RQ1 (To what extent did the occurrence of inquiry stages in the discussion differ?) and RQ2 (To what extent did the pattern of transitions between inquiry stages in the discussion differ?) were posed to investigate the difference in the discussion process of the KBCM and the summary writing treated classes based on: (a) the occurrence of inquiry stages and (b) the transition between inquiry stages. These are the factors that characterize the quality of online discussions. Additionally, RQ3 (Is there a relationship between the learners' conceptual understanding after the treatment and the occurrence of each inquiry stage in the discussion?) was posed to investigate whether the treatment was one of the factors that contributed to the discussion process.

For answering RQ1, we captured the number of messages containing each inquiry from both classes. In terms of the CoI framework, at least, increased quantities of the occurrence of each inquiry stage indicate better discussion. Among triggering event, exploration, integration, and resolution, the rate of messages containing each inquiry stage was calculated for both classes, and then, non-parametric statistical tests (Mann-Whitney and Wilcoxon signed rank tests) were performed. Holm's method was used to adjust the original p-values. The purpose of these statistical tests is to check the difference in the rate of messages containing inquiry stages between the classes. The effect sizes were interpreted according to a benchmark developed by Funder and Ozer (2019). The statistical tests were performed using R packages.

For answering RQ2, we captured the number of directed transitions between inquiry stages that were happening in the discussion groups of both classes. In addition to the quantities of the occurrence of each inquiry stage, in CoI-based discussion, the directed transitions among inquiry stages are important. Basically, CoI-based discussions are expected to proceed in the order corresponding to triggering event, exploration, integration, and resolution. In addition to that, according to the needs, learners can return to any one of the prior inquiry stages. Whether or not learners follow the such transition can be the criteria for conducting CoI-based discussions. To capture the pattern of directed transition, we use ordered network analysis (ONA) with discussion group as the unit of analysis. This is a technique for modeling the structure of connections in data.

Similar to epistemic network analysis (ENA), ONA assumes that: (1) it is possible to identify a set of meaningful features in the data (codes) systematically; (2) the data has local structure (conversations); and (3) an important feature of the data is the way that codes are connected to one another within conversations (Shaffer et al., 2016). However, in ONA, the order of appearance of each code in the data frame is accounted. Thus, ONA could uncover the directed connections between two or more codes within a coded data frame, i.e., the cumulative co-occurrence of two or more codes within one or several messages at a certain point with a certain sequence in a coded data frame (Shaffer et al., 2016). ONA generates a network representing the codes (nodes) and calculates the weight of the connections between the codes, which then allows a statistical test on the projected points in the ONA plane to be performed to determine whether two classes' discussion groups showed a different pattern of connections. In this study, the ONA was conducted through the ENA webtool (https://www.epistemicnetwork.org/) using the discussion transcripts retrieved from both the KBCM and the summary writing classes' discussion groups.

For addressing RQ3, we captured the pre-test and the first post-test scores. The former represents the baseline level of conceptual understanding before the treatment, while the latter represents the level of understanding after the treatment. To check if the improved conceptual understanding, as a result of the treatments, contributed to the discussion process, the correlations between the post-test scores and the rate of messages for each inquiry stage were calculated. Spearman's ρ correlation coefficients as well as the *p*-values were calculated to check whether significant correlations could be found between the pre-test, the first post-test, and the rate of messages containing each inquiry stage. A benchmark by Dancey and Reidy (2007) was used for interpreting the coefficients. The original *p*-values for each correlation were adjusted using Benjamini-Hochberg's method. Both the coefficients and the *p*-values were shown to avoid misunderstanding the strength and probability of the occurring relationship, as suggested by Akoglu (2018).

Results

Rate of Messages Containing Each Inquiry Stage

The KBCM and the summary writing classes showed a total of 105 messages and 83 messages, respectively**.** One message might contain more than one inquiry stage code. In addition, the teacher-created concept map was mentioned one time in the KBCM class, while in the summary writing class, the teacher-created summary was mentioned one time. Table 2 shows the descriptive statistics of the messages containing each inquiry stage from both classes.

Table 2

Descriptive Statistics of the Messages Containing Each Inquiry Stage

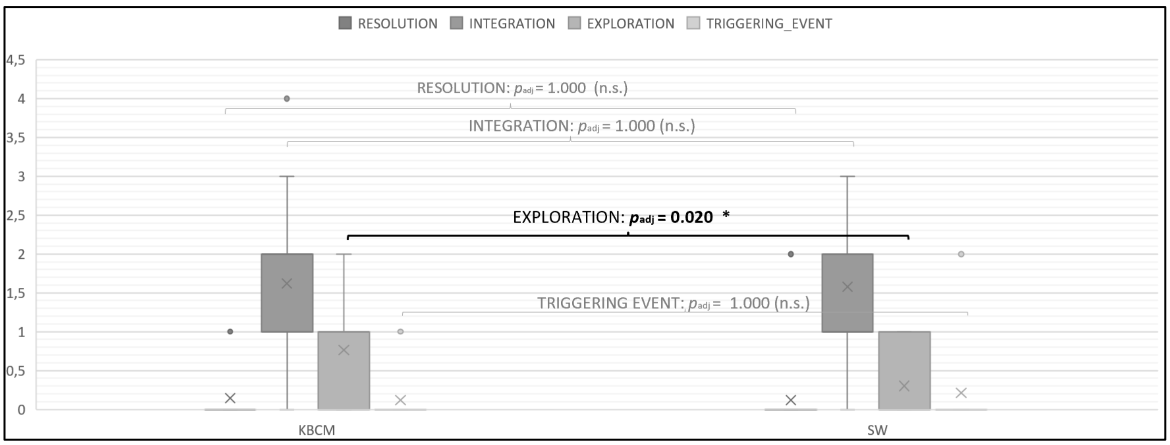
	Triggering Event		Exploration		Integration		Resolution	
	KBCM (*n*=42)	SW (*n*=33)	KBCM (*n*=42)	SW (*n*=33)	KBCM (*n*=42)	SW (*n*=33)	KBCM (*n*=42)	SW (*n*=33)
Total	5	7	32	10	68	52	6	4
Min	0	0	0	0	0	0	0	0
Max	1	2	2	1	4	3	1	2
Median	0	0	1	0	2	1	0	0
Mean	0.12	0.21	0.76	0.30	1.62	1.58	0.14	0.12

Note. KBCM: Kit-build concept mapping; SW: Summary writing.

Non-parametric tests (Mann-Whitney test) were performed on the data. After adjustment using Holm's method, the results show that the KBCM class showed a significantly higher rate of messages (i.e., number of messages per learner) containing exploration (original *p*-value: 0.005; adjusted *p*-value: 0.020; effect size *r*: 0.330 [large]). No significant differences were shown in the rate of messages containing other inquiry stages. Figure 5 shows the comparison of the rate of inquiry stages-containing messages between the KBCM and summary writing classes.

Figure 5

Number of Messages Containing Each Inquiry Stage Per Participant



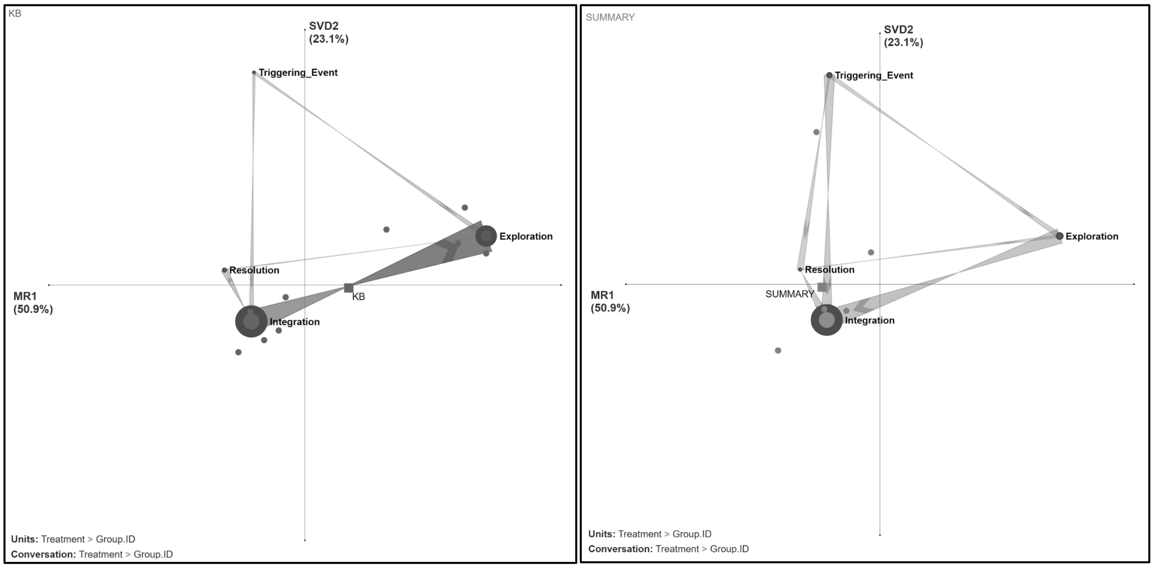
Note. KBCM: Kit-build concept mapping group; SW: Summary writing.

Transition Between Inquiry Stages

The ONA plot illustrates the directed transitions between inquiry stages that were conducted by the learners in discussion groups in both KBCM class (9 discussion groups) and summary writing class (6 discussion groups). The nodes represent the inquiry stages, whereas the directed links represent the existence of certain directed transitions between the inquiry stages. The thickness of the links represents the weight of the transitions, i.e., the number of the co-occurrence of two inquiry stages within two adjacent messages across the conversations in a discussion group. Figure 6 shows the ONA plot illustrating the transitions between the inquiry stages that were made by learners within the conversation of the discussion groups in the KBCM (left) and summary writing (right) classes with the projected points showing each discussion group. Mean rotation was applied to place the means of the projected points of the two classes with different treatments (KBCM & summary writing) as close as possible to the x-axis, which maximizes the distances between them, as described by Tan et al. (2024). The x-axis represents the rotated SVD1, while the y-axis represents the SVD2, which were obtained from the dimensional reductions of the vectors that represent the pattern of transition between inquiry stages (co-occurrences of inquiry stage codes).

Figure 6

The Connections Between Inquiry Stages in the KBCM and Summary Writing Classes



Note. Left: KBCM discussion groups' connections; Right: Summary writing discussion groups' connections.

We checked whether the discussion groups of the two classes have different patterns of directed transitions between the inquiry stages. The square points represent the mean values of the x and y axes for each class, and they are plotted in different locations. In ONA, it is possible to perform statistical tests using these representative values on the two-dimensional plane between the two classes. This approach has been used in prior studies in CoI-based discussion, e.g., Rolim et al. (2019), that used epistemic network analysis (ENA)–Note that ENA is in principle similar to the ONA except in terms of the order of codes' appearances. The non parametric permuted Brunnel-Munzel tests were conducted for each of the x and y axes between the classes (Neubert & Brunner, 2007). The results are shown in Table 3.

Table 3

Non-Parametric Test of Significance for The Projected Points in The ONA Plane

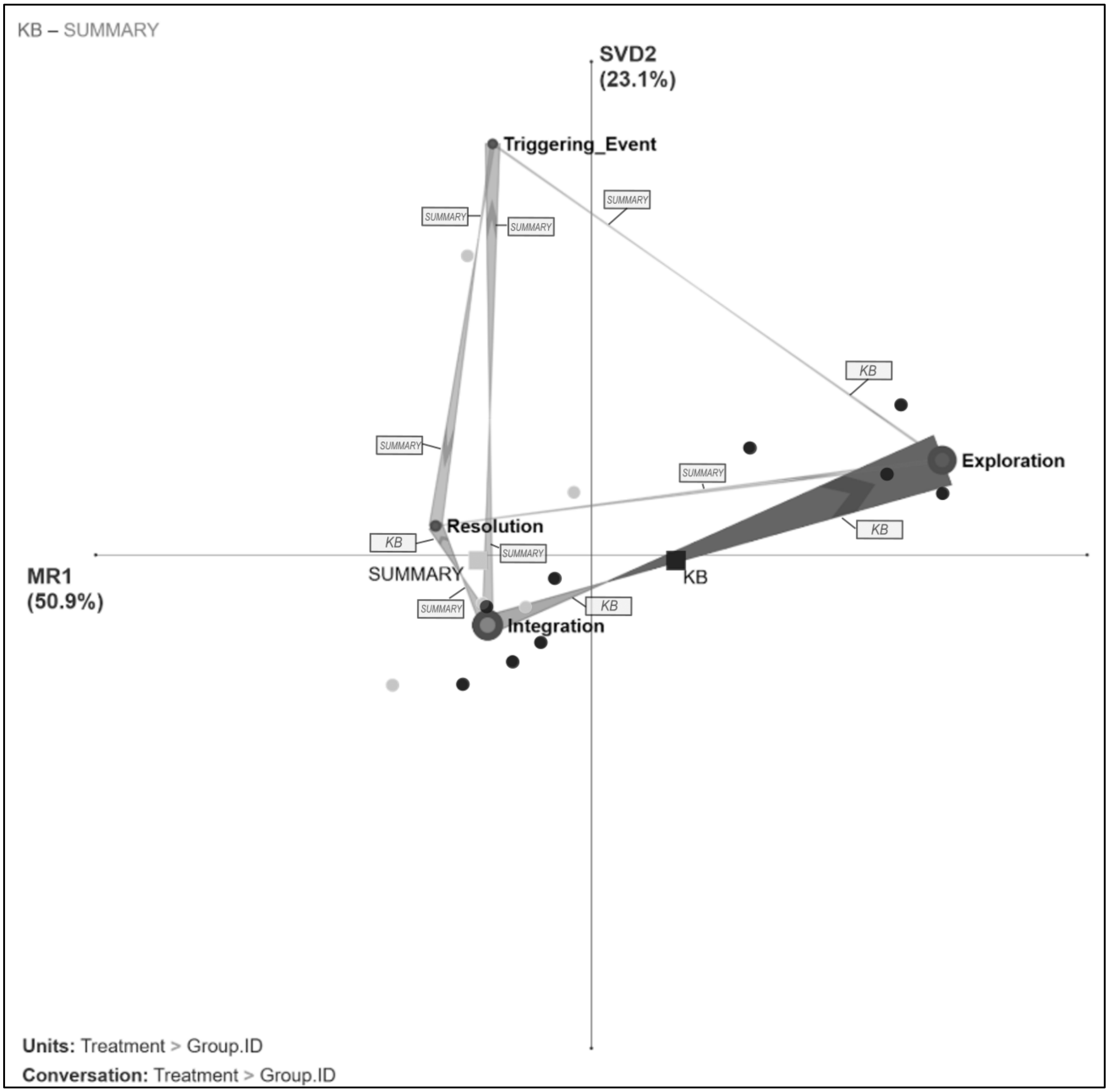
	Median		p	Effect size (stochastic superiority)
	KBCM ($n_{\text{group}} = 9$)	SW ($n_{\text{group}} = 6$)		
x-axis: MR1	-0.081	-0.253	**0.038 ***	0.815 (large)
y-axis: SVD2	-0.051	-0.111	0.580 (n.s.)	0.593 (small)

Note. KBCM: Kit-build concept mapping group; SW: Summary writing.

The non-parametric tests of the projected points shown in Table 3 checked if the discussion groups in the two classes exhibited a different pattern of directed transitions between inquiry stages based on the whole network that was projected on the ONA plane. A significant difference in either *x* or *y* axes indicates a significantly different pattern shown by the discussion groups in the two classes. In addition, the simple comparison shown in Figure 7 can show in what manner the mentioned pattern of directed transitions differed between the classes (e.g., what directed transitions appeared or not appeared in the discussion groups of one class, etc.). Based on the results shown in Table 3 and Figure 7, the discussion groups from the KBCM and summary writing classes exhibited a different pattern of transitions between inquiry stages, in a way that (a) the discussion groups in the KBCM class tended to show more integration→exploration, which is acceptable (e.g., exploring materials after integrating some ideas to support arguments), as well as more integration→resolution (one of the expected transitions according to the practical inquiry model) and (b) the learners in the summary writing group tended to show more integration→triggering event, which may be a reasonable transition (e.g., asking questions after integrating some ideas) and more triggering event→resolution, which may indicate some jumps skipping the stages of exploration and integration.

Figure 7

Comparison Plot of the KBCM and Summary Writing Classes



Note. The labels on connections in the figure indicate which group—KBCM or summary writing—has a higher weight (representing the numerically larger value, not based on statistical test results). The projected points represent the discussion groups in both classes (KBCM: black; summary writing: gray).

Conceptual Knowledge Understanding

The following tests of conceptual knowledge related to the discussion topic were administered: (a) the pre-test (after the lecture session before the information-organizing activities), (b) the first post-test (after the information-organizing activities before the discussion), and (c) the second post-test (after the discussion). The descriptive statistics of the scores for the mentioned tests are shown in Table 4.

Table 4

Descriptive Statistics of The Conceptual Knowledge Test Scores

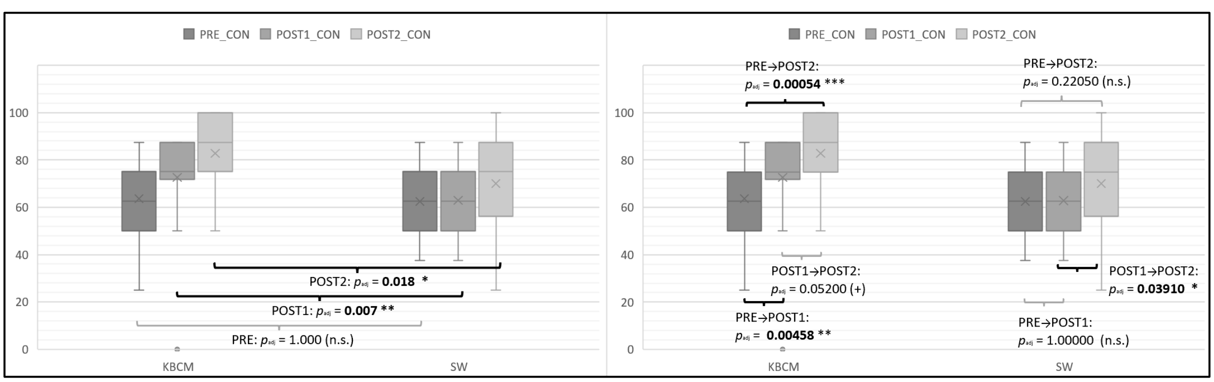
	Pre-test		First Post-test		Second Post-test	
	KBCM (*n*=42)	SW (*n*=33)	KBCM (*n*=42)	SW (*n*=33)	KBCM (*n*=42)	SW (*n*=33)
Min	25.00	37.50	0.00	37.50	50.00	25.00
Max	87.50	87.50	87.50	87.50	100.00	100.00
Median	62.50	62.50	75.00	62.50	87.50	75.00
Mean	63.69	62.50	72.62	62.88	82.74	70.08

Note. KBCM: Kit-build concept mapping; SW: Summary writing.

The test scores of both the KBCM and summary writing classes were compared using non-parametric tests (Mann-Whitney & Wilcoxon tests). The *p*-values were calculated and adjusted using Holm's method. The results of the tests showed that both classes started from the same level of conceptual knowledge related to the discussion topic (original *p*-value: 0.621; adjusted *p*-value: 1.000). After the treatment (before the discussion), the KBCM class showed a significantly higher score for conceptual knowledge compared to the summary writing group (original *p*-value: 0.001; adjusted *p*-value: 0.007; effect size *r*: 0.420 [very large]). In addition, only the KBCM class experienced a significant increase in the test scores before the discussion (original *p*-value: 0.000573; adjusted *p*-value: 0.004584; effect size *r*: 0.514 [very large]). Figure 8 shows the comparisons for the pre-test, first post-test, and the second post-test scores of both the KBCM and summary writing classes.

Figure 8

The Test Scores Measuring Conceptual Understanding Related to Discussion Topic



Note. KBCM: Kit-build concept mapping; SW: Summary writing.
The diagram on the left shows inter-class comparisons, while the diagram on the right shows the comparisons of the change in the test scores.

After the discussion, the KBCM class scored significantly higher for the second post-test than the summary writing class (original *p*-value: 0.003; adjusted *p*-value: 0.018; effect size *r*:

0.340 [large]). However, only a marginally significant increase in the test scores (the first and the second post-test) was observed in the KBCM class.

Correlation Between the Conceptual Knowledge Level Before the Discussion and the Rate of Inquiry Stage-Containing Messages

Correlation analysis was conducted to investigate whether there are relationships between learners' understanding of conceptual knowledge related to the discussion topic and the occurrence of each inquiry stage they performed during the discussion. Table 5 shows the correlation table showing the Spearman ρ values for each variable.

Table 5

Correlation Analysis Between The Inquiry Stages, Pre-Test Score, and The First Post-Test Score

	Triggering Event	Exploration	Integration	Resolution	Pre-test	Post 1
Triggering Event		0.22 (p = 0.0636)	0.13 (p = 0.2770)	0.22 (p = 0.0605)	0.06 (p = 0.5997)	-0.02 (p = 0.8815)
Exploration	p_{adj} = 0.7655		-0.12 (p = 0.3107)	0.02 (p = 0.8532)	0.12 (p = 0.3210)	0.42 (p = **0.0002**)
Integration	p_{adj} = 0.5675	p_{adj} = 0.6019		0.15 (p = 0.1910)	0.09 (p = 0.4414)	0.05 (p = 0.6634)
Resolution	p_{adj} = 0.4537	p_{adj} = 0.8815	p_{adj} = 0.5675		0.15 (p = 0.1878)	-0.06 (p = 0.6320)
Pre-test	p_{adj} = 0.7655	p_{adj} = 0.6019	p_{adj} = 0.6857	p_{adj} = 0.5675		0.17 (p = 0.1430)
Post 1	p_{adj} = 0.8815	p_{adj} = **0.0030**	p_{adj} = 0.7655	p_{adj} = 0.7655	p_{adj} = 0.5675	

Note. The Spearman ρ values are shown outside the brackets in the upper diagonal.
The original p values are shown inside the brackets in the upper diagonal.
The BH method adjusted p values are shown in the lower diagonal.
Post 1: The first post-test.

After adjustment using Benjamini-Hochberg's method, there was a significant and moderate correlation between the first post-test score and the rate of exploration messages (Spearman ρ: 0.42). No significant correlation was observed between the test scores and the other inquiry stages (adjusted p-value ≥ 0.05).

Discussion

Answering RQ1: To what extent did the occurrence of inquiry stages in the discussion differ?

The results regarding the rate of messages containing each inquiry stage indicate that learners in the KBCM class tended to perform more *exploration* in discussion (see Figure 5). Many studies reported that exploration is the most performed inquiry stage (Liu & Yang, 2012; R. L. Moore & Miller, 2022; Olesova et al., 2022). Despite being less intellectually demanding to perform compared to the higher-level stages of integration and resolution, exploration is an important part of the inquiry process in which learners try to gather and share ideas from relevant sources for proposing initial solutions or completing tasks (Garrison et al., 2001; R. L. Moore & Miller, 2022). As a result, a higher number of explorations may provide diverse ideas for the learners to engage in debates on the solution during the integration stage.

Related prior studies with less balanced sample sizes found that KBCM has the potential to be better at fostering triggering event, exploration, and integration messages as well as fostering more critical thinking in a discussion compared to the traditional summary writing (Hasani et al., 2023, 2024; Hasani, Junus, Sadita, Hirashima, et al., 2025). A concept map generally provides common vocabularies and terms used within a knowledge domain (Colosimo & Fitzgibbons, 2012; Novak & Cañas, 2006). Therefore, it has been suggested that if a concept map represents the knowledge related to a topic of a discussion activity, using it potentially increases learners' awareness of the common terms and the interconnected concepts related to the topic (Hasani et al., 2023). This is in line with past studies on concept mapping in general, which suggested the potential of concept mapping as a visualized knowledge representation to enable learners to recognize relationships between concepts and encourage discussions (Baroody & Bartels, 2000; Davies, 2011).

The learners in the KBCM class might conduct more exploration than the summary writing group because they are able to recognize the correct terms to search for relevant resources and form initial answers to the problem posed in the discussion. Williams (1998) suggested that a concept map also represents knowledge fluency (e.g., the use of correct terms representing an idea in a knowledge domain); thus, being able to make one reflects its maker's fluency in the knowledge domain. In contrast, the learners in the summary writing class might have less awareness about the correct terms used in the knowledge domain due to the freedom to use any terms they like when writing the summary despite being provided with a list of keywords as a guide. In a worse case, learners might have performed verbatim copy-paste of the sentences when writing the summaries, which may constitute a non-reflective process as recalling word by word does not mean comprehension (Chuenchaichon, 2022; Spirgel & Delaney, 2016; Wang & Yu, 2024). Thus, different individuals might make a different summary with various qualities. The difficulty in making well-organized and accurate summaries (e.g., using correct terms, no copy-paste sentences), as suggested by Pilegard and Fiorella (2016), might have led to less awareness of the correct terms and concepts in the summary writing class and contributed to the lower exploration in the summary writing class.

However, in regards to the differences in the results of this study and the prior studies on KBCM (e.g., Hasani, Junus, Sadita, Hirashima, et al., 2025), there is an indication that other factors might have played a significant role in affecting the potential of KBCM for fostering *other* inquiry stages. One of the possible influential factors is whether the learners actively mentioned and referred to the teacher-created map throughout the discussion. The teacher-created concept map and summary were mentioned only once in the respective classes. As a result, there was a possibility of inert knowledge in both groups, which might have led to the low amount of triggering event and resolution-containing messages in both groups and the similar amount of integration between the two classes. Inert knowledge is acquired knowledge that was not used when necessary during specific problem-solving episodes (Renkl et al., 1996).

Explicit mentioning of the teacher-created map or summary may trigger (activate) reflection on the information-organizing activity; lacking it may hinder the full potential of KBCM and summary writing. Past studies emphasized the importance of reflection and providing direct instruction for effective progression through inquiry stages (Garrison, 2019; Garrison et al., 2001; Pawan et al., 2003). Therefore, as a practical implication, direct instruction to reflect on the KBCM attempt is recommended to encourage learners to recall and reflect on the knowledge they organized during the KBCM attempt, thus encouraging further progression through inquiry stages.

Answering RQ2: To what extent did the pattern of transitions between inquiry stages in the discussion differ?

The results of the ONA show that the KBCM and the summary writing discussion groups experienced a *significantly different pattern of directed transitions* between inquiry stages (p = 0.038 on the x-axis of the projected ONA plane) in which: (a) the KBCM discussion groups showed a tendency to *transition from integration to exploration,* which is an acceptable transition that may be performed in discussion, as well as to *transition from integration to resolution*, which is a necessary transition (see Figure 7); and (b) the summary writing discussion groups showed a tendency to transition from *integration to triggering event*, which is also acceptable considering the possibility of questioning after integration, and *from triggering event to resolution*, which is a jump skipping exploration and integration. The transition between exploration and integration, as well as between integration and resolution, are important transitions that learners need to perform in a meaningful inquiry. Spending sufficient time to perform preceding inquiry stages before progressing to the next is the characteristic of a scientific inquiry, which served as the basis of the CoI framework (Garrison, 2016). Thus, considering the tendency of jumping the stages among summary writing discussion groups, the KBCM discussion groups showed better patterns of inquiry compared to the summary writing group.

Doing exploration after integration may indicate an attempt to reevaluate understanding expressed during the idea integration by providing relevant learning materials that shows exploring ideas, as described in the descriptors of exploration (Garrison et al., 2001). Concept mapping, in general, has to help learners realize the relationship between important concepts (Davies, 2011). Therefore, KBCM, as a type of concept mapping activity, might have helped learners make connections between ideas and trigger them to share relevant information and brainstorm expressed ideas after seeing a series of organized information in the discussion thread.

A past study on inquiry stages emphasized the importance of enabling the learners to progress from exploration to integration and, finally, resolution (Garrison et al., 2001). Learners have been reported to experience difficulty integrating and building on others' ideas (Pawan et al., 2003). A related past study with unbalanced sample sizes showed that KBCM has the potential to enable learners to experience the following transitions: Triggering event-exploration-integration (Hasani, Junus, Sadita, Ayano, et al., 2025). In regards to the findings, this study provides further evidence that, compared to summary writing, KBCM is mostly effective for encouraging integration→exploration and integration→resolution, which is one of the important transitions that are usually difficult to surpass, as suggested in some studies that showed relatively low amounts of messages containing higher-level inquiry stages (Bissessar et al., 2020; Garrison et al., 2001; Lee, 2014; Vaughan & Garrison, 2005).

Answering RQ3: Is there a relationship between the learners' conceptual understanding after the treatment and the occurrence of each inquiry stage in the discussion?

The correlation analysis suggested a moderate yet *significant and positive* correlation between the learners' *conceptual understanding* after the treatment and the *rate of exploration* messages in the discussion (Spearman's $\rho = 0.42$; $p_{adj} = 0.003$), as shown in Table 5. This result indicated that the learners' conceptual knowledge, as one of many factors, contributed to their discussion behavior in exhibiting exploration messages.

As for the possible explanation of this finding, having an improved conceptual understanding of the discussion topic-related knowledge, i.e., knowledge of the concepts and their relationships (Crooks & Alibali, 2014), might have helped learners to search for relevant resources more effectively (e.g., from books, the internet, etc.). This aligns with a prior study that suggested that having internalized knowledge affects exploratory behavior during a discussion (Hou et al., 2009). In the KBCM class, a better awareness of relevant terms as well as how the terms are interrelated (i.e., internalizing knowledge) may lead to an ease of searching the relevant resources, which, in turn, encourages the learners to share their first thought on the solution based on the resources that they have read or shared. This finding supports prior studies that asserted the potential of concept mapping to develop conceptual understanding (Montpetit-Tourangeau et al., 2017; Varoglu et al., 2023).

Conclusion

Making learners actively perform the inquiry process in an online discussion is difficult, particularly among novice students. KBCM has been suggested as an alternative to improve discussion preparatory activities to realize a productive inquiry. However, there is a lack of evidence regarding KBCM's effect on discussion quality that involves comparison with the typical summary writing under a balanced sample size. Thus, its effectiveness needs to be confirmed. This study proposes and provides further evidence of the KBCM's effectiveness as an alternative information-organizing activity within pre-discussion preparation for improving online discussion quality. The KBCM and summary writing classes showed a significantly different pattern of directed transitions between inquiry stages. The results indicate that KBCM is more effective for: (a) fostering exploration; and (b) encouraging integration→exploration and integration→resolution transitions compared to the traditional summary writing. Moreover, there was also a significantly higher rate of exploration in the KBCM class and a significantly positive correlation between the rate of exploration and the first post-test scores. Learners' conceptual knowledge related to the discussion topic was found to be one of the factors associated with the rate of exploration messages in the discussion. Better improvement in the conceptual knowledge in the KBCM class might have influenced learners' exploratory behavior. In addition, whether learners mentioned and reflected on their KBCM attempts was suggested to be one of the other influential factors. Thus, direct instruction to actively make use of the concept map and to reflect on the KBCM attempts is recommended to maximize the effect of KBCM for improving discussion. Despite involving comparisons with balanced sample sizes, this quasi-experimental study is limited to conducting the experiment in: (a) real classroom settings where many other factors might have played an influential role; and (b) a specific mathematics subject. Therefore, the findings could not yet be generalized. Future studies may be conducted in other learning contexts.

Acknowledgement

This work was supported by JSPS KAKENHI Grant Numbers 23K25700 and 23K11357.

Declarations

Due to the fact that the institutional board had not yet been formed when this study was being conducted, this study has received ethical clearance and has been approved by the teaching team of the involved classes.

Conflict of Interest

The authors declare no conflict of interest in this study.

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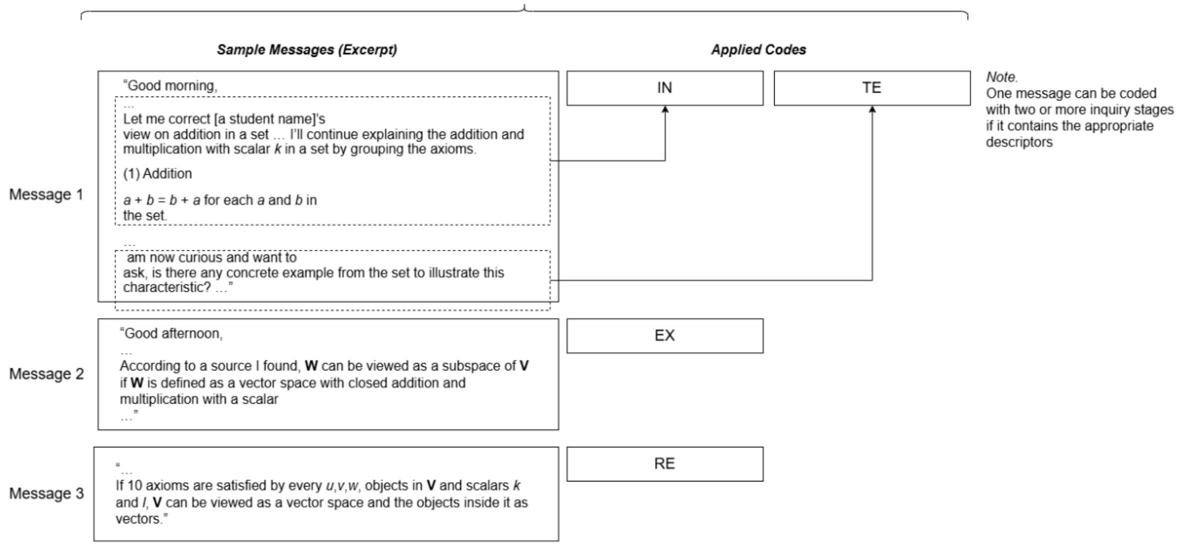
Appendix

Coding Scheme and Examples of Coded Messages (Excerpt)

Coding Scheme

Inquiry Stages Code	Descriptors
Triggering Event (TE)	Identifying problems Asking questions Expressing curiosity or puzzlement
Exploration (EX)	Brainstorming Exchanging prior experience and relevant materials Unsubstantiated agreement or disagreement
Integration (IN)	Connecting and synthesizing ideas Creating solutions Substantiated agreement or disagreement
Resolution (RE)	Applying solutions Defending solutions



Note. The descriptors were based on Shea et al. (2010) and Junus (2023)

The Relationships Between Adolescents' Academic Self-Regulation, Motivational Strategies, and Academic Achievement in Distance Education Process

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Abstract

Considering the spread of distance education worldwide and the acceleration of this situation by the COVID-19 epidemic, this study aimed to explore the relationships between adolescents' academic self-regulation skills and academic performance, and the mediating role of motivational strategies during distance learning. The sample was composed of a total of 311 adolescents (71% girls; M_{Age} = 15.70, S = 1.05) attending public high schools from different socioeconomic levels in the central districts of Ankara, Republic of Turkey. The results revealed gender differences in self-regulation and cognitive strategy use, while academic achievement varied by adolescence stage. Maternal education positively correlated with adolescents' achievement. Duration of participation in distance education impacted academic achievement, with longer participation linked to higher scores. Increased use of self-regulation and motivational strategies correlated with higher academic achievement. Path analysis results indicated that the effect of self-regulation on adolescents' academic achievement in distance education was mediated through motivational strategies. These findings underscore the importance of motivational processes in adolescent academic success, shedding light on critical skills for thriving in distance education.

Keywords: Distance education, self-regulation, motivational strategies, academic success, adolescents

Gür, T., & Yaban, E. H. (2025). The relationships between adolescents' academic self-regulation, motivational strategies, and academic achievement in the distance education process. *Online Learning, 29*(3), 285-310. https://doi.org.10.24059/olj.v29i3.4673

Introduction

The pandemic has led to profound educational shifts, impacting education. Distance education has emerged as a crucial method to ensure uninterrupted learning during this period (Moreno & Gortazar, 2021). Children and adolescents are away from their schools, friends, and even family members for indefinite periods (Huremović, 2019). Children face uncertainties and anxiety, potentially affecting their academic motivation and achievement (Trickey & Black, 2000). To mitigate educational losses, a smooth transition to distance education post-pandemic is crucial, prompting widespread adoption of hybrid education models (Moreno & Gortazar, 2021). For these reasons, investigating the effect of self-regulation skills and motivation on academic performance in distance education is imperative.

Research on middle school, high school, and undergraduate levels suggests that self-regulation and motivation contribute to success in distance education (Cho et al., 2017; Greene & Azevedo, 2009). However, studies on success in distance education (Cho et al., 2021; Wang et al., 2013) were mostly conducted for graduate students. Studies conducted in high school samples are limited. We examined the relationships between self-regulation and motivational strategies and the academic achievement of adolescents in the distance education process together. In addition, the relationship between different types of self-regulation and motivation with academic achievement in distance education was also addressed. In line with the aforementioned information, the constructs addressed within the scope of the study are introduced below and the possible relationships between the variables are explained in the light of the literature.

Literature Review

Distance Education

The coronavirus pandemic has been the main factor in the rapid transition to distance education primarily due to the need for social isolation (Viktoria & Aida, 2020). To ensure uninterrupted learning, distance education has entered our lives as a viable and crucial educational method and thus has greatly affected the field of education (Moreno & Gortazar, 2021; Viktoria & Aida, 2020). Consequently, distance education has started to be used compulsorily and widely during the pandemic. Furthermore, in case of disruption of the traditional education system after the pandemic, a smooth transition to the distance education system has been recommended to prevent interruptions in learning (Moreno & Gortazar, 2021). Distance education is often referred to as the education model of the new generation, particularly for individuals born after 2000 who are considered digital individuals (Öz-Ceviz et al., 2020). This method connects teachers and students through internet technologies, allowing learning to occur without time or space constraints and enabling students to learn at their own pace (Wei & Chou, 2020). As a result, this model places strong emphasis on the value of self-learning skills, underscoring the critical role of self-regulation skills and motivation in facilitating effective learning in a distance education context.

Self-Regulation and Distance Education

Self-regulation skills contribute to academic success in both traditional and distance education settings. Self-regulation involves actions individuals take to adapt towards their goals effectively (Zimmerman, 2000). In an academic context, it refers to students actively evaluating and adjusting their behavior, motivation, and cognitive skills to align with their learning goals, while also considering environmental constraints (Pintrich, 2000). Students lacking adequate academic self-regulation skills often struggle in distance education (Brooks et al., 2001). Studies with high school (Hatami et al., 2018; Sáez-Delgado et al., 2023) and undergraduate/graduate students (Wang et al., 2013; Kashif & Shahid, 2021; Wehrhahn et al., 2024) demonstrate that those employing self-regulation skills in distance learning environments fare better.

Motivational Strategies and Distance Education

Motivational strategies, which define the individual's perception of the tools he/she uses for learning goals and his/her performance, include two basic dimensions: self-regulation strategies and motivational beliefs (Pintrich & De Groot, 1990). *Self-regulation strategies* are the processes students use to access information by their learning goals, including the subdimensions of cognitive strategy use and self-regulation (Zimmerman, 1989; Zimmerman, 1990). Cognitive strategy usage entails methods such as comprehending, rehearsing, and organizing to learn and retain information (Pintrich & De Groot, 1990), while self-regulation involves monitoring and adjusting behaviors, cognitions, and motivations to meet goals amidst environmental influences (Pintrich, 2000). *Motivational beliefs* encompass students' perceptions of their academic responsibilities and cognitive activities, with subdimensions including self-efficacy, intrinsic value, and test anxiety (Pintrich & De Groot, 1990). Self-efficacy involves making and sustaining efforts to succeed, intrinsic value pertains to finding classroom responsibilities engaging and meaningful, and test anxiety encompasses thoughts that may adversely impact academic performance and exams (Pintrich & De Groot, 1990; Schunk & Usher, 2012).

Motivation is pivotal for overcoming challenges and achieving goals in distance education environments (Deimann & Bastiaens, 2010; Yaban & Gaschler, 2024), thereby enhancing academic achievement. Research indicates that employing motivational strategies benefits academic performance in both face-to-face (e.g., Ning & Downing, 2010; Liu et al., 2014; Kryshko et al., 2020) and distance education (e.g., Hodges, 2004).

Self-Determination Theory

This study adopts self-determination theory (SDT) as its theoretical framework because it encompasses self-regulation and motivation, recognized as crucial factors for positive academic outcomes in distance education, providing a comprehensive perspective. SDT proposes a motivational schema based on intrinsic and extrinsic factors that shape an individual's behavior and reveal patterns of motivation and self-regulation (Deci & Ryan, 2000; Ryan & Deci, 2000). Amotivation, extrinsic motivation, and intrinsic motivation refer to states of motivation. Individual's actions move from a state of least autonomy to a state of most autonomy.

Amotivation is a lack of intention, desire, and energy to act (Deci & Ryan, 2008) and related to low academic achievement in adolescents (Taylor et al., 2014). Extrinsic motivation entails engaging in behavior to attain a specific outcome and is categorized into four categories: (1) external regulation (action driven by external factors); (2) introjected regulation (partial internalization of action with internal pressures); (3) identified regulation (valuing and embracing the action); and (4) integrated regulation (actions aligning with individual values and self-congruence) (Deci & Ryan, 2000; Deci & Ryan, 2008). Internalized regulation denotes the most effective internalization (Deci & Ryan, 2000), akin to intrinsic motivation (Deci & Ryan, 2008). However, while integrated regulation aims for outcomes through behavior, intrinsic motivation arises from finding the behavior inherently interesting and enjoyable, reflecting self-determined behavior prototypes (Ryan & Deci, 2000).

In general, motivation is divided into two categories: controlled motivation (introjected and external regulation) and autonomous motivation (integrated, identified, and internal regulation). In controlled motivation, behaviors are generated by external pressure and cannot be internalized (Deci & Ryan, 2008). Areepattamannil et al. (2011) indicated that when behaviors cannot be internalized, academic performance indicates negative consequences.

Research examining the role of self-regulation and motivation on academic performance in distance education primarily comprises undergraduate and postgraduate students. These studies consistently demonstrate that achievement and motivation are positively related (Goulimaris, 2015; Rêka et al., 2015). Conversely, the current study focuses on adolescents aged 14 to 18, encompassing middle and late adolescence stages.

The Mediating Role of Motivational Strategies

Self-regulation skills can foster high academic achievement by increasing students' motivation, which is one of the basic skills for learning (Kosnin, 2007; Uçar & Zarfsaz, 2023). Motivated students typically display enthusiasm for challenging tasks, invest effort in learning endeavors, and consequently exhibit favorable academic outcomes (Brenner, 2022).

These skills also facilitate the use of motivational strategies (e.g., Daniela, 2015). Virtanen et al. (2015) found a relationship between certain motivational strategies (e.g., self-efficacy, performance anxiety) and self-regulation among undergraduate students. Moreover, reciprocal effects between these constructs were emphasized (Ning & Downing, 2010; Yaban & Gaschler, 2024). In their study focusing on students aged 16 to 19 based on the SDT, Liu and colleagues (2014) found that students exhibiting autonomous self-regulation also used motivational strategies. In a distance education environment, students with high self-regulation and motivation levels are likely to have high performance levels (Semmar, 2006). However, most of the studies focus on undergraduate and graduate students.

The Current Study

It is crucial to identify the factors influencing academic success in the context of widespread distance education that has become widespread with the pandemic. Thus, this study aimed to (1) identify the status of adolescents engaged in distance learning, (2) investigate the relationships between academic self-regulation skills, usage of motivational strategies, and the academic performance of adolescents, and (3) examine whether motivational strategies mediate the association between self-regulation skills and academic achievement. Furthermore, the study assessed the group differences based on developmental stage, gender, and socioeconomic status (SES). Specifically, the following hypotheses were tested:

(1) Adolescent students' self-regulation skills in the academic field are related to their success in distance education environments.
(2) There is a relationship between adolescents' ability to use motivational strategies and their success in distance education environments.
(3) Motivational strategies have a mediating role in the relationship between adolescents' self-regulation skills and their academic achievement.
(4) We expect that academic achievement, self-regulation, and motivational strategies will differ according to adolescents' age, gender, SES (e.g., maternal education level), and adolescents' distance education status. Based on previous research, we expect girls to have higher academic achievement (Carvalho, 2016), self-regulation (Liu et al., 2021), and intrinsic motivation (Oga-Baldwin & Fryer, 2020) than boys. Studies also indicate

that self-regulation (Størksen et al., 2015), motivational strategies (Tan et al., 2023), and academic achievement (Li et al., 2020) vary with socioeconomic status. Academic achievement decreases with age (Hartanto et al., 2018). Finally, participation in distance education affects self-regulation (Landrum, 2020) and motivational strategies (Geng, 2022).

Method

Participants

A total of 315 adolescents attending the first through fourth grades of public high schools in the central districts of Ankara, Turkey province took part in the study. Four participants were excluded from the analysis because they filled out the scales incorrectly. A priori sample size estimation for regression was performed using G*Power with 95% power, $\alpha = .05$ type I error, 0.3 effect size (Faul et al., 2009), and the minimum required sample size was calculated as 232.

Of the participants included in the study, 222 were girls (71%) and 89 were boys (29%). The mean age was 15.70 years ($S = 1.05$). Most of the participants were in the first (36.3%) and second (37.3%) years of high school. The educational level of the participants' parents was assessed on a 6-point scale (0 = illiterate to 5 = master's degree and above). It was observed that 36% of the mothers were high school graduates, 26.7% were university graduates, 18.6% were primary school graduates, 15.4% were secondary school graduates, 2.6% were postgraduate and above, and 0.6% were illiterate. It was observed that 30.2% of the fathers were university graduates, 30.2% were high school graduates, 18.3% were middle school graduates, 16.1% were primary school graduates, and 5.1% had a master's degree or higher. Most of the adolescent participants (79.7%) considered themselves and their families to be in the middle SES.

Measurements

<u>Demographic and Personal Information Form</u>.
Participants were asked to indicate their gender, age, educational level of their parents, and where they considered themselves and their families to be in terms of SES on a six-step ladder visual (bottom two steps: low status, middle two steps: medium status, top two steps: high status).

<u>Frequency of Participation in Distance Education.</u>
Adolescents were asked to rate the frequency of their involvement (attending class online) in distance education on a scale of 0–10.

<u>Measurement of Academic Achievement.</u>

We used the weighted end-of-semester e-school grade point average of the first semester of the 2019–2020 academic year in which participants received face-to-face education and the first semester of the 2020–2021 academic year in which they received distance education.

<u>Academic Self-Regulation Questionnaire (SRQ-A; Ryan & Connell, 1989).</u>

The Turkish version (Kındap, 2011) of the Academic Self-Regulation Questionnaire (SRQ-A) was used. The SRQ-A contains 29 items and four subscales: intrinsic, identified, introjected, and external regulation. Adolescents rated their perceptions of self-regulation for each target situation and possible responses (e.g., Target situation: “Why do I do my homework? Possible response: “Because I want my teacher to think I am a good student,” with eight possible responses for each situation) on a 1 (not at all true) to 6 (very true) point scale. A high score on a sub-dimension indicates high regulation. The four subscales can be combined into two general subscales: controlled motivation (introjected and external regulation) and autonomous motivation (integrated, identified, and internal regulation). The Turkish validity and reliability study of the scale was conducted by Kındap (2011). The Cronbach’s alpha internal consistency coefficients of the subdimensions range from .74 to .89.

<u>The Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich & De Groot, 1990).</u>

The 44-item Turkish version (İlker et al., 2014) of the MSLQ was used. It includes motivational beliefs (e.g., “I hope that I will be successful in this course compared to other students in the class”) and self-regulation strategies (e.g., “When I study for an exam, I try to combine the information in the book with the information I have learned in the course”). We used these two sub-dimensions. Motivational beliefs have three subscales: self-efficacy (9 items), intrinsic value (9 items), and test anxiety (4 items), while self-regulation strategies have two subscales: cognitive strategy use (13 items) and self-regulation (9 items). Participants answered on a Likert scale ranging from 1 (does not fit me at all) to 7 (fits me completely). The Cronbach alpha internal consistency coefficients of the subdimensions of the scale are between .70 and .88.

Procedure

The study had been approved by the ethics committee of the Hacettepe University. The scales were administered to adolescents who had received informed consent from their parents and agreed to participate. The adolescents and their parents were informed about the study, that the study was voluntary, and that their information would remain confidential. Data were collected online via Google Forms (Google Survey) due to the pandemic. The data collection tools took an average of 15 minutes to complete.

Data Analysis

Data were analyzed using SPSS software (IBM SPSS Statistics 26 and AMOS 28). Before analysis, the data were examined to determine univariate and multivariate extreme values, multicollinearity, missing values, and normality. Absolute skewness and kurtosis values were within the limits of 2 (-1.317 – .104) and 7 (-.878 – 2.130); respectively. Considering the z value ±3.29, two participants were excluded. Twenty-six participants identified with multivariate extreme values were also excluded from regression-based analyses. There were no variables with a tolerance score below .1 and a VIF value above 10, except the intrinsic subdimensions of self-regulation and motivational strategies. Thus, in the mediation analysis, we used the sub-dimensions by combining them as mentioned before (e.g., Kındap, 2011; İlker et al., 2014; Guo et al., 2016).

We examined whether self-regulation, motivational strategies, and academic achievement differed by gender and developmental stage by using a 2x2 MANOVA. To determine whether the related variables differed by SES variables and weekly participation rate, one-way ANOVAs were conducted. The relationships were assessed by calculating Pearson correlations. Path analysis was used to test the mediating role of motivational strategies.

Results

The Role of Demographical Characteristics

We categorized adolescents into two developmental stages: middle adolescents (1st and 2nd grades, $n = 229$) and late adolescents (3rd and 4th grades, $n = 82$). Bonferroni correction was used to control for type I errors in comparisons ($p < .004$). The MANOVA results indicated the main effects of gender (Wilk's $\lambda = .891$, $F(11, 297) = 3.29$, $p < .001$, partial $\eta^2 = .11$) and developmental stage (Wilk's $\lambda = .805$, $F(11, 297) = 6.53$, $p < .001$, partial $\eta^2 = .19$) were significant. The interaction was not significant. Follow-up analysis revealed self-regulation and cognitive strategy use differed by gender; girls were higher than boys (self-regulation, $M_{Girls} = 4.70$, $SD = .91$; $M_{Boys} = 4.29$, $SD = .81$; cognitive strategy use, $M_{Girls} = 5.36$, $SD = 1.06$; $M_{Boys} = 4.87$, $SD = 1.02$). Middle adolescents' GPAs for the first semester of 2019–2020 ($M = 85.02$, $SD = 11.28$) were higher than late adolescents' GPAs for the same semester ($M = 78.48$, $SD = 12.45$).

Academic performance differed by maternal education level, F2019-2020 (3, 277) = 10.413, partial η2 = .10, p < .001; F2020-2021 (3, 277) = 7.625, partial η2 = .08, p < .001. The effect of economic status was significant only for self-efficacy scores; F (2, 280) = 5.788, partial η2 = .04, p = .003. For Semester I of 2019-2020, the GPAs of students whose mothers had a college degree or higher (M = 93.38, SD = 7.85) were higher than those whose mothers had a primary, secondary, or high school degree (MPrimary = 80.59, SD = 11.39; MSecondary = 81.01, SD = 12.68; MHigh = 88.94, SD = 9.45). Students whose mothers held a university degree or higher (M = 94.75, SD = 4.59) exhibited higher GPAs compared to adolescents whose mothers had completed middle, elementary, or high school (MMiddle = 83. 21, SD = 12.32; MElementary = 84.47, SD = 10.90; MHigh = 89.61, SD = 9.03). The self-efficacy among students from high (Mn=35 = 5.32, SD = 1.05) and low (Mn=22 = 5.31, SD = 1.25) SES are higher than those of students from middle SES (Mn=226 = 4.71, SD = 1.24).

Approximately one hundred and eighteen adolescents (37.9%) engaged in distance education for 11 to 20 hours per week, 34.1% participated for 21 hours or more, and 28% participated for less than 10 hours. Students must participate in distance education courses; however, the number of hours participated in varied among students due to individual circumstances, including technical difficulties and access to adequate devices (e.g., computers, tablets, phones). Differentiation status of academic self-regulation, motivational strategy uses, and grade point averages in two semesters between the groups is presented in Table 1.

Table 1

The Effect of Frequency of Participation in Distance Education (Weekly Hours)

Dependent Variables	*Sum of Squares*	*SD*	*F*	*p*
Self-Regulation				
External	10.79	2	5.03	.007**
Introjected	12.50	2	6.36	.002**
Identified	13.77	2	5.25	.006**

Internal	3.28	2	1.96	.141
Motivational Strategies				
Self-regulation	6.56	2	4.14	.017*
Cognitive	9.57	2	4.27	.015*
Self-efficacy	15.63	2	4.45	.012*
Intrinsic	10.12	2	2.88	.057
Anxiety	8.33	2	1.54	.215
Academic Achievement (GPA)				
2019–2020 I. Semester	1428.53	2	5.14	.006**
2020–2021 I. Semester	1292.63	2	5.24	.006**

Note. $^{*}p < .05$, $^{**}p < .01$.

The results indicated the SRQ-A external ($F(2,308) = 5.03$, $p = .007$), introjected ($F(2,308) = 6.36$, $p = .002$), and identified ($F(2,308) = 5.25$, $p = .006$) self-regulation and the MSLQ self-regulation ($F(2,308) = 4.14$, $p = .02$), cognitive strategy use ($F(2,308) = 4.27$, $p = .02$), and self-efficacy ($F(2,308) = 4.45$, $p = .01$) and GPAs in two semesters ($F_{2019\text{-}2020}(2,308) = 5.14$, $p = .00$; $F_{2020\text{-}2021}(2, 308) = 5.24$, $p = .00$) was significantly differentiated between groups (see Table 1).

Academic Self-Regulation.

Post-hoc analyses indicated students who participated in 21 hours or more of distance education ($M = 5.20$, $SD = .99$) had higher external self-regulation scores than those who participated in 10 hours or less ($M = 4.74$, $SD = 1.14$) and 11-20 hours ($M = 4.90$, $SD = .98$). Introjected self-regulation was higher for students who participated in 21 or more hours ($M = 4.89$, $SD = 1.03$) than those who participated in 10 or fewer ($M = 4.37$, $SD = 1.04$). Identified self-regulation scores were higher for students who participated in 21 hours or more ($M = 5.35$, $SD = 1.14$) than those who participated in 10 hours or less ($M = 4.82$, $SD = 1.34$).

Motivational Strategies.

Self-regulation was higher for students who completed 21 hours or more of distance education ($M = 4.75$, $SD = .88$) than those who completed 10 hours or less ($M = 4.38$, $SD = .98$). The cognitive scores of students who participated in 21 or more hours ($M = 5.44$, $SD = 1.05$) were higher than those who participated in 10 or fewer hours ($M = 5.00$, $SD = 1.18$). Self-efficacy scores were higher for students who participated in 21 or more hours ($M = 4.99$, $SD = 1.30$) than those participating in 10 or fewer hours ($M = 4.44$, $SD = 1.49$).

Academic Achievement.

The GPAs for the 2019–2020 I. semester were higher for students who participated in 21 hours or more ($M = 85.16$, $SD = 11.7$) than those who participated in 11–20 hours ($M = 84.09$, $SD = 13.1$) and 10 hours or less ($M = 79.93$, $SD = 9.75$). The GPAs for the 2020–2021 semester were higher for students who attended 21 hours or more ($M = 87.73$, $SD = 10.2$) and 11-20 hours ($M = 86.05$, $SD = 11.6$) than those who attended 10 hours or less ($M = 82.59$, $SD = 11.3$).

Correlations

The correlations between the sub-dimensions of academic self-regulation and motivational strategies and the mother's education status and academic achievement are presented in Table 2.

Table 2

Descriptive Statistics

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	-												
2. Mother Education	-.09	-											
Self-Regulation			-										
3. External Regulation	.04	-.08											
4. Introjected	.06	-.14*	.78**	-									
5. Identified	.10	-.08	.85**	.81**	-								
6. Internal	.05	-.09	.60**	.69**	.61**								
Motivational Strategies						-							
7. Self-regulation	.02	-.10	.77**	.63**	.72**	.42**	-						
8. Cognitive	.01	-.15**	.77**	.75**	.76**	.50**	.74**	-					
9. Self-efficacy	.12*	.00	.81**	.69**	.84**	.52**	.58**	.51**	-				
10. Internal	.11*	-.11*	.81**	.82**	.87**	.66**	.67**	.65**	.75**	-			
11. Anxiety	-.10	-.05	.05	.25**	-.01	.48**	-.08	.11*	-.15**	-.08	-		
Academic Achievement (GPA)													
12. 2019–2020 I. Semester	-.37**	.26**	.02	-.06	.03	-.15**	.04	.04	.06	-.05	-.13*	-	
13. 2020–2021 I. Semester	-.06	.15**	.17**	.07	.21**	-.10	.18**	.15**	.24**	.10	-.18**	.66**	-
M	15.69	2.77	4.96	4.65	5.12	4.47	4.58	5.22	4.70	4.90	4.64	83.29	85.65
SD	1.04	1.13	1.04	1.00	1.16	.91	.89	1.06	1.33	1.33	1.64	11.93	11.25
Range	13-18	0-5	2-7	1.7-7	1.4-7	2-7	1.4-6.4	1.7-7	1.1-7	1-7	1-7	39-100	30-99

Note. *p < .05, **p < .01.

Positive correlations were observed (see Table 2) between adolescents' external self-regulation and academic achievement scores for 2020–2021 (r = .17, p = .002), as well as between identified self-regulation and GPA scores for 2020-2021 (r = .21, p < .000). Conversely, internal self-regulation was negatively correlated with academic achievement for 2019–2020 (r = -.15, p = .006). GPA scores for 2020–2021 were positively related to self-regulation of motivational strategies (r = .18, p = .001), utilization of cognitive strategies (r = .15, p = .007), and self-efficacy (r = .24, p = .000). Anxiety levels were negatively correlated to academic achievement in both years ($r_{2019\text{-}2020}$ = -.13, p = .015; $r_{2020\text{-}2021}$ = -.18, p = .001). Maternal education was positively correlated to academic achievement ($r_{2019\text{-}2020}$ = .26, $r_{2020\text{-}2021}$ = .15).

The Mediating Role of Motivational Strategies

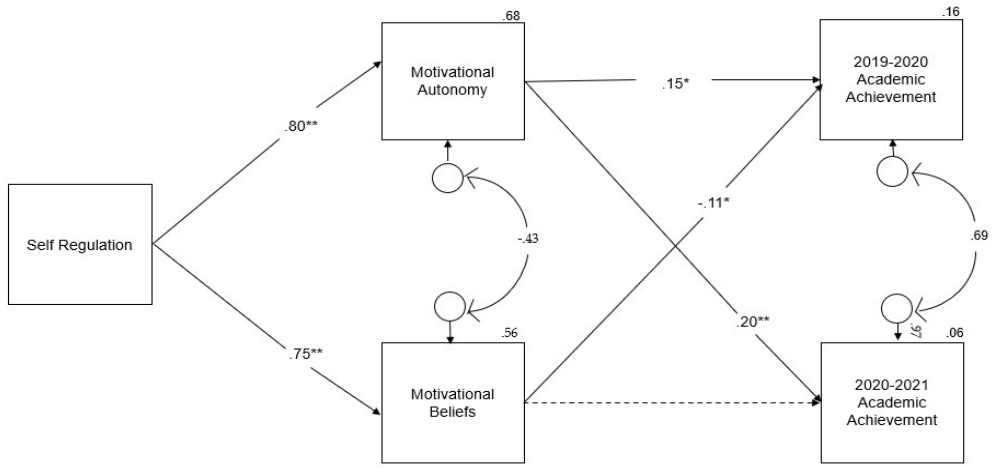
Both self-regulation (controlled motivation – introjected and external regulation – and autonomous motivation – integrated, identified, and internal regulation –) and motivational strategies (motivational autonomy – including cognitive strategy use and self-regulation – and motivational beliefs – including self-efficacy and test anxiety –) were represented by two general sub-dimensions (see İlker et al., 2014; Kındap, 2011). Age and gender (dummy-coded, 0-males, 1-females) were included as control variables. Self-regulation skills (r = .14, p = .02) and motivational autonomy strategies (r = .22, p < .001) were positively associated with academic performance in the 2020–2021 academic year.

Primary analysis indicated that the relationship between motivational beliefs and 2020–2021 semester I academic achievement was not statistically significant (*Coefficient* = -1.219, p = .107). After removing the nonsignificant path, the data had an excellent fit to the mediation model: $\chi^2(3, n = 283) = 2.768$, χ^2/df < 2, p = .429, GFI = .997, AGFI = .974, CFI = 1.000, NFI = .997, TLI = 1.000, RMSEA = .000 (see Figure 1). Age negatively correlated with academic achievement for 2019–2020: β = -.36, SE = .62, t = -6.67, p < .001. The gender correlated with motivational autonomy: β = .15, SE = .07, t = 4.40, p < .001.

Self-regulation positively predicts both motivational beliefs (β = .75, SE = .04, t = 19.01, p < .001) and motivational autonomy (β = .80, SE = .03, t = 23.49, p < .001). Motivational autonomy positively predicted GPA scores for Semester I 2019–2020 (β = .15, SE = .81, t = 2.46, p = .01) and Semester I 2020–2021 (β = .20, SE = .77, t = 3.41, p < .001). Motivational beliefs negatively predicted GPA scores for Semester I 2019–2020 (β = -.10, SE = .55, t = -2.53, p = .011

Figure 1

The Mediating Role of Motivational Strategies



Note. The model controls for possible confounding effects of age and gender.

The effect of self-regulation on adolescents' achievement emerged through motivational strategies (see Table 3). The indirect effect of self-regulation on academic achievement in the 2020–2021 semester was calculated as .16 (p = .001, BC = .07–.26). The indirect effect of self-regulation on adolescents' academic achievement in the 2019–2020 semester was not significant (p = .454).

Table 3

Effect of self-regulation on adolescents' achievement emerged through motivational strategies

	Coefficient	*SE*	*BC*	*p*
Direct Effects				
Self-Regulation→Motivational Strategies	.750	.027	.692–.799	.001**
Self-Regulation→Motivational Autonomy	.798	.024	.748–.839	.001**
Motivational Beliefs→2019-2020 GPA	-.112	.046	-.202–.021	.019*
Motivational Autonomy→2019-2020 GPA	.146	.053	.045–.257	.011*
Motivational Autonomy→2020-2021 GPA	.202	.059	.085–.317	.001**
Indirect Effects				

Self-Regulation→Motivational Autonomy→2019–2020 GPA	.032	.042	-.054 - .112	.268
Self-Regulation→Motivational Autonomy→2020–2021 GPA	.161	.048	.067- .256	.001**

Note. *$p < .05$; **$p \leq .001$. GPA: Grade point average.

Direct and Indirect Effects

Self-regulation was correlated with increased use of motivational autonomy strategies, and increased use of motivational autonomy strategies was associated with increased academic achievement in 2020–2021. Controlling for age and gender, self-regulation, and motivational strategies explain 6% of the variance in academic achievement in 2020–2021 while explaining 16% of the variance in academic achievement in 2019–2020.

Discussion

Distance learning has become widespread today. There is a necessity for supportive frameworks that can mitigate the impact on adolescents' academic performance. The current study addressed the relationships between adolescents' academic self-regulation and academic performance, and the mediating role of motivational strategies during distance learning. We also assessed developmental stage, gender and SES variables, and participation rate effects.

Our results revealed academic achievement scores of middle adolescents in 2019–2020 were higher than those of late adolescents, aligning with prior evidence (e.g., Momanyi et al., 2015). In Turkey, 12th-grade students (i.e., late adolescents) would take the university exam. Thus, they may focus their priorities on matriculation leading to a decrease in their academic performance.

Girls have higher self-regulation and cognitive strategy usage scores than boys, consistent with previous studies (e.g., Liu et al., 2021; Kesici et al., 2009). Haron et al. (2010) reported that girls demonstrate higher levels of emotional self-regulation than boys, making them more proficient in skills such as structuring their environment before lessons, setting and focusing on goals, self-evaluation, motivation, and recognizing their needs. Girls may also surpass boys in structuring the learning environment, including active participation in the learning process within new educational contexts and building relationships with teachers' key skills for transitioning from face-to-face to online learning (Korlat et al., 2021). Supporting these findings, Du (2016) observed that boys were less inclined to structure their work environment compared to girls. Additionally, Liu et al. (2021) found that female students in distance education exhibited higher levels of self-evaluation, another critical component of self-regulation, than their male counterparts. During the COVID-19 lockdown, Korlat et al. (2021) highlighted that female students were more likely to establish strong relationships with teachers and access them more effectively important self-regulatory skills. Similarly, Alghamdi et al. (2020) concluded that female students tend to outperform male students in using cognitive strategies required for completing academic tasks and organizing their actions.

These self-regulatory actions, essential for achieving academic goals, reflect individuals' ability to align their cognitive skills with their learning objectives. In Turkey, societal expectations may contribute to these gender differences, as girls are often encouraged to pursue careers, maintain organization, and engage in self-regulatory routines such as cooking and planning. These daily roles may foster stronger self-regulatory abilities, enabling girls to focus more effectively on learning and adopt an effort-oriented approach. Likewise, Du (2016) suggested that in China, the greater responsibility women bear for housework may enhance their sense of responsibility and commitment, which extends to their engagement with online courses.

It was also found that the academic performance of both boys and girls whose mothers had completed university and above was higher than those whose mothers had completed primary, secondary, and high school. Awada and Shelleby (2021) found a positive relationship between educational level and academic achievement. As education levels increase, mothers are more likely to provide problem-solving, academic support, and guidance. The effect of SES was significant only for self-efficacy; high and low SES students have higher scores than middle SES students. A limited number of studies examining the relationship between SES and self-efficacy indicated a positive relationship between two variables (Tan et al., 2023). Students from high SES have the educational opportunities they may need, as well as quick access to technological materials needed for distance learning, which may have allowed them to see themselves as more self-efficacious. On the other hand, the self-efficacy of low SES students is higher than that of middle SES students. The limited opportunities available to middle SES students may have led them to exert more effort to succeed and increased their belief in their ability to sustain that effort.

Generally, a majority of students actively engage in distance education. Despite challenges within the distance education framework, students exhibit a commitment to their courses (Niemi & Kousa, 2020). Studies identified low participation as a drawback attributed to factors like lack of motivation and challenges in adjusting to abrupt distance learning transitions (Güney & Yalçın, 2023). The COVID-19 era, marked by uncertainty and anxiety, likely contributed to decreased participation (Çetinel & Gürcüoğlu, 2022). During the period of face-to-face education after the pandemic post-pandemic, student motivation improved, although those affected directly by COVID-19 or with afflicted family members displayed higher levels of demotivation (Karabulut, 2023). In two different semesters, the group that participated more in distance learning had higher academic achievement scores. It is important to note that distance learning in this context was a required component of the curriculum. However, the number of hours participated in varied among students due to individual circumstances, including technical difficulties and access to adequate devices (e.g., computers, tablets, phones). As previously mentioned, approximately 37.9% of students participated in distance learning for 11–20 hours per week, 34.1% for 21 hours or more, and 28% for less than 10 hours. These participation hours, though compulsory, were influenced by challenges that may have affected students' ability to consistently engage in the learning process. A study conducted in high school (Niemi & Kousa, 2020) revealed that participation in distance education is high and distance education is implemented very successfully, while a study conducted at a university (Kurnaz & Ergün, 2019) found that increased participation in distance education supports academic success.

Adolescents who participated in distance education (attending class online) for 21 hours or more per week exhibited higher scores in external, introjected, and identified subdimensions of self-regulation skills. While literature underscores the significance of self-regulation skills in distance education (Cho et al., 2021; Goulimaris, 2015; Rêka et al., 2015), research examining subdimensions based on the duration of distance education is lacking. Generally, adolescents with high self-regulation scores tend to participate more in distance education. However, a study highlighted deficiencies in self-regulation among high school students in distance education due to issues such as time management and environment (Arık et al., 2021). Although internal self-regulation scores were similar across groups, since internal self-regulation involves the internalization of knowledge, it may not have come to the forefront due to problems in the distance education system (e.g., technical problems). Salmela-Aro et al. (2022) in their study with university students stated that at the beginning of the pandemic, the role of distance education-related demands (e.g., technical difficulties, planning of daily programs) and resources (e.g., the ability to work in a digital environment and the support of teachers in distance education) was very important in study engagement (e.g., the student finding the study full of meaning and purpose, being willing and interested in learning). Problems such as technical difficulties related to distance education have reduced study participation. As a matter of fact, the researchers emphasized that finding solutions to the problems (e.g., technical problems) in the distance education system can increase engagement, self-regulation and academic performance. In addition, the researchers stated that identifying existing problems (e.g., technical problems) and finding solutions can increase engagement, self-regulation, and academic performance.

Adolescents engaging in 21 hours or more of weekly attendance showed higher scores in self-regulation, cognitive strategy, and self-efficacy sub-dimensions of motivational strategies. Previous emphasis on the role of self-regulation in distance learning is corroborated by increased cognitive engagement when psychological needs are fulfilled (Chiu, 2022). Geng (2022) reported that self-efficacy in distance learning is directly related to students' participation in distance learning. Generally, high participation correlates with increased use of motivational strategies, albeit with no significant difference observed between groups regarding intrinsic and anxiety subdimensions. Our study consistently found a similar outcome in the internal sub-dimension of self-regulation. Another study based on SDT found that students are not intrinsically motivated in distance learning (Hartnett et al., 2011). During the pandemic's rapid shift to distance learning, decisions like reducing students' subject responsibilities didn't impact anxiety levels between groups. However, systemic issues like technical problems were noted to detrimentally affect motivation (Arık et al., 2021). Addressing these issues can enhance both motivation and student participation.

Our study revealed a significant positive correlation between external and identified self-regulation and their academic achievement scores for 2020–2021. Self-regulation stands pivotal for effective distance learning, as weaker self-regulation places students at risk (Boshoff-Knoetze et al., 2023; Xu et al., 2023). This aligns with Goulimaris's (2015) findings that students who participated in distance education had highly identified regulation skills. Dickson (2018) underscored extrinsic motivation significance for academic success, elucidating our study's observed relationship between external regulation and academic achievement.

Conversely, studies emphasize fulfilling basic psychological needs (autonomy, relatedness, competence) for student success in distance education (Chiu, 2022; Salikhova et al., 2020). Intrinsically motivated students outperform their extrinsically motivated counterparts (Goulimaris, 2015; Rêka et al., 2015). However, our study diverged from this trend, indicating a significant positive correlation between adolescents' external and identified self-regulation and academic achievement, while there was a significant negative relationship between their intrinsic self-regulation and their average academic achievement scores for 2019–2020. The educational systems predominantly assess academic performance in specific subjects, rather than on the knowledge they have internalized about the subjects they are interested in. Intrinsic regulation operates in realms of enjoyment and curiosity, potentially diverging from curriculum mandates. Encouraging extrinsic motivation (e.g., rewards), and emphasizing rote learning may yield short-term successes but could falter in fostering sustainable knowledge internalization (Deci et al., 2001).

In a distance learning context, motivational strategies are crucial for fostering both engagement and academic attainment (Shih & Gamon, 2001). Our study identified a significant positive correlation between adolescents' utilization of motivational strategies and their academic achievement scores for 2020–2021. Cho et al. (2017) emphasize the pivotal role of these strategies in distance education. Research also suggests self-efficacy significantly influences active participation (Zapata-Cuervo et al., 2021), while motivation predicts satisfaction (Goulimaris, 2015).

Using motivational strategies and self-regulation skills in distance learning enhances the likelihood of achieving high achievement (Semmar, 2006). AlMahdawi et al. (2021) found a positive correlation between technology-related self-efficacy in distance education and overall achievement. High self-regulation correlates with increased motivation and cognitive performance, fostering course success in distance learning (Cho et al., 2017; Wang et al., 2013). Our findings align with studies indicating a positive relationship between academic success, motivation, and self-regulatory skills in distance education (Jiang et al., 2023; Koca & Dadandı, 2019). Adolescent learners' use of learning strategies and motivation appears pivotal in promoting strong academic performance.

The findings revealed a significant negative correlation between adolescents' test anxiety and their academic achievement scores across both semesters. This pattern may stem from heightened anxiety hindering the effective use of mental skills and study strategies. Irregular study patterns and low motivation contribute to elevated test anxiety, while motivation and positive thinking aid in maintaining lower anxiety for achieving success. Our result indicating adolescents exhibiting low test anxiety and high academic achievement, attributed to self-regulation and motivational strategy use, is consistent with existing literature (Koca & Dadandı, 2019; Steinmayr et al., 2016).

Adolescents' self-regulation skills were found to predict motivational strategies (i.e., motivational autonomy and beliefs) and motivational autonomy strategies positively and significantly predicted academic achievement in both the 2019–2020 and 2020–2021 academic years. The results are consistent with those of studies linking self-regulation to motivational strategies (Daniela, 2015; Virtanen et al., 2015) and cognitive strategy use and self-regulation (aspects of motivational autonomy) to academic performance in various learning environments (Cho et al., 2015). Enhanced self-regulation fosters positive learning perceptions and motivation, thus promoting academic achievement through goal-directed behavior and reinforced learning with cognitive strategies.

Motivational beliefs (self-efficacy and test anxiety) were noted to negatively forecast academic achievement in face-to-face education, while a non-significant association was found with academic scores in distance education. Increased self-efficacy (Khan, 2023) and decreased test anxiety (Koca & Dadandı, 2019) typically correlate with academic success. However, the sudden shift to distance learning, technical problems, and uncertainties might have obscured the impact of students' motivational beliefs on academic performance. While the transition and exam uncertainties commonly induce anxiety, later decisions to limit exam subjects potentially mitigated anxiety.

A significant positive correlation was found between adolescents' self-regulation skills, motivational autonomy strategies, and academic achievement. Motivational autonomy strategies, encompassing cognitive strategy use and self-regulation skills, are pivotal in distance learning (Boshoff-Knoetze et al., 2023; Xu et al., 2023). Motivation aids in deploying cognitive strategies, thus fostering academic success (Patricia, 2020). Enhanced self-regulation correlates with increased motivation and better use of cognitive strategies, thereby enhancing academic performance (Cho et al., 2017). This finding underscores the mutually reinforcing nature of these skills, culminating in academic success in distance education.

Conversely, the absence of a significant relationship between self-regulation skills, motivational autonomy strategies, and academic achievement in face-to-face education may signify differences in educational paradigms. Traditional practices like homework assignments might have diverted focus from students' intrinsic interests, diminishing motivational resources. These dynamics within the face-to-face education system may have hindered the prominence of motivational autonomy strategies. Giving students a choice can contribute to the internalization process (Patall et al., 2008). Notably, our findings indicated higher academic achievement during the distance education period compared to face-to-face education. The reduced workload and assignment responsibilities in distance education likely bolstered students' academic performance.

Limitations and Future Research

This study focuses on perspectives from students in grades 1–4 of public high schools in Ankara, Turkey, during the first semesters of the 2019–2020 and 2020–2021 academic years. To ensure broader applicability, it is essential to examine whether these findings hold across diverse (cultural) contexts. While our study underscored the significance of researching adolescents' motivation and self-regulation, it primarily explored quantitative aspects and lacked focus on relational dimensions within the context of the basic needs of SDT (i.e., relatedness). Future research can explore environmental influences (e.g., autonomy support) to identify factors in adolescents' academic achievement in distance education.

These findings offer guidance for professionals involved in developing distance education systems, emphasizing the importance of addressing participation issues and seeking student feedback. Implementing strategies like goal-setting, behavior management, study planning, and self-assessment can enhance student achievement. Additionally, organizing seminars for adolescents on motivation and self-regulation, as well as educating parents on supporting these skills, can further promote academic success.

Declarations

Statement Regarding Informed Consent

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

Statement Regarding Ethical Approval

The study data were collected in a manner consistent with ethical standards. We obtained approval from Ethics Commission Board of Hacettepe University (Ethics approval number: E-68552689-300-00001397740) and Ministry of National Education (Ethics approval number: 00001503836). Informed consent forms were also obtained from the parents and the children.

Statement Regarding Research Involving Human Participants and/or Animals

Ethics committee permission was obtained.

Funding

The authors did not receive support from any organization for the submitted work. The authors have no relevant financial or non-financial interests to disclose.

Author's Contribution

Both authors contributed to the concept and design of the study. Dr. Gür conceived of the study, designed and coordinated the study, conducted the literature search, drafted the manuscript, collected the data and wrote the interpretation of the data and discussion. Dr. Yaban helped in drafting the manuscript, critically revised it for important intellectual content, and performed the statistical analysis of the study.

Competing Interests

The authors declare that there is no conflict of interest.

Availability of Data and Materials

Data is not open to sharing for ethical reasons.

Acknowledgement

This article is derived from Tuğçe Gür’s master’s thesis (no. 706869) entitled “The relationship between academic self-regulation, motivational strategies, and academic success in adolescence on distance education,” conducted under the supervision of Dr. E. Helin Yaban. The authors would like to thank the children who participated in this study and the educators and organizations who gave permission for this research.

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Synchronous Online Learning: Why Some Students Don't Actively Participate

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Abstract

In the context of online and distance learning, active student engagement in online synchronous tutorials is important for students' development; yet it can be challenging to achieve. The research reported in this paper explored why some students do not participate actively in online synchronous tutorials, instead preferring passive participation. The research, carried out at a large distance-learning university, employed two large-scale online surveys, one with students and one with tutors, to investigate these issues; over 600 students and almost 200 tutors on a range of modules responded to the surveys. The surveys gathered quantitative and rich qualitative data that provides insights into students' and tutors' experiences. The survey data showed that lack of confidence is an important factor affecting student participation; over a third of students indicated that they experience stress when expected to take part actively. The paper also discusses how the online tools used in synchronous tutorials (e.g. text chat, polls, shared whiteboards) can support different levels of participation; the approaches tutors can use to encourage active engagement; and the role of passive participation.

Keywords: Synchronous online learning; engagement; participation; active learning; confidence; anxiety

Donelan, H., Kear, K., Rosewell, J., Okada, A., Sheehy, K., Amor, K., Edwards, C., Mooney, A., Cuffe, P., & Elder, T. (2025). Synchronous online learning: why some students don't actively participate. *Online Learning, 29*(3), 311-337. https://doi.org.10.24059/olj.v29i3.4641

Introduction

Synchronous online learning has been used in education for many years, enabling teachers and students to attend scheduled sessions, share resources, and interact without being co-located. Distance learning institutions use this approach to complement the other ways students learn at a distance, such as through study of printed or online module materials and the use of asynchronous communication tools, such as discussion forums. More recently, during the Covid-19 pandemic, synchronous online learning was used by the majority of universities worldwide, facilitated using tools such as Zoom, Blackboard Collaborate, Microsoft Teams and Adobe Connect, as a principal way to ensure emergency educational continuity (Oliveira et al., 2021). Despite the move to online learning being hastily implemented during this period, its use in some form to complement face-to-face learning has continued beyond the pandemic, as its benefits (convenience, flexibility and sustainability) are undeniable. However, there are well-documented challenges that need to be addressed (e.g. Vivolo, 2016; Wang et al., 2018; Flaherty, 2020).

Although synchronous tools can be used for large-scale lectures, the research presented in this paper focuses on the use of smaller scale tutorials. A significant challenge here is a lack of active participation by students (Handel et al., 2022; Smith & Smith, 2014). The purpose of the research presented in this paper is to understand the barriers to active student participation, and what can be done to overcome these. Quantitative and qualitative survey data gathered from over 600 students and almost 200 tutors are presented and discussed, along with recommendations for future practice to promote positive experiences and enhance online learning opportunities for students.

Literature Review

It is widely accepted among educators that an active approach to learning is beneficial for students' thinking, learning and performance. Active learning approaches focus on students engaging in activities: whether carried out individually (based on cognitive constructivism) or, more commonly, with other students (based on social constructivism). Active learning is contrasted with more passive approaches such as listening to a lecture. Based on a systematic review of articles focused on active learning, Doolittle et al. (2023) provide the following definition of active learning: "a student-centered approach to the construction of knowledge focused on activities and strategies that foster higher-order thinking." Active participation is believed to be fundamental to student success and educational quality (Lear et al., 2010; Caliskan et al., 2020). A social constructivist approach to learning advocates shared knowledge creation through discourse, and therefore online sessions that encourage active learning and incorporate participatory activities are important (Strang, 2011; von Lindeiner-Stráský et al., 2022).

Active learning can be enabled in synchronous online environments. For example, Wang et al. (2022) discuss how trainee teachers engaged in synchronous online learning during the pandemic, using Zoom, for group discussion (in breakout and plenary rooms) and tools such as text chat, and polls. Bower et al. (2015), in a collection of case studies, demonstrated that active learning can take place in blended learning contexts, where in-class engagement is combined with synchronous online interaction for remote students.

It is clear that there are many ways in which active participation in synchronous online sessions can be encouraged, such as quizzes, well-timed questions, shared whiteboards and text-based communication, as well as through the audio and video channels. However, if students do not engage, tutors may feel unable to adopt these active approaches, due to a lack of feedback from students (Rogers et al., 2021). Tutors may resort to a didactic approach, using PowerPoint-style presentations to replicate traditional lecture-style classes. Such approaches may have limited educational success because students are not learning actively.

Many students value active participation, particularly learner-to-instructor interactions (Martin & Bolliger, 2018). However, other students either opt out of online sessions completely, or attend in a passive capacity, with a reluctance to contribute (Smith & Smith, 2014; Mogavi et al., 2021). Some students' conceptions of learning may not align with an active approach (Richardson, 2011; Okada & Sheehy, 2020; Sheehy et al., 2022). Although teaching staff may be frustrated that students are not being more active, student satisfaction with synchronous online sessions can still be high, regardless of the level of participation (Butler et al., 2018).

There are practical reasons for students not engaging with active approaches in synchronous online sessions; for example, they may not want to use audio and video communication (Castelli & Sarvary, 2021). Some studies have found that reasons for keeping a webcam turned off during an online session include anxiety, shyness, wishing to ensure the privacy of the home, and a fear of being exposed (Gherheș et al., 2021; Rajab & Soheib, 2021). The work presented here explores choices made by students with respect to active engagement on a broader scale – not just the use of webcams.

Several theories offer insights into the liminal space between visible active engagement and lack of visible active engagement, the learning that might occur within this space and how students might traverse it. It has been argued that, in the context of online learning, students' indirect vicarious participation can have benefits for their learning and that this type of engagement can be a central and valued aspect of their studies (Pleines, 2020). The notion of legitimate peripheral participation (Lave & Wenger, 1991) illustrates how those who are new to an online learning community can become aware of its norms and practices and develop the confidence and motivation to engage with 'visible' learning activities (Safadi & Berente, 2019). How learners make this transition is influenced by many factors, including the nature of the platform and study activities (Bozkurt et al, 2020). These factors affect how the community's personal interactions (e.g. tutor-student, student-students) and collaborative activities are introduced, supported, and given value. It is these personal interactions that contribute to the learners' sense of belonging and active engagement with shared learning tasks (Stoytcheva, 2021). If teachers can establish an empathetic environment, students will feel safer engaging actively. Teachers exhibit empathy through their care, concern and understanding of a student's personal situation, while ensuring that the primary focus is student learning (Meyers et al., 2019). Helping students build their confidence enables them to progress from attending passively to making active contributions.

If students' can build the confidence to progress from attending passively to making active contributions, this should bring benefits, not only to their learning, but also in developing important employability skills. Working with others, and being able to communicate effectively, are important in many roles, so employers are keen that students develop these skills (Succi & Canovi, 2020). The Covid-19 pandemic accelerated the rise in remote working (Ng et al., 2021); this means that engaging with others in online environments has become increasingly important.

Online distance learning has the risk of being isolating for a student and this can impact on the student's wellbeing and mental health (Rush 2018; Jones, Samra & Lucassen; 2021). Tutorials can be a means of reducing isolation and providing students with the opportunity to meet others and start to form supportive relationships. Through the activities undertaken within the tutorial, supportive communities and social learning spaces may start to develop (Wang et al., 2022). This not only aids the students' learning, but it also starts to create a feeling of belonging. This can positively impact on retention and outcomes (Peacock & Cowen, 2019).

The research reported in this paper adds to current work through detailed analysis of students' and tutors' experiences of engagement in online sessions. It investigates students' and tutors' perceptions of the barriers to active participation and considers the broad spectrum of approaches and tools that can be used to encourage active participation. The overarching aim of the research is to ascertain how students might be encouraged to move from passive to active engagement in synchronous online learning. The following research questions (RQs) are addressed:

RQ1: How do tutors use active learning approaches in synchronous online sessions?

RQ2: What are the barriers to active student participation in synchronous online sessions?

RQ3: How can these barriers be overcome?

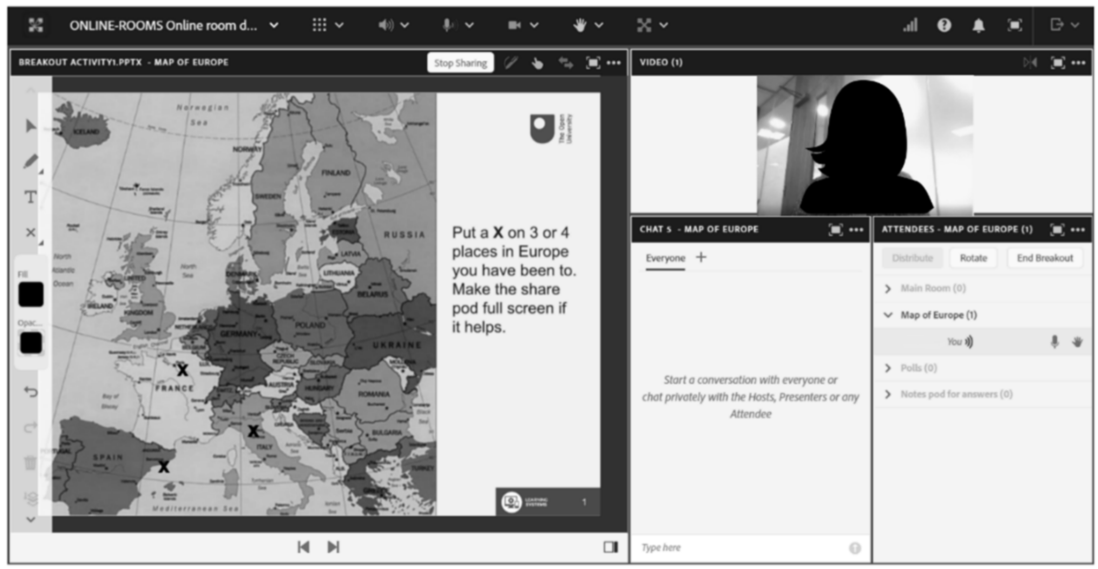
Method

Context

The research reported in this paper is based on the experiences of students and tutors on modules at a large distance-learning university where synchronous online sessions (called 'online tutorials') are an important (though not compulsory) aspect of students' learning experience. At this university, tutors perform various teaching, assessment, and student support activities, including running online tutorials. In most cases, these tutorials are the only opportunities students have to interact with tutors and other students, and to discuss and ask questions, in real-time. The tutorials therefore play a key role in active learning. Prior to the Covid-19 pandemic many of the modules included in this study offered face-to-face tutorials, as well as online tutorials. However, at the time of the research (and at the time of writing) all tutorials were taking place online. Although modules at this university can have hundreds or even thousands of students, attendance at online tutorials is much lower, from as few as five students to around 50, depending on the type of session. Tutorials tend to be one to two hours in duration and are run by one or two tutors using the Adobe Connect web conferencing system (Figure 1). Adobe Connect includes different tools that can be used to facilitate learning and encourage interaction between participants, including audio, video, text chat, whiteboard, breakout rooms, polls, 'reactions' (e.g. thumbs-up) and quizzes. Tutorials at the university have varying focuses, such as preparing for upcoming assessment activities or providing support on specific topics. Most, though not all, tutorials are recorded so that students can view them later if they wish.

Figure 1

Adobe Connect, the web conferencing system used for online tutorials



Research Design

Two large-scale online surveys were used to gather views and experiences about participation in online tutorials; one survey was for students and the other for tutors. Students and tutors were recruited from 18 large-population Stage 2 undergraduate modules from all four faculties of the university. Stage 2 modules are equivalent to the second year of a full-time undergraduate degree. Modules are units of study of 15 or 30 European Credit Transfer and Accumulation System (ECTS) credits that are studied over a period of around 30 weeks, with students typically studying part-time (as many are in work and/or have caring responsibilities). The research project team included members from all faculties, with all team members contributing to the design and content of the surveys, which were implemented using the Jisc online survey tool (https://www.onlinesurveys.ac.uk). Approval to conduct the research was obtained from the university's Human Research Ethics Committee, Student Research Project Panel and Staff Survey Project Panel. All appropriate ethical and data protection guidelines were followed.

By focusing on undergraduate Stage 2 modules the aim was to explore the experiences of students who had already had adequate opportunities to engage with online sessions and would therefore have formed opinions to address some/all of the survey questions. Focusing on Stage 2 also enabled a large number of students on different qualifications and pathways to be included in the research. Stage 2 modules are more likely to be common across qualifications, as compared to Stage 3 modules (equivalent to modules in the final year of a full-time undergraduate degree), which are often more specialised and smaller in terms of student numbers. Sample sizes from each of the 18 modules were dependent on the number of students available. For the larger modules, the sample size was capped at 650 students to aim for a more balanced spread of responses across modules and faculties.

Participants

A survey invitation was sent to a total of 7450 students towards the end of their module but before the exam period. It remained open for a month, with reminders sent before the survey closed. The overall response rate was around 8%; this is low but not unusually so for student surveys at this distance-learning university, where students are typically working and balancing family commitments with study. The total number of useable responses (where student consent had been given) was 609. Depending on their previous answers, respondents were routed around questions that were not applicable; the number of students answering each question (n) therefore varied and is reported in the results where the question is discussed.

The invitation to participate in the tutor survey was sent to tutors on the same set of modules. 866 tutors were sent the invitation and a total of 196 useable responses were received, giving a 23% response rate. As with the student survey, the number of responses received (n) for each question is reported in the results.

Table 1 illustrates the modules included in the research and the number of responses received from students and tutors for each module.

Table 1

Modules Included in the Research and the Number of Responses

Module name	Number of student responses	Number of tutor responses
Early modern Europe	40	8
The British Isles and the modern world	53	8
Exploring the classical world	31	8
Reading and studying literature	36	9
Shaping business opportunities	19	14
Developing leadership	10	9
Exploring mental health and counselling	53	17
Living psychology	82	27
Understanding criminology	40	15
Exploring childhood and youth	35	12
Sport and exercise psychology in action	32	4
Critical Issues in health and wellbeing	35	15
Object-orientated Java programming	34	23
Mathematical methods	27	5
Physics: from classical to quantum	19	3
Design essentials	10	5
Core engineering	15	6
Public law and criminal law	38	8
Total	**609**	**196**

Student Demographics

Tables 2 and 3 illustrate the demographics of students that responded to the survey.

Table 2

Ages of Student Respondents

Age	%
<25	21.6
23 to 35	38.8
35 to 45	21.7
>45	17.9

Table 3

Demographic information of student respondents

Gender	%	Ethnicity	%	Previous study	%	Socio-economic status	%	Disability	%
Female	60.4	White	87.8	Less than two A-levels	29.9	Low	18.5	No	74.6
Male	39.6	Other	12.2	Two A-levels or higher	70.1	High	81.5	Yes	25.4

Student demographics varied considerably across the modules surveyed, but the demographic profile of students who responded to the survey was generally a reasonable representation of their cohort. For example, the proportion of female students registered on a module varied from very high (over 90% in some cases) to very low, the lowest being 16%. For modules where the proportion of female students was over 90%, the proportion of female respondents was also over 90%. For modules which had very low numbers of female students, female students were slightly over-represented in the survey respondents. The proportion of students declaring a disability also varied across modules, from around 16% up to 32%. Modules with a higher proportion of students declaring a disability were somewhat underrepresented in the respondents, with proportions between 17% and 26% in responses.

Survey Questions

Data gathered from students was a mix of quantitative (from multiple choice questions and Likert-type questions) and qualitative (using open text boxes for students to give their views or add more detail). This mixed approach resulted in clear findings, backed up by rich, in-depth explanatory data. Students were asked to identify a module they were currently studying and to focus their responses on this module. The student survey then explored a number of areas, such as how students feel before attending an online tutorial; what opportunities they have to take part actively in the sessions they attend; whether they find activities valuable/enjoyable/useful; and the tools they use (e.g. audio, video, chat, whiteboard, polls etc). Examples of some of the question types and areas explored are shown below:

Example 1

Which of the following activities were included in the tutorial(s)? (Please select all that apply.)

- ☐ Answering questions
- ☐ Asking questions
- ☐ Taking part in a poll or quiz
- ☐ Taking part in discussions in the main room
- ☐ Taking part in discussions with other students in break out rooms
- ☐ Solving problems
- ☐ Practising skills
- ☐ Contributing on the whiteboard
- ☐ Other

Example 2

Reflecting on a tutorial that you have enjoyed and/or found useful, please describe the factors that you think made the tutorial enjoyable or useful.

Example 3

Please indicate how you feel about the following statements

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Students learn best through collaborative activities	○	○	○	○	○
Helping students to talk to one another productively is a good way of teaching	○	○	○	○	○

The tutor survey followed a very similar structure, and had a similar set of questions, to the student survey. This enabled a comparison between student and tutor responses. In addition, the tutor survey explored tutors' experiences of teaching online, asking, for example: "What approaches or techniques do you use that encourage active student participation?"; "Which techniques have worked well?"; "Which techniques have not worked so well?". Tutors were invited to provide specific examples.

Results

Tutor Approaches to Active Learning in Synchronous Online Sessions

Tutor Practices

Questions were included to explore aspects of tutor practice in online synchronous tutorials. For example, we asked tutors whether tutorials were hosted by one, or more, tutors (tutor responses n = 195). Mostly (36%) tutorials were hosted by one tutor, but having two tutor-hosts was also common (31%). Other tutors mainly said they had run tutorials both on their own and with other tutors.

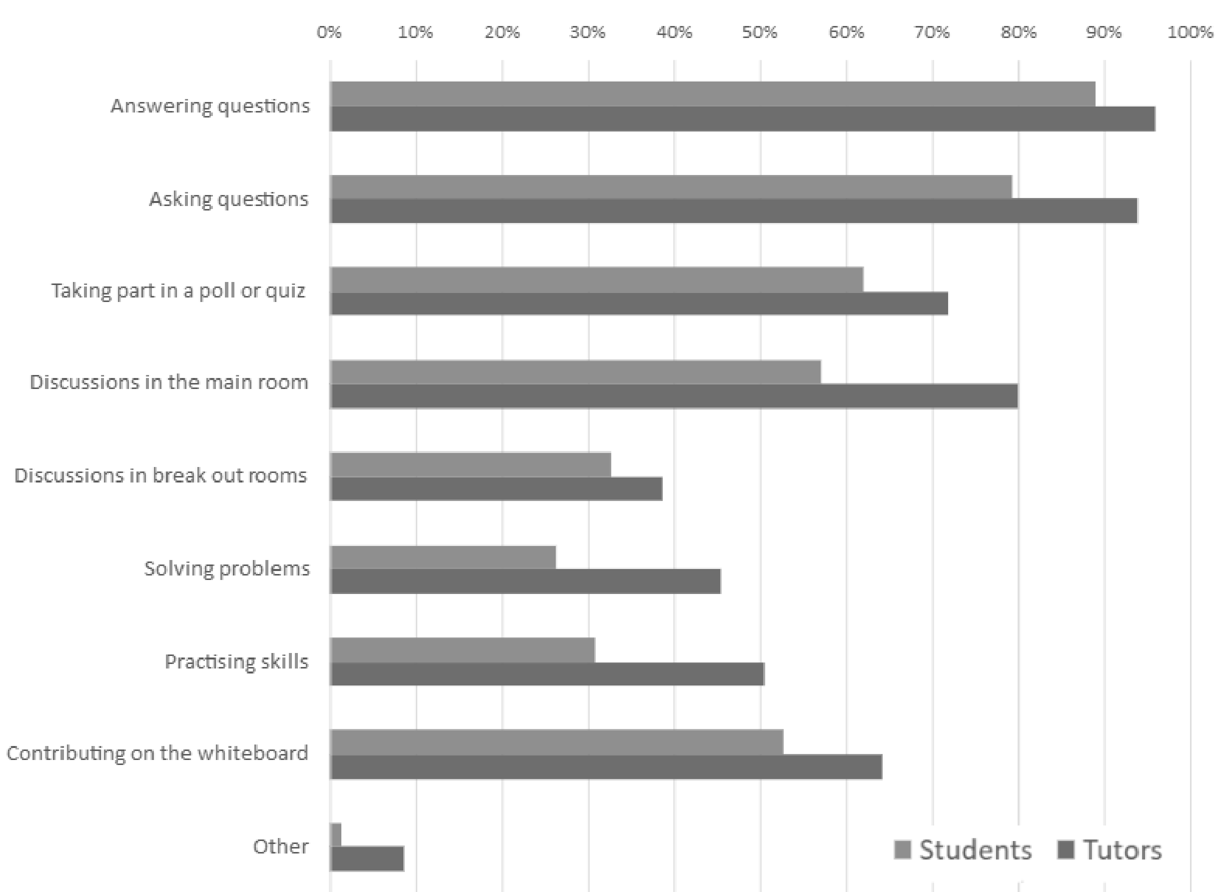
Tutors were asked whether they used their webcam: only 29% (n = 196) used a webcam, and this relatively low level of use was consistent across faculties. This is likely to be because historically video has caused problems for students with poor internet connections.

When tutors were asked if they provided opportunities for students to take part actively, all said they did. Tutors were asked which of the following activities they use in their sessions: asking and answering questions; polls and quizzes; discussion (in the main online room and in breakout rooms); solving problems; providing opportunities to practise skills; and inviting contributions on the shared online whiteboard. All the options offered were used by some tutors, and some mentioned alternatives. When students were asked if they had been given opportunities to take part actively in at least some of the tutorials they had attended, 98% said they had (n = 523).

The different activities tutors said they use in their sessions are illustrated in Figure 2. Also shown are students' responses regarding which activities they had been offered in the sessions they attended. There is reasonably close agreement between students and tutors on some of these (particularly answering questions and discussions in breakout out rooms). The largest discrepancy is for discussions in the main room, with 80% of tutors choosing this option but only 57% of students.

Figure 2

Activities Used in Online Sessions

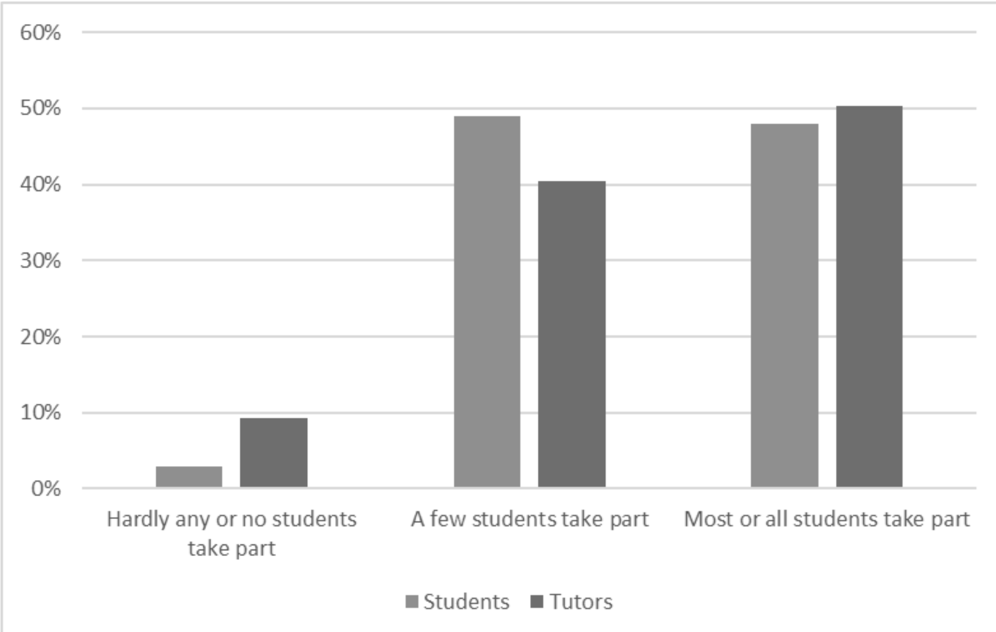


When students were asked if they themselves took part in activities, 40% of students said they took part a lot in activities, 48% said they took part a little, and 12% said they did not take part (n = 515).

Figure 3 compares tutors' and students' responses to whether students in general took part in the activities offered. Perceptions of tutors and students about how many students took part were similar.

Figure 3

Numbers of Students Who Took Part Actively in Online Sessions (Student responses n = 512; Tutor responses n = 195)



In a question in the tutor survey that enabled open text responses, we explored the approaches tutors use to encourage active participation. Many responses were received, covering a range of aspects:

> Friendly approach, materials in advance so no surprises, alternative ways of participating.
>
> Make sure they can contribute (ask/answer) anonymously
>
> Starting with simple warm up activities, polls and whiteboard […] then get better interaction for the rest of the tutorial.

When asked specifically what techniques work well, many responses echoed those above.

> Starting off with broad questions with no “right or wrong”' answer to build confidence.
>
> Students love whiteboarding - it's anonymous (chat isn't)
>
> I always spend a few minutes chatting informally with students before the session starts. I have my webcam on—they can see the 'real' me. And I try to get them involved, even if it's only asking them about the weather where they are. By making them feel included and comfortable, they join in more with the session.

Tutors were also asked about approaches that have not worked well. Again, there were many responses, but with much commonality. Breakout rooms were given as one example that did not generally work well. Another example (mentioned by several tutors) was:

> Asking again and again for them to use the mic (or whatever). Just wastes time and if they don't want to they won't.

Tools and Features

The survey data contained a considerable amount of information from students and tutors about which tools within the web conferencing environment were used in online sessions. The findings are summarised in Table 4 which shows students' and tutors' responses when asked which tools were used (multiple options could be selected).

Table 4

Tutors and Students' Responses on Which Tools Are Used in Online Sessions

Tool	Percentage of ***tutors*** who reported using the tool with students	Percentage of ***tutors*** who report ***students*** using the tool	Percentage of ***students*** who report using the tool
Text chat	96%	98%	94%
Reactions	82%	74%	65%
Poll/quiz	71%	71%	60%
Whiteboard	66%	58%	46%
Microphone	86%	37%	33%
Webcam	29%	1%	3%

From Table 4, tutors' perceptions of which tools students use, and the tools students reported using are quite closely aligned. As would be expected, tutors' use of microphones and webcams is much higher than students' use. Tutors report that students engage more with the text chat, reactions (e.g. 'thumbs up'), polls/quizzes, and the whiteboard than with audio and video channels.

Nearly all students use text chat to participate, a third use their microphone, and very few their webcam. Tools such as whiteboards, reactions, and polls are used by many students, and this may be partly because they offer anonymity. Students commented:

> The poll and quizzes are more enjoyable than writing answers.
>
> The whiteboard helps to put answers down instead of using the chat box to save any embarrassment if the answer is wrong.

Some of the available tools may be seen to offer only a superficial level of interactivity.

One student commented:

> I would much rather a tutor be doing things that will further our education rather than asking us to use the tick box or smile to make sure we are still listening!

Breakout rooms were offered by 39% of tutors (n = 196), and 33% of students (n = 515) reported being offered activities in breakout rooms. Of tutors, 26% (n = 196), and 25% of students (n = 512) said there was active participation in breakout rooms during tutorials they attended. However, students described some issues:

> I find breakout rooms quite stressful because you often end up with nobody saying anything, which makes me feel like I have to start off or lead the discussion. I don't want to feel like I'm talking so much other people can't participate. Breakout rooms are most effective with a facilitator.

and:

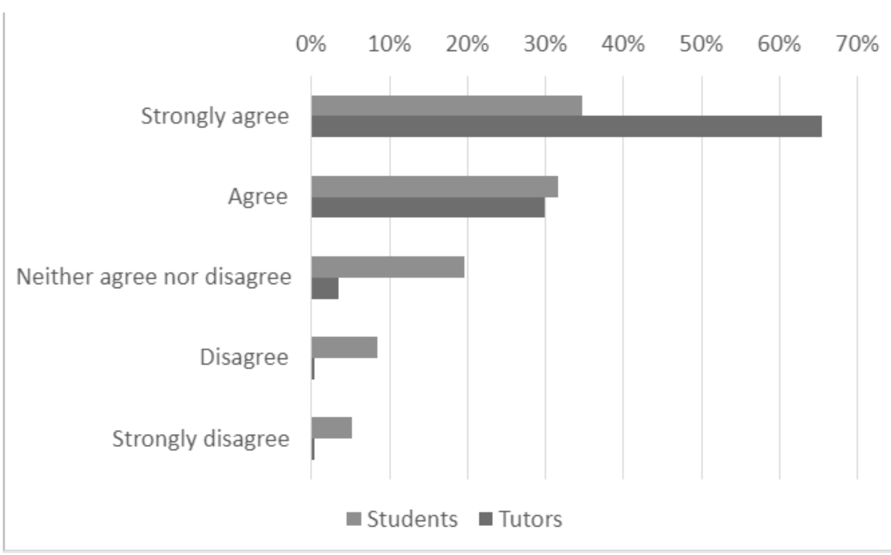
> I think it depends on who you are in the breakout room with because some students are very engaged in the breakout room activity, which is fine. I was in a breakout room on one tutorial when I was the only one speaking. The rest was typing and it was really difficult to get anything done …

Similarly, tutors are aware of the problems; one commented: "I avoid breakouts as they are time-consuming, disruptive and unpopular with students."

Text chat, on the other hand is popular with students: 94% (see Table 4) indicated that they use text chat and, when asked whether they prefer to use it rather than speak in online tutorials, around two thirds (67%) of students said they did (see Figure 4). "I'm a nervous speaker however there's no pressure and often when I use the chat box my comment is addressed which is good confidence boost."

Figure 4

Students' and Tutors' Responses to "I [Students] Prefer to Use the Text Chat Rather Than Speak in Online Tutorials" (Student responses n = 603; Tutor responses n = 194)



An interesting aspect of Figure 4 (and similar Likert-type questions coming up) is that student responses are more distributed across the range of available responses than tutor responses, which tend to be clustered around agree/strongly agree (or disagree/strongly disagree in other questions). This is addressed later in the Discussion section.

Although text chat is popular, there were some negative comments from students about it:

> I don't find it useful when attendees use the chat box for the entire tutorial as it can be very distracting having to keep up with important comments and answers in between random waffle whilst also trying to listen to the tutor. It can also result in only a couple of eager students getting a say and answering questions first all the time. The chat box doesn't seem to have any code of conduct for this and it can never be minimised to decrease the distraction. For me it's sensory overload.

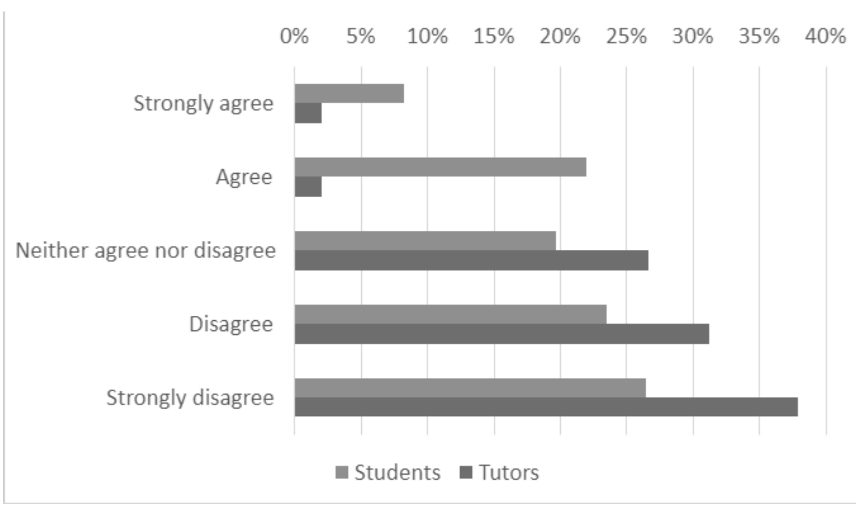
Tutors were strongly of the opinion (95% agreement – see Figure 4) that students prefer text chat to speaking. One tutor commented: "Many students are reluctant to use mic and those who do tend to dominate thus intimidating others even more as they sound intelligent and authoritative."

When asked about webcams, 30% of students said they would feel comfortable using a webcam in an online session (n = 604). In support of using webcams, two students commented: "I would prefer if the tutorials were similar to zoom calls where we could see each other as well." "Hard to feel you can ask questions of someone if you don't feel you know them."

However, only 4% of tutors thought that students would feel comfortable using a webcam (n = 195). The results imply that a larger proportion of students may be open to the idea of using webcams than tutors think.

Figure 5

Students' and Tutors' Responses to "I [Students] Would Feel Comfortable Using a Webcam in an Online Tutorial" (Student responses n = 604; Tutor responses n = 195)



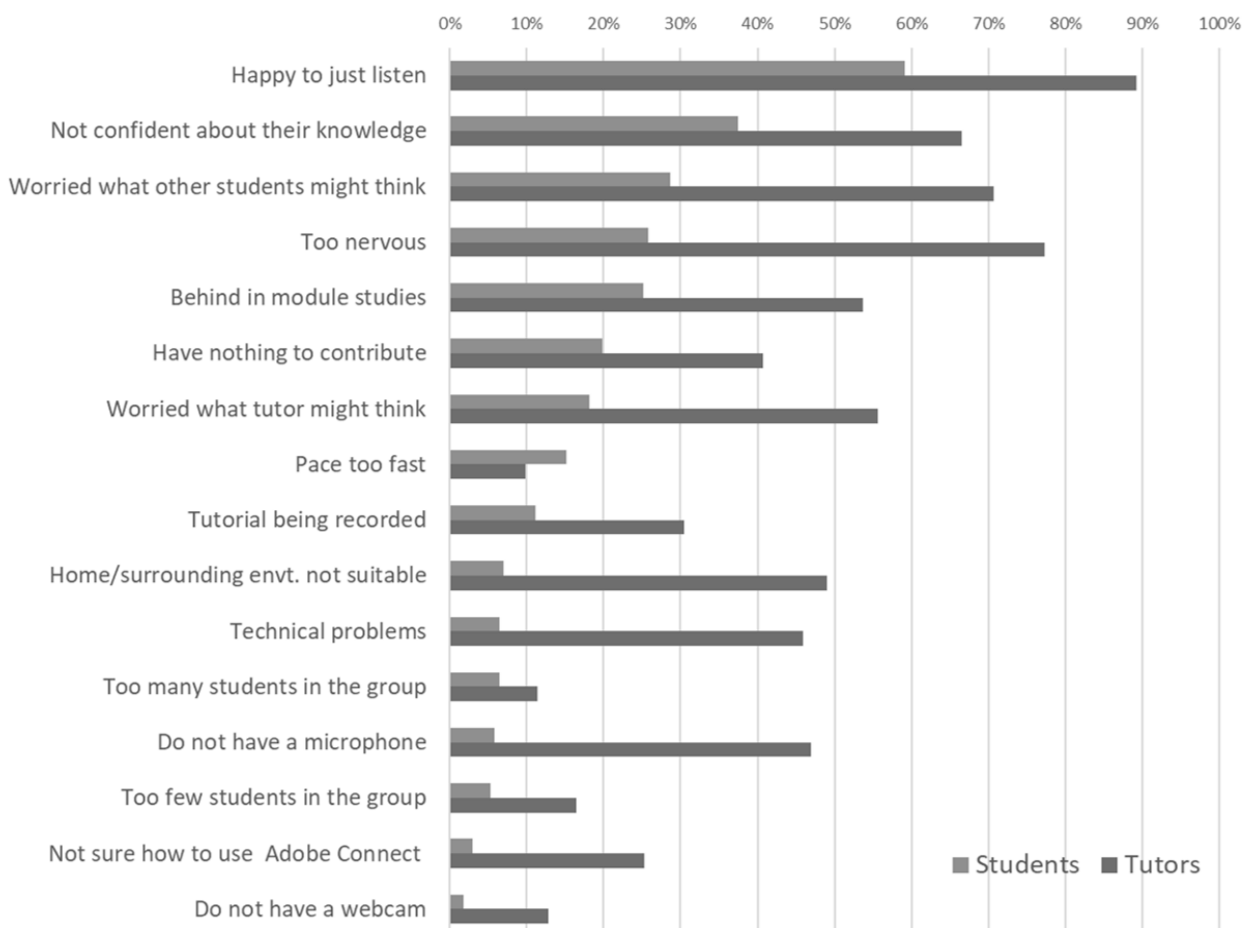
Barriers to Active Participation

In the student survey, students were asked about how they felt before online tutorials. Although 50% of students said they looked forward to tutorials, 10% of students reported feeling anxious beforehand (n = 521). Some student comments reveal anxiety and how it can be managed: “I felt anxious as I was struggling with some of the content and didn't want to be the only person attending.” “I like that the tutors don't put us on the spot too much. I like that we only type and don't have to speak.”

The surveys went on to explore reasons for students not actively participating. Students who said they didn’t participate actively were offered a number of possible reasons and were able to select as many as they felt applied. An “other” option was also provided and an open text box to enable elaboration. Tutors were also asked about what they thought students’ reasons were for not participating actively. The results from these questions are shown in Figure 6.

Figure 6

Students’ Responses to: “If You Didn’t Take Part in These Activities Can You Explain Why?” (N = 171); and Tutors’ Responses to: “Thinking About Students Who Don't Participate Actively, Which of the Following Reasons Do You Think May Contribute?” (n = 194).



In both cases the most popular selection was “I am [students are] happy to just listen.” This is explored in more detail in a later section of the paper. The next section is on the next group of reasons that emerged as popular choices: “Not confident about knowledge of module materials,” “Worried what other students might think,” “Too nervous,” “Behind in module studies,” “Have nothing to contribute,” and “Worried what the tutor might think.” It is noticeable, firstly, that there is a link between these reasons; they all concern a lack of confidence or an element of worry, whether about something specific, such as what others might think or their knowledge of the materials, or more generally. Secondly, there is agreement between the students and tutor results on the importance of these, in comparison to the other options.

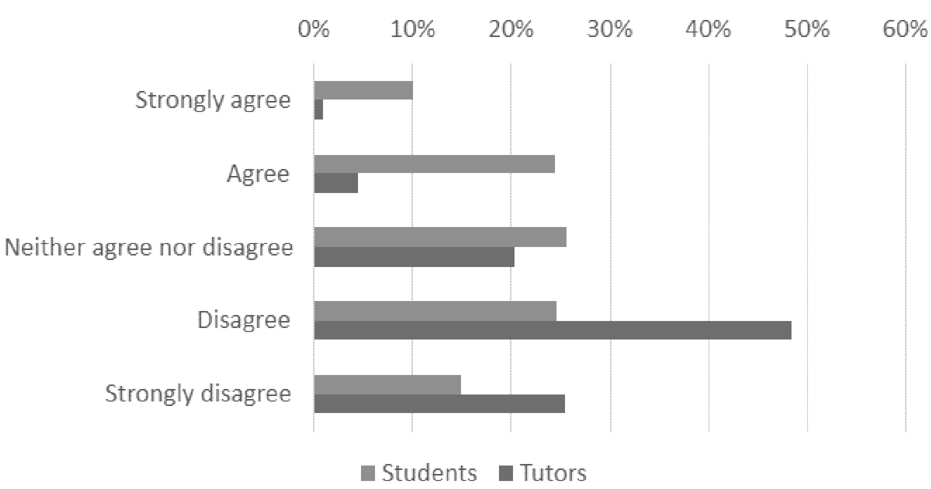
Some of the additional comments received from students in response to this question expanded further on the issues: “I prefer to listen and make notes. Occasionally put something in chat box. Am always relieved that there are others who contribute more as I get a little anxious.” “I'm really shy about this sort of thing and prefer to keep a very low profile.” “I find it a bit unnerving. I think this is true for many mature students. We need perhaps a little practice.”

Lack of Confidence for Active Participation

Confidence was explored further in a question which asked students and tutors to indicate their level of agreement with the statement: “I [students] feel confident speaking in sessions.” Responses to this statement are illustrated in Figure 7, which shows students’ and tutors’ responses.

Figure 7

Students’ and Tutors’ Responses to “I [Students] Feel Confident Speaking in Online Sessions” (Student responses n = 603; Tutor responses n = 196)



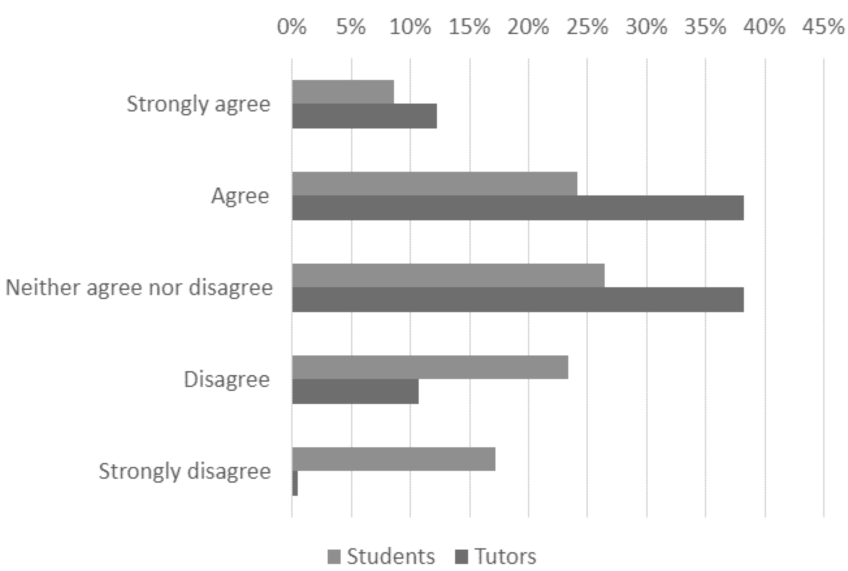
Students were divided on whether they felt confident speaking in sessions, with 35% feeling confident (agree / strongly agree) compared to 40% who did not feel confident (disagree / strongly disagree). The responses to this question from students were more evenly balanced than the responses from tutors: 74% of tutors thought that students did not feel confident speaking, compared to only 6% who thought that students did feel confident.

The following comments from the tutor survey show that tutors take steps to allow for students' lack of confidence: "There are always a few students who just want to listen in and some who are shy therefore lack confidence to participate. I always encourage both types to actively engage..." "Students tend to prefer to use chat rather than talking & some are too shy even to use the response function, but I do my best to make everyone welcome in whatever capacity they want to participate." "'I deliberately do not require students to use camera or voice because this intimidates many students. I ensure students can always ask and answer anonymously to avoid pressurising them."

Students and tutors were also asked to respond to the statement "I [students] feel stressed when expected to actively take part." Responses are illustrated in Figure 8, which compares students' and tutors' responses.

Figure 8

Students' and Tutors' Responses To "I [Students] Feel Stressed in Online Tutorials When Expected to Actively Take Part" (Student responses n = 603; Tutor responses n = 196)



Again, there was a disparity between student responses and tutor responses to this statement: 33% of students agreed that they felt stressed when expected to take part actively, whereas 41% did not feel stressed. Tutors' views were somewhat different: 51% thought that students felt stressed, and only 11% thought they did not. Quotes from the student survey show examples of some students' feelings on this. The second quote demonstrates the link with students' mental well-being. "If you have something to contribute, they [activities that encourage active participation] have value. If not, then they're stressful, and you end up feeling a bit stupid." "I don't like it when tutors pressure you to turn your mic on at the start and use that. I have severe anxiety and I find it very stressful when I feel I have to talk on the mic. Tutors should be more mindful of this before pressuring students or making us feel bad for using the chat box."

Preferences for Passive Attendance

Returning now to a key result highlighted from Figure 6, "I am [students are] happy just to listen" was the most popular choice for students and tutors as a reason for students not actively participating. 58% of students who responded to this question (n = 171) and 89% of tutors (n = 194) selected this option. Quotes from comments expand on students' views: "I'm more of a listener than a talker and I prefer to take in what everyone else contributes than to miss something thinking about what I might contribute - sounds a bit selfish now that I've said it!" "I'm more of an observer than participator, however, I will type something in the chat box if I have a question or particular idea to clarify."

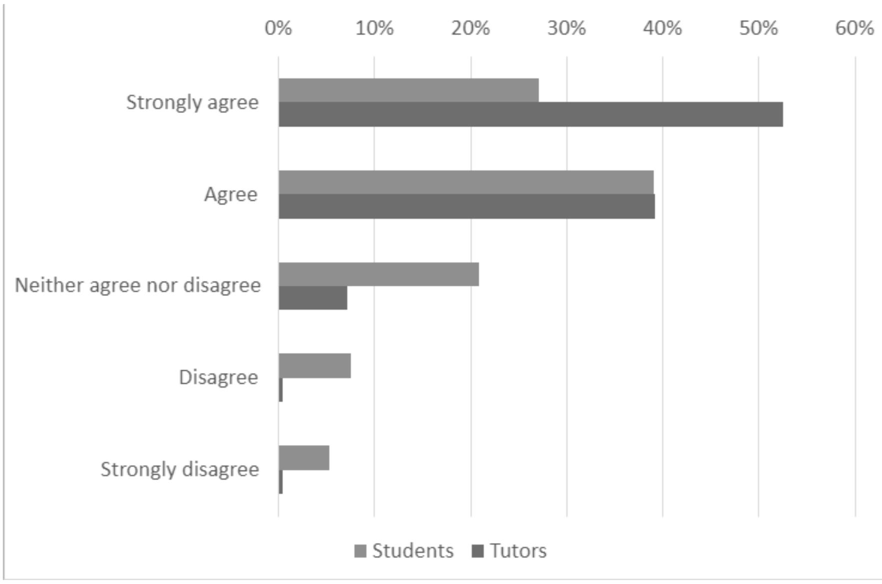
The research questions this project aims to address imply that, ideally, all students should actively participate in online sessions. Something to consider, and which is discussed in more detail later, is whether it is sufficient for some students to attend but not to participate actively, as the following tutor comment suggests: "I say it's fine to listen without actively participating and that I don't put people on the spot."

Another consideration is whether there could be other reasons for students saying they prefer just to listen. For example, there were comments from students concerning other students dominating discussions. "There were too many people all wanting to say something. The same people seemed to dominate proceedings." "Not everyone feels comfortable to participate so you find you have 5 students dominating discussion."

Despite 58% of students stating they were happy just to listen (Figure 6), another survey question showed that around two thirds of students (66%) and a higher proportion of tutors (92%) feel that there is benefit for students in actively taking part in sessions (Figure 9). One student commented: "It is important to participate actively, especially in terms of asking questions … sometimes the other students ask questions that I haven't even thought about."

Figure 9

Students' and Tutors' Responses to "I [Students] Benefit If I [They] Actively Take Part In Online Tutorials" (Student responses n = 604; Tutor responses n = 194)



Discussion

In this part of the paper, the findings are discussed in relation to the research questions. The first section below discusses our findings regarding barriers to active student participation in synchronous online sessions. This section (which addresses RQ2) provides the basis for moving on, in the second section, to discuss how these barriers can be overcome. Here we consider the approaches tutors are currently using (RQ1) to encourage active participation, and how these approaches can address barriers for students (RQ3). We also discuss where our findings indicate there is more work to be done on overcoming barriers, and how this might be achieved. We consider whether attendance without active participation, which emerged as a key theme during analysis of the data, is a legitimate approach for some students.

Barriers to Active Participation

A key aspect of our findings is that many students are anxious about online tutorials, particularly if they are expected to participate actively. A third of students expressed feelings of stress about taking part actively, and over a third did not feel confident about speaking; these are significant proportions. This suggests that lack of confidence is a primary factor affecting students' engagement in online tutorials. This finding is in line with previous work that identified anxiety and shyness as major reasons for keeping webcams turned off during online sessions (Gherheș et al., 2021; Rajab & Soheib 2021) and for low online engagement more generally (Mogavi et al. (2021). Our findings show that students' two main reasons for lack of confidence in participating are that they are unsure of their knowledge of the module and are worried about what other students might think of them (Figure 6). Although a lack of confidence may be anticipated for students who are new to studying or attending online tutorials, it is worth noting that the respondents were students on undergraduate Stage 2 modules, so online tutorials were not new to them.

Our data has also highlighted problems with the "synchronicity" of activities in online tutorials. For example, if a tutor asks a question, one student may come in quickly with an answer (by speaking or by text chat) and this can discourage contributions by other students. There can be a perception that certain students are dominating the discussion, and this may further undermine the confidence of those who are hesitant about contributing.

Some ways of participating in online tutorials were more popular than others. In the context investigated in this research, webcams were hardly used by students. There was some use of audio, but most students engaged via text chat. Although text chat was by far the most widely used tool for participating in tutorials, it still drew some negative comments that indicated barriers to its use. Whilst some students found text chat a less stressful way of participating, others felt it could be distracting, easily going off topic, and was sometimes difficult to keep up with.

Overcoming Barriers

There is a need to build students' confidence and alleviate the anxiety that is associated with actively taking part. Previous work has established that if teachers can establish an empathetic and caring environment, students will feel safer engaging actively (Meyers et al., 2019). In our research, tutors identified ways of creating a safe and empathetic environment. Examples included: encouraging different forms of engagement (e.g. through text chat); enabling ways of participating anonymously (e.g. using the whiteboard or polls); and tutors having their own webcam on while chatting informally with students at the start of sessions. However, given that one of the main reasons for students' lack of confidence in participating was that they are worried about what other students might think of them, there is the need to encourage students (especially the more confident ones) to show empathy and support to other students. Building a sense of community and belonging among students is necessary to help them feel comfortable when learning with others (Peacock and Cowan, 2019).

Another key finding about lack of confidence related to students' knowledge of module materials. Again, examples of tutors seeking ways to alleviate this worry were identified, for example by making materials available in advance of the tutorial. Providing students with information before the event should help relieve some of the worry around this, for example by giving a clear description of the purpose of the tutorial, the approach to be used, and the content that will be covered.

Students need to be persuaded of the value of active participation, and that it does not have to be daunting. Ice-breaker activities can build confidence in using the tools and have previously been identified as a valuable way to engage students and encourage learner-learner interaction (Bolliger & Martin, 2018). Initially, tools that offer a degree of anonymity can be used; for example, polls and whiteboards are anonymous; comments were received from tutors that highlighted the benefits these afford. The text chat tool may also feel somewhat more anonymous to students, compared to using audio or webcam. Many tutors were aware of students' worry around using audio or webcam and did not force this, instead encouraging the different forms of engagement already discussed. There was also an awareness from some tutors about the problems that breakout rooms can cause students.

As already identified, text chat was a popular choice for students as a way to participate in online tutorials. Other studies have explored the benefits of text chat in different online learning environments. Huang (2022) looked at the types of interaction occurring through chat in an online course and found that the majority of contributions were meaningful. Goodman and Moore (2023) found that text chat was a "facilitator of increased confidence in learning in an online lecture environment." Whilst there is no doubt that text chat affords many benefits, there are still ways to improve its effectiveness. Developing protocols for tutors and students on how to use it in sessions, depending on the aim of the session, could help keep things on track; so could approaches such as having two tutors to alleviate the cognitive overload that a single tutor managing multiple online tasks can experience (Kear et al., 2012; Mogavi et al., 2021).

For tutors, ongoing training and awareness-raising is important, encompassing both pedagogical development and technical skills. There would be benefit in supporting tutors to manage online rooms where some students dominate discussions. This was an issue raised by students, so finding ways to deal with this, and sharing ideas amongst tutors, would be helpful. Tutors could discuss with students the "protocols" of effective synchronous communication (e.g. the value of visual and voice interaction; how to interact without dominating discussions; and how to use the text chat effectively). Again, the challenge here is finding ways to enable less confident students to contribute, without them feeling forced to.

Attending Without Active Participation

In this study the fact that students attended at all, when online sessions were optional, is a positive factor; attending without actively participating still offers benefits over not attending. Vicarious learning, i.e. listening to, and observing, interactions between other students, and between students and tutor(s), certainly has value. This can extend to use of recordings; see for example a review by Mayes (2015) and a study by Pleines (2020), although both authors suggest that the benefit is increased by active engagement with the recording, for example by pauses for reflection. Participating on the periphery of a community of practice, particularly as a new member or beginner (Lave & Wenger, 1991) is an important part of learning.

However, it is also acknowledged that becoming more active as experience grows is desirable. There are learning opportunities that students are missing by not being more active: for example, developing their knowledge through involvement in discussions, having their questions answered, having their opinions heard, and gaining valuable transferable skills in communication. There is therefore a balance needed that encourages students to engage in active ways, by gradually building the confidence that enables them to do this without anxiety. As Wang et al. (2023) suggest, a good approach is to balance instructor-led teaching with learner-centred activities (both individual and group-based activities), interspersing short periods of each approach.

Comparing Student and Tutor Responses

A particular aspect of the findings, with respect to the Likert-type questions, is that student responses tended to be more distributed across the range of available responses than tutor responses—which tended to be clustered, either round agree/strongly agree or disagree/strongly disagree—depending on the question. See, for example, Figure 7: students' feeling confident speaking, or Figure 5: students feeling comfortable using a webcam. One interpretation of these differences is that tutors are under-estimating students' confidence in online sessions; as pointed out by Mogavi et al. (2021), educators' perceptions about barriers to participation might differ significantly from those of students. In our study, tutors may have been focussing their responses on the students who do lack confidence.

An alternative (or additional) interpretation is that the student sample, which was self-selecting, may have comprised students who were more likely to attend tutorials, and who might be more confident online than the student body as a whole. Our results indicate the diverse nature and preferences of students regarding online tutorials—with some keen to engage through the use of video and audio and others preferring to remain anonymous and attend passively.

Limitations and Future Work

The main limitations of this research are the relatively low response rates for the surveys: 8% for students and 23% for tutors. The actual size of the samples was large (around 600 students and 200 tutors) but it is possible that the resulting sample was biased towards students (or tutors) who were particularly interested or concerned about the topic of the research.

In terms of future work, it will be important to extend the investigation of active participation in synchronous tutorials to other Higher Education Institutions. This will explore the extent to which our findings can be generalised to different kinds of students and educational settings. A particular aspect of the distance-learning university in this study is that it is open access, so students come from a wide range of educational backgrounds, and some students have no prior study beyond secondary school level. This may mean that they have low levels of confidence. Students also rarely meet each other (even online) which may affect their willingness to interact with each other. Finally, the technology used (Adobe Connect), though helpful for many aspects of online tutorials, does not necessarily encourage the use of audio and video channels. For all these reasons, broadening the research to other institutions will be of value, and this is already underway.

Another aspect of future work that we would like to pursue is to gain the perspectives of students with disabilities, those with mental health issues, and neurodivergent students. We believe that the issues highlighted in this paper may apply even more to these students and may limit their learning opportunities. It will be important to find solutions which help put all students on an equitable footing, taking account of their personal situations.

Conclusion

Online synchronous sessions can enhance and deepen students' learning and can also help build a sense of belonging. But, as our findings demonstrate, this potential may not be fully realised because many students lack confidence in participating actively in these sessions. There is a need to share more information with students about what to expect from a particular online session (e.g. what teaching approach will be used), to build students' confidence, and to develop students' understanding of the benefits of participating actively.

We have identified areas for improvement to the design and implementation of online sessions. We are convinced that ongoing discussion and sharing of good practice among tutors could further improve online sessions, resulting in better experiences for students, and also for tutors.

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Teacher—Student Relationships in an Online Graduate Program: A Phenomenological Analysis

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Abstract

Student experiences of closeness in teacher–student relationships can be of profound influence. Better understanding the personal and emotional contexts of such a phenomenon are of critical importance, especially in online and blended learning environments where students and teachers are physically or geographically separated. Such physical distance between teachers and students may diminish or heighten experiences of closeness in this relationship. However, less is known about student experiences of the relational quality of closeness with teachers in distance learning environments. This phenomenological study focused on exploring and reporting on such experiences of closeness. Semi-structured interviews with doctoral students, doctoral candidates, and recent graduates from a fully online graduate program were conducted. A phenomenological analysis was used to shed light on closeness in the postsecondary teacher–student relationships that unfold online. The analysis led to the thematization of four aspects or sets of aspects of closeness in the teacher–student relation: direct teacher–student communication, style or the communication of personality (teacher persona), indirect teacher–student communication, and student self-relation. Through descriptions and researcher commentary on selected accounts and extracts of students' lived experiences, this study details how these four aspects intertwine and contribute to the relational quality of closeness in the teacher–student relation. Further, this study suggests that prolonged exposure to these aspects may provide greater opportunities for closeness to emerge in this relation, but such exposure is not required to experience closeness. Findings and avenues for future research are discussed.

Keywords: Teacher–student relationships, relationships, online, closeness, connectedness, higher education

Belt, E. S., Friesen, N., Lowenthal, P. R., & Snelson, C. (2025). Teacher–student relationships in an online graduate program: A phenomenological analysis. *Online Learning, 29*(3), pp. 338-369. https://doi.org/10.24059/olj.v29i3.4604

Introduction

Teacher–student relationships are integral to the academic experience (Chickering & Gamson, 1987). Researchers have explored teacher–student relationships with adolescents (Ang, 2005; Engels et al., 2016; Hughes et al., 2012; Jia et al., 2017; Muller, 2001; Murray & Malmgren, 2005; Murray & Pianta, 2007; Wang et al., 2013), with adult learners (De Jong et al., 2014; Frymier & Houser, 2000; Jorgenson et al., 2018; Lee et al., 2020), and across multiple fields (i.e., psychology, education, and communication; Hagenauer & Volet, 2014). Research has shown, among other things, that positive teacher–student relationships are a key factor in student success (Arbaugh & Hornik, 2006; Johnson, 2006; Meyer, 2003). Yet, Hagenauer and Volet (2014) contend that too much of the research on postsecondary teacher–student relationships has focused only on student attrition.

Communication and interaction between teachers and students are essential to the teacher–student relationship (Katz, 1968). The frequency and occurrence of teacher–student interactions in postsecondary settings has been widely studied (Hagenauer & Volet, 2014; Lamport, 1993). Research has shown that the frequency of interactions between teachers and students influences, among other things, the quality of the teacher–student relationship (Jacob, 1957; Rogers, 1962) and student learning outcomes (Pascarella & Terenzini, 1978). Yet, less is known about the quality of these interactions, particularly those taking place between teacher and student in postsecondary settings (Hagenauer & Volet, 2014).

Communication between teachers and students can be conceptualized as interactions that occur at either a sociological level of roles (e.g., teacher or student) or a psychological level of individuals that constitutes interpersonal communication (Dobransky & Frymier, 2004; Millar & Rogers, 1976). Interpersonal communication involves relational qualities or factors that influence experiences of the relationship (e.g., control, trust, and intimacy; Millar & Rogers, 1976). Relational qualities such as intimacy are often interpreted differently by researchers, leading to overlapping definitions. Regardless, Dobransky and Frymier (2004) argued that “while the terms immediacy and intimacy have been used differently, they have both essentially been conceptualized as closeness” (p. 213).

Closeness, in turn, has consistently been used in the study of teacher–student relationships in a way that is similar if not interchangeable with connection or connectedness (see Dikkers et al., 2012; Giles et al., 2012; Hattie & Yates, 2013; Jorgenson et al., 2018; Lundy & Drouin, 2016; Townsend & McWhirter, 2005; Trespalacios et al., 2021). Of further significance to the present study is the fact that in their review of the relevant literature, Townsend and McWhirter (2005) found that “most conceptualizations of connectedness included a self-in-relation to others component and a more internally focused self-component” (p. 168). In other words, the student’s experience of connectedness to teachers in the teacher–student relationship concerns both how they relate to their teachers as well as how they relate to themselves. In summarizing the work of Pianta and others, Hattie and Yates (2013) described closeness in teacher–student relationships simply as “…the emotional context of teaching interactions” (p. 17).

Research suggests that students who perceive a sense of connectedness or closeness with teachers are more confident (Ryan et al., 1998), less anxious (Creasey et al., 2009), and perform better academically (Eccles, 2004; Pianta & Stuhlman, 2004). There is also reason to believe that developing such a relational sense is even more important in online doctoral programs, where students, typically enrolled for over five years (NSF, 2019), often rely on their working relationships with their faculty supervisors and dissertation committees for success (see Fuller et al., 2014; Lee et al., 2020).

Literature Review

Research suggests that teacher–student relationships in traditional in-person classroom settings are multidimensional and dynamic (Frymier & Houser, 2000; Giles, 2008; Hagenauer & Volet, 2014; Jorgenson et al., 2018)—multidimensional in that there are many factors that may influence the relationship (e.g., age, parents, teachers, schools, community, and environment). Teacher–student relationships are dynamic in that they are subject to changes over time (Gehlbach et al., 2012), marked by relational turning points (Docan-Morgan & Manusov, 2009), and involve highly contextualized and individualized processes and events (Pianta et al., 2012). The case can be made that such processes and events emerge between teacher and student and are not the result of impersonal factors and techniques that can simply be manipulated at will by the teacher.

Research also suggests that the dynamics of teacher–student relationships in online courses may differ from those developed in face-to-face courses (Song et al., 2016). For instance, teachers and students in online courses interact with multiple communication modes both within and outside the learning management system (e.g., discussion boards, virtual office hours, email). Teacher–student relationships in online programs may also differ from those in a single or one-off online course as students may have greater opportunity to engage, communicate, and interact with teachers in different ways over longer periods of time. Research has also shown, among other things, that graduate student perceptions of connectedness to online programs may vary (Bolliger & Inan, 2012; Green et al., 2017; Irani et al., 2014; Jamison & Bolliger, 2020; Rockinson-Szapkiw et al., 2014; Trespalacios et al., 2021). However, teacher–student relationships in online courses and programs are under-researched; the majority of literature on this relationship focuses on the face-to-face context.

Researchers seek to correlate the development of positive teacher–student relationships in online settings with other factors. These include the intensity and frequency of teacher communication (Green et al., 2017), type of communication (e.g., email or feedback) (LaBarbera, 2013), and delivery method (e.g., asynchronous, synchronous) (Martin et al., 2018). Despite such studies, researchers agree that further research on connectedness in online settings is needed (Green et al., 2017; Irani et al., 2014; LaBarbera, 2013; Martin et al., 2018; Trespalacios et al., 2021).

Untangling highly related constructs such as connectedness, belongingness, and community may be an onerous task when defining terms in research (Trespalacios et al., 2021). Indeed, "previous research suggests that [teacher–student relationships] can be described using a range of concepts including closeness, care, connection, safety, trust, honesty, fairness, respect, openness, support, encouragement, availability, and approachability" (Hagenauer & Volet, 2014, p. 378). Yet, connectedness, in various definitions and interpretations, appears to presuppose a shared faith between members in relation, often implying mutuality or relational symmetry (Irani et al., 2014; Martin et al., 2018). In contrast, closeness, as conceptualized in the literature, is more individualized and may arise from unique personal experiences and interactions rather than mutual expectations (Clark & Lemay, 2010; D'Alba, 2014; Rempel et al., 1985). This distinction is particularly relevant in teacher–student relationships, which are inherently asymmetrical (Hagenauer & Volet, 2014). In such relationships, closeness may be built not on mutuality but rather on a foundation of predictability and dependability, which can foster trust over time (Rempel et al., 1985). This is even more salient in online teacher–student relationships, where psychological and physical distance may shape relational experiences (Liberman et al., 2007; Moore, 1993; Won et al., 2018), and where a sense of closeness may depend on a student's ability to interpret relational cues across multiple communication modalities (see Bolinger et al., 2024; Cai et al., 2022; Dixson et al., 2017; Richardson & Lowenthal, 2017). Given these distinctions, further research is needed to explore how students experience and interpret closeness in online teacher–student relationships.

Previous research has yet to capture the nuanced complexities of students' lived experiences in sensing closeness to their teachers. Studies on teacher–student relationships suggest that developing positive relational attributes (e.g., a sense of connection) is predicated upon positive emotional experiences (see Arbaugh & Hornik, 2006; Green et al., 2017; Johnson, 2006; LaBarbera, 2013; Martin et al., 2018; Meyer, 2003). Yet, less is known about what constitutes such positive emotions in this relation. The quality of the teacher–student relationship—like any relationship—is lived, involving changing feelings and impressions that are inadequately communicated through scales and other measures. Survey instruments, for example, presuppose the relevance of fixed, a priori constructs (such as positive or negative valuations or satisfaction levels), potentially limiting the range of relational phenomena and variations that may be available for study (see Bolliger & Inan, 2012; Terrell et al., 2009). Through its phenomenological design, this study focused on the experience of relation between teacher and student without unnecessarily framing it as a question of predefined evaluative or correlational categories.

Thus, the teacher–student relationship is a relationship that is simultaneously professional and personal, cognitive and affective in character. It is one that lacks the mutuality, say, of a friendship and is deliberately arranged to come to an end. In these and other ways, the relationship between student and teacher appears different from other relationships in our lives. However, few studies explore this unique combination of qualities in postsecondary teacher–student relationships or in online settings.

Methods

The purpose of this study was to investigate students' lived experiences of teacher–student relationships while completing an online doctoral program. Specifically, the guiding research question of this phenomenological study was: How do doctoral students experience the teacher–student relationship in a fully online doctoral program? A phenomenological research design was employed to answer this question. This study was approved by an Institutional Review Board (protocol #101-SB21-091), and all participants provided informed consent.

Data Collection

This study was conducted with graduate students enrolled in a fully online Educational Technology doctoral program at a university in the western United States. A mixture of convenience and purposive sampling was used to identify participants. The first author piloted the interview questions with a fellow doctoral student. The pilot interview helped refine the semi-structured interview protocol. The finalized semi-structured interview questions can be found in Appendix A.

The first author invited 29 current students or recent graduates to participate in this study. A total of 11 students were purposely sampled and interviewed. However, extracts from only seven interview transcripts were included in the final report of the findings. The first author felt that these extracts, which include participant vignettes and research commentary, demonstrated "...convergence and divergence, representativeness and variability" (Smith, 2011, as cited in Beck, 2021, p. 124). Table 1 presents demographic characteristics of the seven participants included in the final report.

Table 1

Selected Participant Profiles

Pseudonym	Gen	Race	Age	Emp	Occ	Prog	Courses	Exp
Emerson	M	W	25-34	FT	HE	CW	6	None
Kerri	F	W	35-44	FT	HE	CW	11	1-5 yrs
April	F	W	25-34	FT	HE	CW	8	1-5 yrs
Rory	M	N/A	25-34	FT	K12	CW	9	1-5 yrs
Rylee	N/A	N/A	35-44	FT	HE	Diss	10	1-5 yrs
Leila	F	W	35-44	FT	HE	Diss	15	10+ yrs
Brax	M	W	35-44	FT	HE	Grad	16	5-10 yrs

Note. Gen: Gender, Emp: Employment Status, Occ: Occupation, Prog: Program Status; CW: Coursework, Diss: Dissertating, Grad: Graduated, Exp: Online Teaching Experience, yrs: years

Data Analysis

The first author used NVivo to code, visualize, and query data. Data analysis adopted an iterative, hermeneutic approach, engaging deeply with each participant's account through a fusion of horizons and the hermeneutic circle (Gadamer, 1975). The analysis incorporated analytic memo writing, coding, modeling, and thick description to deepen interpretive engagement with the data.

To begin, the first author read the transcripts multiple times to develop familiarity, followed by in vivo coding to capture significant participant statements in their own words. Next, significant statements were examined for patterns, relational dynamics, and recurring concerns that informed broader meaning-making (Saldaña, 2015). Rather than treating these patterns as fixed themes, the first author maintained an openness to evolving interpretations, resisting premature formalization of categories. Subsequently, subcategories within these patterns were developed manually and refined into broader conceptual groupings (Alsaigh & Coyne, 2021). These groupings—interpreted as abstractions of first-order participant expressions—were shaped through both theoretical insights and reflexive engagement with the data corpus.

Because the first author was also a student in the same program as participants, his positionality functioned as both an interpretive advantage and a reflexive challenge. While his shared academic context allowed for greater sensitivity to the subtleties of relational dynamics in online education, it also required active engagement with the hermeneutic circle to differentiate between shared assumptions and emergent participant meanings. Reflexivity—sustained through analytic memoing—ensured that interpretation remained dynamic rather than a reproduction of prior assumptions, engaging the hermeneutic circle where understanding evolved iteratively through the interplay of the whole and its parts (Friesen et al., 2012; Gadamer, 1975; Gallagher, 1992).

As interpretation progressed, participant accounts were transformed from first-person narratives into third-person descriptions. This shift enabled the first author to move beyond individual descriptions toward an interpretive understanding shaped through a fusion of horizons (Gadamer, 1975). This interpretive process unfolded as an ongoing dialogue between the researcher's preconceptions, emergent participant meanings, and the broader theoretical and historical context of the teacher–student relationship in online education.

Through multiple readings of the data, patterns of relational dynamics began to take shape, leading to the identification of aspects or sets of aspects of closeness as described by participants. Rather than treating these as rigid themes, the analysis sought to preserve their evolving nature within the interpretive dialogue. Statements were not merely counted or categorized but examined for their depth of meaning, revealing interwoven dimensions of communication, presence, and self-relation. Returning to the data at different stages of interpretation helped refine these aspects and ensure coherence in the final synthesis (Friesen et al., 2012; Gadamer, 1975).

Positionality

While multiple authors contributed to this study, the first author was solely responsible for data collection, analysis, and interpretation. Co-authors contributed through methodological consultation, feedback on study design, and revisions to the final manuscript.

At the time of the study, the first author was a 36-year-old cisgender white male, brother, husband, and father—roles that shaped his understanding of relational dynamics and emotional connection in human relationships. His lived experiences—both positive and challenging—within these roles informed his sensitivity to the nuances of teacher–student relationships in online education. Before the study began, he had extensive experience designing and supporting the design of online courses and had taught both online and in person in postsecondary settings, though he was not teaching at the time of data collection or analysis.

He also espoused a social constructivist pedagogy in his teaching, interpretation, and understanding of the world at the time of the study. As a doctoral candidate in educational technology, he analyzed the qualitative data corpus independently. His insider-outsider position as a student in the same program as participants fluctuated throughout the research process, from conceptualizations to outputs. He considered these positions situationally dependent on contextual shifts in role and relationship (e.g., receiving feedback on the proposal or manuscript from his teachers versus analyzing the qualitative data corpus), yet he acknowledges that a complete dichotomy of positions was never achieved.

Rather than viewing his shared academic background with participants as a limitation, he actively engaged in reflexivity to interrogate the influence of prior assumptions and maintain interpretive openness. This positionality provided a unique lens for meaning-making, allowing for deeper engagement with participants' narratives while requiring careful attention to differentiating between personal familiarity and emergent aspects of relational closeness in the data.

Throughout data collection and analysis, he engaged in analytic memoing and field notes, documenting evolving interpretations and reflexive insights in the tradition of Gadamerian hermeneutic phenomenology (Friesen et al., 2012; Gallagher, 1992). The impetus for this study arose from his own personal and emotional experiences of closeness in the teacher–student relation in the study site, and previous experiences of related closeness in other settings and contexts in his life. He wondered whether his experiences were unique, shared, or arbitrary and sought to better understand how the teacher–student relation unfolds online.

Results

Four aspects or sets of aspects of closeness in the teacher–student relation emerged in this study: direct teacher–student communication, indirect teacher–student communication, student self-relation, and the style or the communication of personality (understood as teacher persona). These aspects were present in all of the participants' descriptions of experiences. These aspects attempt to illustrate the phenomenon of closeness in the teacher–student relationship. The interplay of these aspects is of critical importance as the first author believes that in various combinations, they underlie the subtle and overt, complicated and simple facets of the emotional context of teaching interactions in online settings. Table 2 contains definitions of each of these four aspects and is followed by researcher commentary on selected accounts and extracts of participants' experiences.

Table 2

Aspects of Closeness in the Teacher–Student Relation

Aspect	Definition
Direct teacher–student communication	The relation or atmosphere shared between student and teacher is cultivated through asynchronous or synchronous communication that occurs directly and mutually between the teacher and the student (e.g., feedback on academic work; individual emails) or in group settings (e.g., course announcements or discussion boards). This is one way, perhaps the dominant way, in which relation arises and is experienced.
Indirect teacher–student communication	Communication that discloses aspects of the teacher to the student only indirectly, through myriad aspects of curricular and course design (e.g., teacher instructions and introductions, instructional media), and the habits and tempo (for example) associated with the course as the semester progresses.
Student self-relation	How the student relates to themselves in relation to the teacher. Students see themselves as being (mis)recognized, (under)valued and/or (mis)understood in their relationship with instructors.
Style or the communication of personality (teacher persona)	How the student perceives the instructor's personality or teacher persona that is conveyed and indirectly expressed through all of the forms of communication described above.

Experiences of Closeness and Disconnect

Closeness and disconnect are not inherently oppositional constructs but exist along a continuum of relational experience. Moments of perceived disconnect do not necessarily signal relational absence; rather, they reveal the nuanced emotional contours of teacher–student interactions. These moments may sometimes be best understood as relational ambiguity, where interpretation of connection or distance is fluid and shaped by context. Importantly, both closeness and disconnect emerge from the depth and salience of emotional engagement in teaching interactions—not merely by the presence or absence of positive emotion. In the following section, six vignettes of participant experiences illustrate extended patterns of interaction over time. These accounts—shaped by direct and indirect communication, teacher persona, and students' self-relation—illuminate how the emotional context of teaching interactions manifests dynamically through both closeness and moments of perceived disconnect.

<u>Emerson's Experience</u>

Emerson discussed three instructors, each with a unique style: One focused on building community, another on facilitating small group work, and the third on providing project feedback. He associated instructors' teacher persona with their course design and interaction foci (e.g., discussion forums, feedback, annotation, peer review), noting that "the course design is reflective of the instructor." Emerson appreciated the mentorship, opportunities to co-author papers, and personal insights and experiences shared by his instructors. He was actively curious about his instructors, seeking to understand their perspectives and approaches, yet found himself drawn more to one specific instructor, whose style resonated with him. He explained, "I could relate to [one instructor] because [they have] a little bit of [a condition] and kind of jumping around more and I could see that in [their] personality, and how and I could relate to that myself." In discussing perceived distances between online teachers and students, Emerson felt reassured that "their personality comes across for sure." He also felt that a student could glean a preview of an instructor's personality based on their research interests. He continued, "...seeing the different specialties of research is really the main window that's provided." Emerson also shared that recollections of interactions with teachers were not always episodic. He explained: "It's not always an episodic memory but it's more a change in how you approach things. You see somebody else format[ting] or editing, and you're like, 'I'm going to take this,' and suddenly you're incorporating [a] new process."

Emerson was in the early stages of his program. Despite positive interactions, he did not feel particularly close to any one instructor yet. Direct and indirect teacher–student communication and the instructors' style therein all resonated with Emerson in a few different course-based interactions. His association of teacher persona with the design of an online course suggests that closeness in the teacher–student relationship may be difficult to sense when only exposed to one instructor for one course. In addition, he described the process of becoming a doctoral student as matriculating with instructors in *their* environment (e.g., attending conferences) as well as collaborating on publications. In his self-relation, his description of being a student was very self-reflective, self-aware, almost as if he understood how he would grow from being exposed to different online instructors in the program. He described associating an instructor's personality with their research interests, which speaks to his own curiosity in research and how he may be exploring a path forward and searching for guidance. In this way, he demonstrated a cautious optimism. He was eager to build relationships but also self-protective in keeping instructors at arm's length. Emerson was still gathering information about himself and others that demonstrated a relational curiosity rather than a strong sense of closeness within any one particular teacher–student relationship.

Kerri's Experience

Kerri recalled and described three different instructors, each with distinct teaching styles: one as "approachable, flexible, and down-to-earth," another as having "quite high standards," and the third as offering "constructive criticism." Generally speaking, Kerri expressed a positive disposition toward the program, her instructors, and her experiences. She explained, "I would characterize myself a year ago [as] nervous and [un]sure, and a year later, as two different people …that's due to the instructors and the intentionality they build into the courses …ways for people to interact …feel more comfortable."

Although she had only been exposed to a small number of instructors, Kerri described a sense of closeness to her research advisor emerging from a series of interactions that included receiving feedback on academic work and receiving encouragement and support for pursuing publication. She explained:

> My [research advisor] had a positive influence …something really positive was, at the end of the class, [they] said, 'you should pursue publication on this, let's work on this

> together.' …It was a series of interactions, getting positive feedback, improving my paper, and culminating in 'I'm willing to help you take it a step further.' We're [also] trying to co-develop a grant together. …it'd be nice to take more classes with [them to] get a better feel for [their] instructional type outside the one class I've taken with [them].

Kerri's experiences with her research advisor were generally positive. She described how this instructor's feedback empowered her to make mistakes. She also conveyed that the quality of her academic work was acknowledged and valued by this instructor in their willingness to support the publication process, which resonated with her positively. Kerri developed a sense of closeness to this instructor that was enabled via direct teacher–student communication and further shaped by the instructor's teacher persona and communicative style.

Kerri wanted to pursue the relationship with her research advisor further but struggled with self-relating. On one hand, she respected the boundaries of the teacher–student relationship and recognized how communication technology can shape and color teacher–student interactions. Still, she yearned for more video interaction. For Kerri, synchronous video-based communication with her research advisor and other instructors may have helped build relationships, noting how Zoom sessions helped "humanize" experiences and improve instructor familiarity. She also felt that she could exhibit *her* personality in a "humanizing" way in annotations that she placed in Google Docs, suggesting that instructors might glean her personality from such comments. In these ways, Kerri exhibited a desire to build relationships with instructors through direct and indirect communication. On the other hand, Kerri also expressed that she was "self-directed and could manage her time" but struggled with unclear feedback from instructors. She hesitated to ask for clarification, fearing it would "expose ignorance" and be bothersome (i.e., infringing on an instructor's time). As a result, she sought help from peers, concealing her uncertainties from her instructors, including her research advisor, despite her confidence in task completion. This tension highlighted her desire to connect while grappling with self-doubt and the fear of judgment.

Kerri's experience suggests that sensing closeness may be shaped by direct interactions and also by one's capacity to trust both instructors and oneself. Kerri described sensing closeness with her research advisor that began with course-based interactions and moved into other forms of collaboration, yet also noted wanting to "get to know" her research advisor better "if [they] were going to be working together *that* way." Her experiences suggest that sensing closeness in the teacher–student relationship may emerge from direct teacher–student communication alone in a single course, but may also be dependent upon continued communication and interaction beyond a single course.

<u>Rory's Experience</u>

Rory remembered his most recent instructor for teaching the "most organized and well-run course out of all that I'd taken so far." He also expressed that "every professor has their own style of doing things." He recalled positive experiences with four different instructors: enjoying the content presentation from one, learning a lot as a teaching assistant to another, appreciating helpful explanations from a third, and respecting the strict yet valuable feedback from the fourth. Rory developed a sense of closeness to these four instructors due to prolonged communication, interaction, the teaching assistant role, and receiving feedback on academic work. He described his research advisor as smart and helpful in developing his research, while also feeling a personal connection with his teaching assistant mentor through regular Zoom meetings. Rory sensed closeness to these instructors, which included sustained communication and interaction. He explained, "...the ones that I've had to just communicate with more I've gotten in a closer relationship to …[my research advisor], [my teaching assistant mentor] just because I had to regularly communicate with them, that was a part of it."

Rory also sensed closeness to two other instructors from course-based interactions, one for providing robust feedback, answering questions, and engaging in discussion forums. He explained:

> I was kind of more drawn to [this instructor] just because I love the way [they] had set up [their] class …[they] would clearly respond to my questions …give so much feedback [read] our discussion posts …so that kind of drew me to [them] as a professor, even though I didn't have that same relationship where I had to speak to [them] regularly every week in a you know Zoom conference like I did with [my research advisor] and [my teaching assistant mentor]... [they're] just approachable… I feel comfortable with [them] and I just had [them] as my professor for a semester, and [they] just engaged with me like [they] did with anyone else so I guess that online presence is really just that level of engagement that they give and how well they're able to communicate.

The other instructor, with a different teaching style that initially intimidated Rory, ultimately earned Rory's appreciation and respect for their approach to teaching, particularly resonating in the feedback provided on his academic work. He explained:

> I don't know, [they] had a way. It's something I can't describe. I don't know what [their] style is; [they were] very blunt, [they] pushed me hard to do good … unlike other professors, [they'd] call me out. What I'm saying is personal, when [they] leave comments and everything, [they'll] let me know how it is… Writing is never my strong suit, but I grew, I learned a lot.

Rory was exposed to different types of communication and interactions with instructors from which he sensed closeness. He described sensing closeness to his research advisor and teaching assistant mentor due to frequent and prolonged communication and interaction, along with sensing closeness to two different instructors stemming from course-based interactions. Rory demonstrated an awareness and sensitivity to direct and indirect teacher–student communication in these teacher–student relations. For Rory, a sense of closeness emerged with one instructor, in part, due to the design of the course (i.e., indirect teacher–student communication) when he affirmed that "I love the way [they] had set up [their] class." His sense of closeness to this instructor was also influenced by direct communication with the instructor, stemming from feedback on his academic work.

Direct teacher–student communication with other instructors also resulted in a sense of closeness, although the nature of these communicative exchanges were somewhat different with each instructor. He received feedback from his research advisor on research interests and ideas, and from his teaching assistant mentor on teaching style, with sustained conversations allowing personal aspects to evolve, fostering a relaxed and casual exchange between teacher and student beyond academic feedback. However, he found feedback on assignments and discussions from other instructors profoundly helpful, despite taking only one course with each. Both instructors had different communication styles; each resonated with him. He sensed closeness to one instructor based on the abundance of feedback, which he felt revealed instructor engagement, online presence, and teacher style. He sensed closeness to the other instructor as a more knowledgeable other, demonstrating instructor engagement, online presence, and teacher style, yet in different ways that did not manifest positive emotions in Rory. In his self-relation, he gained an appreciation for the teacher persona of the latter instructor as it helped him grow as a student. Rory's experiences also suggest that a student may sense closeness in the teacher–student relationship even when it is not explicitly recognized or reciprocated by the instructor. For example, both instructors providing feedback on academic work were likely doing so instinctually, out of duty or habit, and not necessarily doing so with the intention of building relational closeness or mutuality in the relationship.

Rylee's Experience

Rylee was writing a dissertation and felt that being an online teacher and an online student provided perspectives that informed one another. Rylee found one course lacking instructor presence but overall felt that instructors were engaged, creating a welcoming online learning environment. Rylee also perceived the instructors in the program as busy, a preoccupation that seemed to shape their availability and engagement in teaching. Rylee did not sense closeness with any instructors in the program, though they expressed an awareness of its potential development. They explained, "I honestly don't have a close relationship with any instructors, not even my advisor. I wished that we had developed [it] earlier. [Now], I feel it's kind of late. Not one instructor in the entire program knows me well."

Rylee attributed this disconnect to several factors, including limited awareness of opportunities to engage with instructors, shifting job locations and research interests, and a perceived lack of agency in relationship-building as a student. They explained:

> ...it's a possibility there's this disconnect, there could be some space outside [a] course to get to know [instructors and] for them to get to know you, but I [haven't] felt compelled to participate in any of those opportunities …I would have strategically connect[ed] with instructors who had expertise in a particular area, but I moved my research focus so many times … I've never looked at instructors as peers or colleagues, and that could be a barrier for some of the relationship building.

Rylee expressed that they were starting to get to know their research advisor more but did not sense closeness in any teacher–student relationship. Rylee discussed receiving feedback on academic work as both positive and negative, feeling impressed when feedback was relevant to their specific research area but frustrated when an instructor expected more from their work, considering page requirements arbitrary and exhausting. Rylee exhibited self-relation relative to relationship building and demonstrated some personal ownership of any shortcomings in teacher–student relationships. Yet, Rylee's experiences suggest that sensing closeness in the teacher–student relation is not experienced by all students. Further, Rylee's experiences suggest that a student's awareness of closeness in the teacher–student relation embodies self-relation. Rylee had prolonged exposure to different instructors, experiencing both positive and negative emotions in various communicative exchanges, which led to a sense of disconnect. Such mixed emotions highlight that sensing closeness to instructors may be influenced not only by interaction opportunities but also by students' underlying motivations and expectations for engagement.

Leila's Experience

Leila was also writing her dissertation and enjoyed teaching online and the flexibility of asynchronous online learning. Overall, she described a positive disposition about the program and her experiences with different instructors. She described having "strong impressions" of three instructors: Her research advisor's support, prompt feedback, and regular video meetings left a positive impact; serving as a teaching assistant helped her know another instructor in a casual and informal way, and she resonated with the teaching style of a third. Leila appreciated instructors' efforts in creating engaging classes through personalized videos, curated content, active presence, and consistent feedback, approaches she considered as enhancing her learning experience and teacher–student interactions. She explained:

> There's a couple professors who go out of their way to put something of themselves into the class every week… one does weekly videos, they're just a minute long but it gave you a sense of [them] being there …[they] would respond in the discussions, you could tell [they were] reading everything ….there was an element of curation to how [they] approached the classes, which at the doctoral level felt appropriate …I've modeled some practices of my own on that …[They were] another who was very good about having a very visual and active presence in the class, [they were] extremely consistent, you would see new content Tuesday by noon, and feedback at a certain time, [in] a certain form so that was very effective.

Teacher persona resonated with Leila, and she attributed her awareness of teacher persona to previously teaching in face-to-face classrooms and "having gone through some teacher training." In this program, Leila had some choice as to who her research advisor was but also described not having a choice as to who her instructors were on a course-by-course basis. Leila described how an instructor's teacher persona shaped her learning experiences and engagement, noting that she felt more aligned with some approaches than others. She explained, "I never had a choice of instructors... there are people I wouldn't take again because their style is frustrating to me, but there are plenty of others I would take again, having taken one already."

Leila reflected on the professionalism and evolving power dynamics in teacher–student relationships in online settings. Her descriptions suggest that doctoral students may bring their own prior experiences and expectations about communication, interaction, and instructor roles, which shape how they engage with faculty and coursework. Leila's experiences also highlight the potential for a teacher's style to have either positive or negative emotional connotations that inform student actions, reactions, and behaviors. She considered her online instructors still as "teachers" because she has not graduated yet but considered other instructors (outside of the study site) as colleagues. Leila also discussed that consistent, clear, and sustained communication were advantageous to the teacher–student relationship, especially with one-to-one feedback from instructors on academic work. Leila was seemingly very aware of the teacher–student relationship and understood it quite profoundly, describing her engagement with instructors as intentional and adaptive. She expressed how her communication and interaction with her instructors was predominately academics-related, career-focused, or professionally based and that this made sense, was expected, hoped for, and appropriate. Leila sensed closeness to instructors that had teaching styles that resonated with her own. She also described attempting to tailor, match, or model an instructor's communication prose back to the instructor via email as a way to communicate more efficiently and effectively, wanting to emulate student behavior that she would appreciate as an instructor.

Brax's Experience

Brax was a recent graduate of the program and remembered ten different instructors from the program, one of whom was his research advisor and one of whom he met at graduation. He remembered the other eight instructors from the courses that he completed. Brax's general disposition about the program, the instructors, and his experiences were overwhelmingly positive. He described being drawn to instructors that were leaders in their fields and in online education. He explained, "I gravitate to the ones that lead. They're not like, 'here's my canned course…' It's, 'I'm going to lead you, I'm going to be your professor,'…for the most part, all of them in the program were like that."

He described three instructors in particular as having a "commanding online presence" and "very well-designed courses." Brax described feeling a sense of closeness to these three instructors as their teaching styles resonated with him. He explained:

> ...it was their teaching style, their ability to connect with students. They had [a] commanding online presence, like a brand, very intentional interaction, communication, presence, they were very involved, they're not just this face behind a screen ...we're not being forced to connect [and] that made me feel more connected to them ...they get to know you at a professional [and] personal level …I was connected to them, even in those interactions that we're at a distance, it wasn't always school, we talked about work, life.

Brax described how these three instructors, including his research advisor, established professional and personal connections with him, indicating their interest in maintaining a professional relationship beyond graduation, treating him more like a colleague than a student. He explained, "...they never treat you like 'I'm this professor, you're this student' …that relationship exists but 'I'm here to help, I want to be your peer'… 'let's cement that professional relationship, we're peers, let's do things together'..."

Brax sensed closeness to certain instructors that stemmed from a combination of direct and indirect teacher–student communication, teacher persona, and self-relation. He took many courses with his research advisor and two other instructors, describing his dissertation committee relationship as "particularly strong." In addition, he noted that his courses felt intentionally designed (i.e., predetermined or scaffolded) but not prescriptive. Several instructors exhibited welcoming and affable teaching styles, "folks who [were] not afraid to take on the challenge of working at a distance." Brax often viewed these experiences through the structure of the program, but he also described a gradual shift in how he related to certain instructors, moving from a student-teacher dynamic to a more collegial rapport after graduation. Self-relation was also present in how Brax described receiving feedback on academic work from different instructors, with detailed, guided feedback evoking emotional resonance, while less guided, open-ended feedback evoked dissonance. For instance, he described struggling with one instructor's feedback style, which felt less structured and left him uncertain about how to apply it. This experience contributed to his disengagement with a particular research methodology, as he perceived a mismatch between his current expertise and the expectations set by the instructor. He explained: “I would never expect my master students to be at my level. I would expect them to be at the master student level... I get it, we’re doc students but we’re also not perfect and we need help and support to get there.” In his self-relation, Brax attributed emotional dissonance to feeling less supported, although he acknowledged being a doctoral student, he paradoxically was quick to dismiss the doctoral station and that the feedback provided by the instructor was intended to guide him. In this way, Brax displayed a conflict between his self-image as a student and how his instructor asked him to see himself in this specific communicative interaction. In this instance, the instructor’s communicative style did not resonate with Brax, but he maintained that this instructor was “brilliant… wonderful at the research [they] do.”

Brief and Unexpected Experiences of Closeness

In the following section, two extracts of participant experiences were analyzed relative to lived time, lived body, and lived space. These two extracts are representative of short communicative exchanges that arose between a student and a teacher and were selected to illustrate a range of emotional responses in sensing closeness in the teacher–student relation.

April’s Experience

April described feeling closer to her research advisor because they had “constant” communication and recounted a specific, brief, and unexpected experience of closeness with them. She explained: “When I got a new puppy, we’re both German shepherd fans …we’re talking about dogs, sending pictures …I have a really great connection with [them], but I think that’s just because [they’re] my advisor in the program.”

The experience of getting a pet, of conversing about that experience with another person, and sharing pictures of pets tend to evoke positive feelings that can be traced in terms of both lived body and lived space. Sharing pictures and accounts about their dogs can be said to have oriented teacher and student around a common time: the present in their engagement with their pets. It also brought them together around a common (but admittedly still divided) space: the “here” of their homes or domestic environments, which they shared with their pets. It is perhaps not surprising that this experience of a common space and time brought the two closer in their relationship, as it is certainly more concrete and unambiguously positive than discussions about a student’s writing or about feedback on a submitted document. Important, also, in this communicative exchange between April and her advisor, is how April was relating to herself in the teacher–student relation (e.g., describing her experiences, her eagerness to share, her excitement about pet ownership). In this way, sensing closeness requires, in part, an awareness of individuality, a consciousness of our influence on others, and what we desire or need from others. In April’s description of this communicative exchange, it is evident that the experience was not prolonged. The experience was rapid and intense. Although April described sensing closeness to a teacher based on shared and immediate experiences, one cannot assume that such personal qualities are the only ways in which closeness can emerge between teacher and student in relation.

Relating to someone based on these and other moments of sharing can emerge in subtle and complex ways and circumstances. For instance, when viewing a film, one might relate to a character in a scene, or when listening to music one might relate to the melody, the lyric, or the composer, or when browsing social media one might relate to the posting of a complete stranger. In an educational context, these moments may similarly arise between teacher and student in both the direct and indirect communication taking place between them. While direct communication between teacher and student in online settings may rise and fall relatively quickly, indirect communication manifests a certain constancy (e.g., through ever-present course design, curricula, instructor-created videos, and so on). April's experience also exemplifies how the time of the teacher–student relation is discontinuous: Sharing their experience about their pets only lasted briefly in their communication. At the same time, the feelings involved in such an exchange may linger. In April's description of her experience, closeness appeared suddenly, prompted by a sudden communicative exchange with a teacher; however, she ended up attributing this closeness to their regular and ongoing communication throughout the course.

Leila's Experience

Leila experienced a moment of perceived disconnect in a brief communicative exchange with an instructor. She described a challenging interaction during a synchronous Zoom meeting that was shaped, in part, by prior perceptions of the instructor. Her disposition during the meeting was influenced by a previous instance of indirect teacher-student communication initiated by the instructor. She explained, "[This instructor] has a tendency to go on, to complain on social media about students in general and forget that students can see it, so I may have already had a negative feeling about that before we met."

The experience of scanning social media for context cues about others can evoke both positive and negative feelings. Feelings of joy may arise when scrolling past a witty meme or feelings of anger or disgust may arise when scrolling past that same meme. Feelings will vary by taste and individuality but are felt, nevertheless. Leila described a distaste for this particular exchange as she interpreted it as personally directed. Like April's experience, however, it is impossible to know or assume how the instructor felt at this moment. Leila's experience alludes to several aspects of the teacher–student relation that include teacher persona, direct and indirect communication, and self-relation. Her description suggests that students may enter into direct communication in the teacher–student relationship with preconceived notions about a teacher or their teacher persona. The Zoom meeting she described as a negative experience was direct teacher–student communication, whereas the posting on social media was indirect. Yet, this indirect communication stirred such a sudden and intense emotional response that Leila could not let it go when meeting and communicating directly with the instructor. What Leila's experience illuminates is the subtle and overt implications of the communicative exchanges (that may span multiple communicative episodes) that surrounds the teacher–student relation and how sudden and perhaps nuanced the exchanges can be that at once constitute and also color the relationship either positively or negatively over the course of its existence.

Discussion

The lived experiences of students in this study show various teacher–student relationships, including those with research advisors, as teaching assistants, and with specific instructors through courses, program coordination, and scholarly pursuits (e.g., grants, publications). Each type of teacher–student relationship may require further investigation as several factors may influence emotions and communication (Quinlan, 2016), and students will undoubtedly encounter different levels of predictability and dependability in each relationship.

For instance, research has shown that supportive or difficult teacher–student relations during the dissertation process can significantly affect students (Burkard et al., 2014). Dynamics like interdependence or long-term commitment in these relationships may influence perceptions of closeness differently than teacher–student relations in short-term, course-based interactions.

This study explored how the emotional context of teaching interactions shaped the dynamics of teacher–student relationships in a fully online doctoral program, including moments of closeness, ambiguity, and perceived distance. Participant descriptions revealed that a sense of closeness may develop gradually through ongoing communication and interaction or in very instantaneous and granular ways (i.e., brief moments when a student receives or is exposed to teacher), such as receiving feedback on academic work, viewing instructor-created videos, attending instructor-led synchronous sessions, or interpreting an instructor's communication prose in email, course-based announcements, discussion boards, or social media. Participant descriptions suggest that sensing closeness in the teacher–student relationship is experienced individually and requires a degree of student self-awareness in the relationship. Teachers may not share or be aware of students' emotional resonance with their communication or teacher personas. For example, Rory's experiences in course-based interactions with two different instructors suggest that the instructors communicated out of habit, not necessarily out of a shared sense of closeness. In an online learning environment, students sensing closeness to teachers may also confound teachers as they often cannot observe how students engage with the content they create or respond to the feedback they provide as they would in traditional in-person classroom settings. Moreover, moments of perceived disconnect did not always signal relational absence but instead revealed shifts in engagement, differing expectations, or tensions in communication. Relational ambiguity emerged when participants were uncertain about the depth of their connection with instructors, particularly in infrequent interactions or when navigating professional boundaries. These findings suggest that closeness is not simply the presence of positive emotions, nor is disconnect the absence of relationship; rather, both are shaped by how students interpret and navigate their interactions over time, including moments of brevity, unexpected connection, or discontinuous engagement.

Four aspects of closeness in the teacher–student relation emerged in this study: direct teacher–student communication, indirect teacher–student communication, self-relation, and style or the communication of personality (teacher persona). Each of these four aspects are influential to experiences of closeness and are discussed in greater depth below.

Direct Teacher–Student Communication

The preponderance of participant descriptions of feedback or lack of feedback on their academic work supports findings of previous studies that suggest a strong correlation exists between connectedness and instructor feedback (see Gallien & Oomen-Early, 2008; Glazer & Wanstreet, 2011; LaBarbera, 2013). Additionally, studies have shown that clarity, timeliness, delivery method, and the credibility of instructor feedback may influence students' perceptions of connectedness (Poulos & Mahony, 2008; Sheridan & Kelly, 2010). Together, these and other findings, along with our own, hint at a nuanced distinction between connectedness and closeness. While consistent and reliable communication can gradually cultivate a sense of closeness over time, moments of unexpected or discontinuous interaction may also contribute to students' sense of relational engagement with their instructors.

Participants described instances of engaging with instructors feedback as a form of relational connection, even when emotional resonance was not explicitly mutual (i.e., the students not knowing the teacher's style or personality). This suggests that closeness may emerge from a foundation of predictability and dependability in teacher–student interactions, irrespective of shared emotional connection. For example, Kerri developed a sense of closeness with her research advisor, appreciating the positive feedback and encouragement for publication despite not having extensive interactions, synchronous or otherwise. However, further research is needed to understand the communicative role of *feedback* in fostering closeness, especially in online settings, as participants' experiences suggest that closeness may develop even when feedback elicits a negative emotional response. Emerson, for instance, appreciated the mentorship and personal insights shared by his instructors but did not yet feel particularly close to any one instructor. This highlights that while feedback may contribute to a sense of connection, other factors (e.g., time in the program, online teaching experience, or prior exposure to online learning) might shape the development of closeness. Our inclination is that an instructor's acknowledgment via feedback on a student's academic work establishes a personal connection, a communicative episode that is often the first and most direct exposure of the teacher to the student in online learning environments. This acknowledgement, whether perceived positively or negatively by the student, outweighs the content of the exchange itself. While students expect to receive feedback on their work, being "seen" in this way may briefly heighten their emotional response, especially as they may have a limited exposure to and understanding of the instructor's teaching style and personality prior to that moment.

Participants also described how nonverbal cues in synchronous video-based communication (e.g., Zoom, Google Hangouts) informed their perceptions of instructors' teacher personas, shaping and orienting their sense of closeness either positively or negatively. Brax, for instance, described developing a sense of closeness with instructors who displayed a commanding online presence and engaged in regular Zoom meetings. Such interpretations influenced participants' sense of closeness to teachers either by supporting or opposing their preconceived ideas of teacher persona. Martin et al. (2018) found a small correlation between instructor use of synchronous videoconferencing features (e.g., polls, emoticons, whiteboard, text, or audio and video chat) and student perceptions of connectedness to instructors. More research is needed, but these findings, along with our own, suggest that certain features of synchronous communication technology (e.g., video chat or webcam use) may afford students with revelations of teacher personas not otherwise available in asynchronous text-based communication alone (see Gherheș et al., 2021; Richardson & Lowenthal, 2017). Participants noted that both recurring and intermittent synchronous interactions allowed them to experience their instructor's personality in authentic, casual, and informal ways. For example, recurring sessions with research advisors allowed a sense of closeness to emerge for Rory, Leila, and Brax. However, Rory and Leila, and several other participants also found that viewing instructor-created videos asynchronously in a single online course allowed a sense of closeness to emerge as they were able to experience the instructor's teacher persona individually and on their own terms. Similarly, April's experience of exchanging messages and sharing pictures asynchronously with her advisor in a single online course allowed a sense of closeness to emerge as she was able to connect with her advisor on a personal level outside of formal interactions.

Students often form assumptions about teachers from peers, evaluations, bios, or social media, which are likely to persist in the student psyche until the student communicates directly with the teacher and can rectify the unknown with the actual on their own terms. In moments of such confirmation, the student is likely unwavering in their opinion (good or bad), and in moments of opposition, the experience is likely pleasantly or unpleasantly surprising. Thus, sensing closeness may develop or be moderated by preconceived ideas of others (good or bad).

Indirect Teacher–Student Communication

The design of an online course appears to influence student perceptions of closeness in the teacher–student relation. Each participant expressed (dis)interest in getting to know specific instructors better based on the design of the online course the instructor taught. Participants described feeling as if the design of the online course mirrored the motivation and interest of the instructor. When participants perceived the course design favorably, they also perceived the instructor favorably. Favorable online courses included structure, sequence, clarity, curation and organization, and students associated these design characteristics with positive instructor attributes (e.g., caring, organized, invested, supportive). Shea et al. (2005) suggested that the design of an online course can have a positive effect on "students' sense of being connected with and supported by their instructor" (p. 72). Conversely, in unfavorable online courses, participants perceived the content in the learning management system as outdated, inaccessible, or lacking organization and clarity. One participant noted, "...even naming files appropriately… little things that made the course easy to follow" signified instructor commitment. Participants discussed how in the absence of instructor curation or attention to course-related details they were left to their own devices to construct meaning or "guessing," often turning to peers for support in understanding resources and materials.

The interplay of indirect teacher–student communication and teacher persona became evident as participants drew associations and inferences about teaching persona from the design of an instructor's online course that positioned course design as a meaningful communicative act. Such indirect communication seemingly affords students an initial impression, an assumptive opportunity that the teacher is not similarly afforded at the same time, suggesting that initial impressions may be discontinuous for both students and teachers in online learning environments. For students, early assumptions about their teachers can shape their engagement and openness in the course, which might be disrupted by subsequent experiences that contradict those assumptions (see Bélanger & Longden, 2009). For teachers, forming impressions of students often requires more time and interaction, leading to a delayed and potentially fragmented understanding of students' perspectives and needs (see Forster-Heinzer et al., 2020). This asymmetry and potential discontinuity in forming initial impressions may influence experiences of closeness, as both students and teachers must navigate their perceptions and expectations over time.

Teacher Persona and Student Self-Relation

Etymologically, the word *persona* derives from the Latin or Ancient Greek connotation of wearing a mask, referring to the personality or social role one presents or adopts. In education, teacher and student personas represent different social roles. These personas can vary widely, such as the dutiful student or strict teacher, but commonalities exist among the teacher and student personas in how they emerge or are shown to one another. Yet, a shortcoming of the student persona, is that “an unrealistic view of the self is often part of the student persona” (Steiner, 2014, para. 4). Meaning, students may not see themselves for who they truly are in the persona they choose to embody and display to teachers. Misaligning or lacking such self-awareness provides greater freedom from the responsibility of the student role and challenges educators in deciphering a student’s individuality or individual needs. Further, the pedagogical relation is asymmetrical in that the balance of power tilts in favor of the teacher (Friesen, 2017). As such, students are disadvantaged by stereotypical student personas and need to possess the apt self-awareness to overcome such stereotypes as well as the motivation and courage to reveal themselves to teachers so that they can be seen as who they truly are or what they truly need in their present and future selves.

Participant descriptions of teacher persona also shed light on how students experience and interpret teacher persona in a distance learning environment. Teacher persona permeated through the communication media students encountered, including emails, discussion forums, course-based announcements, feedback on academic work, synchronous meetings, and asynchronous video recordings. Additionally, the interplay of teacher persona and self-relation is informative as it captures how students may be drawn to teachers that resonate with their own personalities or aspirations as teachers. Similarity-attraction theory may inform this interplay in the teacher–student relation (see Berscheid & Walster, 1969; Byrne 1961, 1971). Yet, this occurrence may be more nuanced than similarity-attraction in the teacher–student relation. For example, Rory sensed closeness to an instructor whose style did not resonate with Rory. In this instance, and instances of the like, it is possible that the teacher persona acts as a catalyst toward self-relation like looking in a mirror. Style (1996) provided a metaphor for the curriculum as a window and a mirror. Style posits, “if the student is understood as occupying a dwelling of self, education needs to enable the student to look through window frames to see the realities of others and into mirrors to see her/his own reality reflected” (p. 1). Like curriculum, students may experience teachers as windows into other realities and mirrors that spark introspection. Students may perceive teachers as mirrors in that the more self-aware students are, the more apt they may be to sense closeness in the relation and navigate it appropriately.

Different communication theories offer possible explanations for typified personas in online settings. For instance, the online disinhibition effect posits that individuals communicate differently in online environments compared to in-person environments as online communication acts as both a shield and a sword in online interactions with far less physical consequence (Suler, 2004). Still, other studies suggest that silent or uncommunicative behaviors are common online (Creelman, 2017; Smith & Smith, 2014). In either case, the persona the student chooses to embody in online spaces is not the mirror as in Style’s metaphor; it is in fact the teacher persona that reflects the students to themselves, and the student must be ready and willing to experience their reflection.

Moreover, the power dynamics in the teacher–student relationship inform a sense of closeness, affecting how students relate to the teacher persona and themselves. Participants described how they did not always feel comfortable communicating and interacting with teachers. For example, Kerri’s experiences highlighted how power dynamics affected her interactions; she felt hesitant to seek clarification and feared judgment, impacting her self-confidence and sense of closeness with instructors. Hesitancy, in these instances, stemmed from participants seeing themselves as less knowledgeable, incompetent, lacking confidence, or feeling as if their research interests were too far removed from instructor expertise. Participants also conveyed that at times they felt that their instructors were busy and, as such, they did not want to be bothersome or intrude on an instructor's time, highlighting the influence of perceived authority on student-teacher interactions, as exemplified by Rylee's reluctance to engage with instructors due to feeling less knowledgeable and competent, and fearing their research interests were too distant from instructor expertise (see Jónsson, 2023; Murray, 2007). Although the participants in this study were all adult learners, they described being intimidated by and fearful of a more knowledgeable teacher (see Rowe & Fitness, 2018). Seemingly, participants who had previous teaching experience were more in tune with this power dynamic and their experiences may have informed their self-relation in ways to which other students may have not yet been exposed or capable of, as expressed by Leila and Brax, whose descriptions showcased a transition from student to peer. Additionally, participants described how they often did not have a choice as to who their instructor was for many of the courses in this particular program, (see *bounded communities*, Wilson et al., 2004, p. 2). Participants conveyed that they were generally appreciative of the structure of the program, yet reducing students' choice of instructor may moderate their sense of closeness in the teacher–student relationship.

The teacher–student relationship is different from other relationships in our lives. Participants described this relationship as professional, collegial, mentorial, and personal. Although students described how they felt that they knew more personal information about some instructors compared to other instructors based on what these instructors chose to share in their communication and interaction, the relationship is personal in that students grapple with, navigate, and experience the relationship individually. The relational quality of closeness may or may not appear for all students in the teacher–student relation. Yet, there are moments that strike an emotional chord, tone, or response within students, shaping whether or not they permit closeness to develop in this relation. Importantly, these moments do not always have to be shared, resonate universally, or have a positive emotional connotation for a sense of closeness to emerge.

Limitations

The findings of this study cannot be generalized. Participants' experiences may not reflect the views of other students in online doctoral programs. Readers of this study must bring in their own experience and critical judgment to moderate this limitation, with acknowledgment that different readers will do so differently. The first author's experience in the program as a student and researcher gave him greater understanding of some particularities of participant experience but also limited his purview to just one program. Other researchers, even those with similar backgrounds, could interpret the data differently.

Participants were also in different stages of the program (e.g., completing coursework, writing dissertations, and recent graduates) and described varied perspectives and experiences of closeness in the teacher–student relation. However, these participants are not entirely representative of the breadth of individuality that students may embody. Nonetheless, phenomenological research gains its value by producing descriptions and interpretations whose value and validity is recognized not just on a conscious, critical level but also on one that is non-cognitive, emotive, and intuitive (Friesen, 2023).

Conclusion

Research has shown that the distant or online learner is often relegated to a position of inherent self-direction and autonomy, which requires at least a partially developed understanding of oneself as a learner. In such environments, it may be unrealistic to expect students to independently arrive at this kind of meaning-making and self-realization without support. A student's relationship with their teacher is personal and often fleeting, yet it can leave a lasting impression beyond immediate or ongoing communication. In this way, the teacher–student relationship is not necessarily bi-directional or reciprocal but shaped by the student's individual interpretation and sensitivity to their own growth and development.

Such an interpretation of closeness suggests that the terms *connectedness* and *closeness* may be similar but not synonymous relative to teacher–student relationships. For instance, connectedness presupposes mutuality or perhaps a reciprocity of emotions of subjects in relation. However, such mutuality, shared faith, or emotional reciprocity between subjects are not necessarily presupposed in our understanding of closeness in the teacher–student relation: We understand that closeness may well be perceived in feelings more related to antipathy, ambivalence, or appreciation, rather than reciprocity and mutuality. Future studies may benefit from such an interpretation.

This study adds to the research on personal aspects of the teacher–student relationship and fills a noted gap in the literature. The four aspects of closeness described in this study provide a model of this relational phenomenon and shed light on the little-studied postsecondary teacher–student relations that unfold online. Moreover, the open-ended phenomenological focus on student experience provides a novel contribution to research into teacher–student relationships more broadly.

The emotional context of teaching interactions is personal. Students grapple with several aspects of closeness that include direct and indirect teacher–student communication, self-relation, and teacher persona. Each of these provides different areas for future research in distance learning environments, as well as nuanced pathways or lines of inquiry in the establishment of trust between teachers and students. The findings of this study suggest that the interplay of these four aspects are inseparable from the relational quality of closeness. Future studies could explore students' intrinsic and extrinsic motivations relative to self-relation with teachers with different student populations, courses, and programs. Further, studying experiences of closeness resulting from indirect teacher–student communication alone could shed light on the atmosphere of this relation and the multiple ways the student is exposed to the teacher in online settings. Findings from this study suggest that a student's sense of closeness may emerge in asynchronous communication and interaction alone. Yet, questions remain as to whether or not the communicative aspects that color and surround the teacher–student relation in predominantly asynchronous communication constitute a mutually shared atmosphere.

There are multitudes of ways in which students and teachers communicate and interact in online settings, providing greater opportunities for experiences of closeness to emerge. Student and teacher experiences in online courses and programs will undoubtedly vary from person to person and course to course. However, the technologies that were formerly thought of as creating an undesirable distance between teachers and students may now present greater opportunities for varied and frequent teacher–student communication and interaction that might not have been previously possible with in-person instruction alone. Teacher persona has been studied in many ways, and similarity-attraction theory offers a plausible explanation, yet resonance with teacher persona or sensing closeness in the teacher–student relation is not relegated to teachers like ourselves. Lastly, there are many types of teacher–student relationships (e.g., research advisor, program coordinator, teaching assistant mentor) that moderate or exacerbate direct and indirect teacher–student communication that could be studied relative to sensing closeness in the teacher–student relation.

Declarations

The authors declare no conflicts of interest. The authors received no funding for this research. This study was approved by the Boise State University Institutional Review Board (IRB) (protocol #101-SB21-091).

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Appendix A

Semi-Structured Interview Questions

1. Can you describe your experiences teaching and learning online in general?
2. Approximately how many courses have you taken so far in the program?
3. Of the courses you have taken, which online instructors do you remember? What do you remember about those online instructors?
4. Which online instructors had a positive influence on you? What was it that made you consider this as positive? If needed: Could you provide a specific example of a positive interaction with an instructor?
5. Which online instructors had a negative influence on you? What was it that made you consider this as negative? If needed: Could you provide a specific example of a negative or frustrating interaction with an instructor?
6. How would you describe the relationship you had or have with your online instructors? If needed: How has this relationship changed post-graduation?
7. Do you feel drawn to specific online instructors? What was it that made you feel this way?
8. Do you feel that you know your online instructors on a personal level? Why or why not?
9. Do you feel that your online instructors know you on a personal level? Why or why not?
10. Do you communicate with online instructors outside of an online course? Why or why not? If needed: How did you communicate with them and why did you choose that method of communication?
11. Do you have control in how you communicate and interact with online instructors? Why or why not?

Enhancing Online STEM Education: Impacts of Pre-Released Exam Materials and Remote Proctoring

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Abstract

Student attrition in online courses remains a significant concern, particularly in STEM disciplines. Common pedagogical practices in STEM, such as timed, high-stakes “traditional” exams, may contribute to attrition by adversely affecting cognitive development, student attitudes toward their discipline, and various aspects of motivation. I hypothesized that the pre-release of exam materials could mitigate such undesirable effects of exams. To test this, I investigated the effect of pre-released exam materials on student outcomes in an upper-division online biology course, focusing on exam performance and impacts to student attitudes and motivational factors. Results indicated that in comparison to a traditional exam system, the pre-release of exam materials did not significantly improve student exam performance, attitudes, or motivation, nor did it affect the achievement gap associated with lower socioeconomic status (SES). However, student responses to a qualitative survey suggested a trend for unique benefits of pre-released exam materials, including reduced anxiety and an enhanced focus on core concepts. This implies that pre-released exam materials have the potential to improve the qualitative test-taking experience of online STEM students without disadvantaging students from lower SES backgrounds. In addition to the above, I found that remote proctoring significantly penalized exam performance, with more pronounced effects for students from lower SES backgrounds. Nevertheless, proctoring requirements maintained favorable student attitudes, with all attitude categories remaining expert-like only under proctored conditions. These findings suggest that remote proctoring in online STEM courses can have complex and multi-faceted effects that warrant further investigation.

Keywords: Achievement gap, attitudes, grades, motivation, online education, exams, remote proctors, socioeconomic status, STEM, test anxiety

Landys, Mėta M. (2025). Enhancing online STEM education: Impacts of pre-released exam materials and remote proctoring. *Online Learning,* 29(3), 370-416. https://doi.org.10.24059/olj.v29i3.4743

Introduction

Online education continues to grow at a rapid pace. However, student attrition rates from online learning environments remain a concern, particularly in online Science, Technology, Engineering and Mathematics (STEM) courses. High attrition not only limits the sustainability of online STEM programs but also disproportionately impacts historically underrepresented groups, exacerbating existing inequities. Addressing these challenges requires innovative pedagogical approaches that enhance academic performance, discipline-related attitudes, and motivational beliefs—all key factors for online STEM student success and retention.

One promising strategy is the pre-release of exam materials. Students in a face-to-face introductory STEM course self-reported that the pre-release of exam materials helped them to focus their studying on key concepts, promoted deeper critical thinking, and reduced test-taking anxiety (Wiggins et al., 2023). The current study aims to investigate whether implementing a pre-released exam delivery system in an online biology course can similarly enhance outcomes, and whether effects are equitable across diverse student groups.

Literature Review

Online learning platforms have transformed higher education, becoming a core mode of instruction at most colleges and universities. Post-secondary institutions use online learning platforms to enhance financial sustainability and reach a broader, more diverse pool of students. For students, online learning offers the benefits of flexibility, convenience, and affordability (Shay & Rees, 2004). However, student attrition in online learning environments remains a concern, as dropout rates often exceed those in traditional classroom settings (Bawa, 2016; Shaikh & Asif, 2022; Xavier & Meneses, 2020). STEM courses experience particularly high attrition rates (Wladis et al., 2014). This not only limits the successful growth of online STEM programs but also negatively impacts the well-being of students who do not persist (Xavier & Meneses, 2020). Furthermore, remote STEM education disproportionately challenges historically underrepresented students (Barber et al., 2021). Consequently, the continued expansion of online STEM education could exacerbate the existing high attrition rates in underrepresented groups (Crisp et al., 2009, Estrada et al., 2016), potentially deepening social inequities and detracting from impactful and innovative STEM work through loss of diversity (Barber et al., 2020; Hofstra et al., 2020).

Although no single factor fully predicts student attrition from an online course, instructional strategies play a key role in students' success (Muljana & Luo, 2019). For example, instructors' ability to spark intellectual curiosity and appropriately challenge students is linked to improved retention; online learners tend to report greater satisfaction and demonstrate greater persistence when engaged with rigorous and relevant content (Artino & Stephens, 2009; Muljana & Luo, 2019; Shaikh & Asif, 2022). In support, instructional practices that foster higher-order learning in face-to-face courses improve student performance (Haak et al., 2011; Stanger-Hall, 2012).

Online student retention is influenced not only by engagement in higher-order learning but also by socio-psychological factors that contribute to learning readiness, such as discipline-related attitudes and components relating to motivation, academic self-efficacy, and self-determination (Bawa 2016; Muljana & Luo, 2019; Shaikh & Asif, 2022; Xavier & Meneses, 2020). Thus, enhancing attitudes and motivational beliefs in online learners may improve academic success (Artino & Stephens, 2009; Cho & Shen, 2013; Chung et al., 2022; but see Walker et al., 2024). Supporting this, studies of face-to-face students show a strong correlation between socio-psychological factors and achievement (Burtner, 2005; Oseguera et al., 2019; Perkins et al., 2005), with evidence suggesting that participation in a single STEM course can impact socio-psychological factors (e.g., Cleveland et al., 2017; Liu et al., 2022; Stanger-Hall, 2012).

While online STEM faculty who emphasize higher-order learning and foster positive motivational beliefs in their students have the potential to address the ongoing issue of attrition, certain pedagogical practices like timed, high-stakes traditional exams may undermine these efforts. In most STEM courses, exams are the primary assessments of learning. Typically, students first see exam questions during a testing period with time constraints, requiring students to rapidly process instructions, question texts, and any accompanying figures or tables. Moreover, these timed exams often constitute a significant portion of the course grade, determining whether students pass or fail. Such traditional characteristics of STEM exams pose at least four challenges for online students, particularly when students are from historically underrepresented groups.

First, traditional STEM exams favor simpler, lower Bloom's-level questions due to time constraints, encouraging rote memorization rather than deep, critical thinking (Black & Wiliam, 2010; Jensen et al., 2014; Stanger-Hall, 2012). For online students, who may already feel less connected to the discipline (Delahunty et al., 2014; Selco & Habbak, 2021), this focus on surface-level learning can hinder engagement and development of mature, discipline-specific thinking. Effects may be especially harmful for historically marginalized students, who need to counter social stereotypes regarding their pursuit of a STEM career.

Second, the high-stakes nature of traditional STEM exams often generates counterproductive anxiety which can hinder memory and learning, weaken exam performance, and erode students' STEM identity (Seipp, 1991; Vogel & Schwabe, 2016). This anxiety may be particularly detrimental to online students, who already feel a reduced sense of community (Delahunty et al., 2014; Selco & Habbak, 2021), as well as to underrepresented students, who face additional cognitive loads related to stereotype threat and systemic inequities (Ballen et al., 2017; Cohen et al., 2006; Putwain, 2008; Salehi et al., 2019).

Third, students who receive poor scores on traditional STEM exams often attribute their poor performance to external factors, such as "tricky" questions or an "unfair" exam. Such excuses are especially common in students with low motivation, a group that includes many online students (Stark, 2019). Such perceptions can lead students to adopt a defeatist attitude and take the naïve stance that they cannot do much to improve their academic standing (Black & Wiliam, 2010).

Fourth, traditional STEM exams often impose strict time limits while not accounting for language challenges, which may disproportionally penalize non-native speakers and students for whom the "language of college" was less prevalent in their upbringing, such as students from low-income or first-generation backgrounds. This inability of traditional exams to separate language difficulty from content mastery can exacerbate achievement gaps.

These identified issues with traditional STEM exams can increase attrition rates, especially in online settings, as well as perpetuate demographic achievement gaps (Salehi et al., 2019; Stanger-Hall, 2012). An assessment system that incorporates the pre-release of exam materials may offer a promising solution (Johnson & Crisp, 2009; Wiggins et al., 2023). In this system, students are given access to certain textual and visual components (e.g., scenarios, tables, or graphs) before the exam. This approach is widely utilized in K-12 education and is likely to translate well to college environments (Johnson & Crisp, 2009; Pellegrino et al., 2001; Wiggins, 1998).

In response to the four specific challenges associated with traditional STEM exams discussed above, an assessment system that incorporates the pre-release of textual and visual information (hereafter referred to as "pre-released exams") could: (1) facilitate the inclusion of higher Bloom's-level questions that promote deeper conceptual thinking and strengthen students' connection to the discipline (Jensen et al., 2014; Stanger-Hall, 2012); (2) reduce unproductive anxiety, especially important for online and underrepresented students (Ballen et al., 2017; Cohen et al., 2006; Jegede & Kirkwood, 1994; Putwain, 2008); (3) enhance student "buy-in" for assessment accuracy that can foster motivation, encourage responsible learning behaviors, and improve future performance (Brazeal & Couch, 2017); and (4) promote equitable comprehension of exam materials, particularly under narrow time constraints.

A recent study of face-to-face students in a large introductory biology course supports these benefits: students reported positive impacts of pre-released exam questions on their understanding of study priorities, depth of thinking, and test-taking anxiety (Wiggins et al., 2023). Students also expressed a strong preference for exam questions with pre-released material. Importantly, pre-released materials did not worsen demographic achievement gaps.

Building on this evidence, I hypothesized that integrating a pre-released exam system into online STEM education would significantly enhance learner outcomes in an equitable manner by fostering higher-order cognitive thinking and key socio-psychological factors, such as mature attitudes toward the discipline and increased learner motivation.

To test this hypothesis, I examined the effect of pre-released exam questions on student exam performance in six sections of an asynchronous, upper-division online biology course. I assigned pre-released exams versus traditional exams at the section-level. Additionally, I examined the effects of pre-released exams on socio-psychological factors relevant to online learner success and retention, including attitudes toward the discipline, motivational beliefs, and qualitative experiences with exams, while also collecting demographic data to assess equity.

In sum, I addressed the following research questions (RQs) in my study:

- **RQ1**: Do pre-released exams improve exam performance and socio-psychological factors relevant to the success of online STEM students?
- **RQ2**: Do pre-released exams help reduce disparities in educational outcomes for students historically underrepresented in STEM?

I initiated this study during the COVID-19 pandemic and could not use on-site proctoring centers for exams as planned, because these centers were closed. Midway through the study, I implemented a remote online proctoring system provided by my institution, creating a natural experiment in which earlier course sections operated without proctors, while later sections included proctoring requirements. As a result, I included "proctoring requirements" as a potential explanatory factor in all statistical analyses, enabling me to additionally assess the effect of remote proctors on online learner outcomes. Findings from this part of the study add to the growing body of literature on the use of remote proctors in distance education (Harmon et al., 2008; Daffin & Jones, 2018; Wuthisatian, 2020). Accordingly, my study also addressed a third research question:

- **RQ3**: How do remote online proctors influence exam performance and key socio-psychological factors in online STEM students?

In sum, my study aims to advance understanding regarding the impact of assessment practices in online STEM education and to identify strategies that foster equitable academic success and retention.

Methods

Context

I conducted my study at a Research 1 (R1) university in the Pacific Northwest, USA. I collected data from an asynchronous upper-division online biology course which focuses on the sub-disciplines of molecular genetics, transmission genetics, and quantitative genetics. This course is a core requirement for online Zoology majors and includes on-campus Biology and Zoology majors. Additionally, this course attracts post-baccalaureate students who are fulfilling prerequisites for professional programs. Each section spans 11 weeks and consistently reaches its enrollment capacity of 60 students.

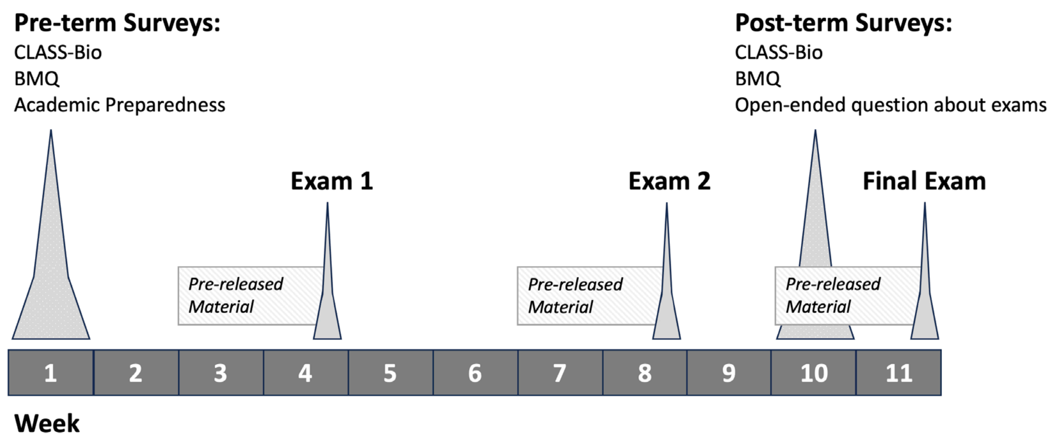
For all sections of this course, I served as the principal instructor; I am a woman with a PhD in Zoology and over a decade of experience teaching college-level courses. In 2018, prior to the commencement of this study, I applied for and received Quality Matters (QM) certification for this course. QM certification serves as an internationally recognized standard that acknowledges courses that provide high-quality online learning experiences and adhere to rigorous QM course design criteria.

Exams

Each section of the course included three timed online exams (Figure 1), which I administered remotely. I permitted students to use their notes and a calculator during the exams but instructed them to complete the exams individually and refrain from sharing answers. Students signed an academic integrity statement at the start of each exam affirming their intent to follow these instructions and comply with our institution's Student Code of Conduct.

Figure 1

Timeline of Research Flow and Data Collection



Note. The listed surveys and three exams were delivered for all sections. In the sections assigned to the pre-released exam treatment, exam material was shared with students 13 days prior to the start of each test-taking period. CLASS–Bio: Colorado Learning Attitudes in Science Survey–Biology. BMQ: Science Motivation Questionnaire II-Biology.

I included a combination of question formats in exams, including constructed-response questions (short answer, fill-in-the-blank, and short essay) and restricted-response questions (multiple choice, multiple select, true/false, and matching). I graded all exam questions.

To limit the use of unauthorized resources during remote exams, I utilized topic-specific question bins. For each assessed topic, I had the learning management software randomly draw one question from its respective topic bin for each student. The assessed topics for all three exams remained consistent throughout the study, with the third (final) exam being comprehensive.

To help students prepare for exams, I provided a comprehensive list of measurable weekly learning outcomes in advance of each exam. These outcomes outlined the skills, abilities, and knowledge that students might be expected to demonstrate.

Performance on Exams

The learning management system randomly drew exam questions from topic-specific bins for each student, resulting in unique subsets of questions on each student's exam. This randomization made direct comparisons of overall exam performance among students challenging. However, I repeated three exam questions for every student across all sections of the course (see Appendix A). These questions targeted learning goals traditionally emphasized in undergraduate genetics courses, focusing on: (1) linkage and gene mapping, (2) transcription and translation, and (3) genomics. The average score on these three repeated questions demonstrated a strong positive correlation with the average score on the three exams, as shown by the Pearson product-moment correlation coefficient, $r(171) = .67$, $p < .001$. Based on this strong correlation, I used the average score on these three repeated questions as a proxy for overall course exam performance.

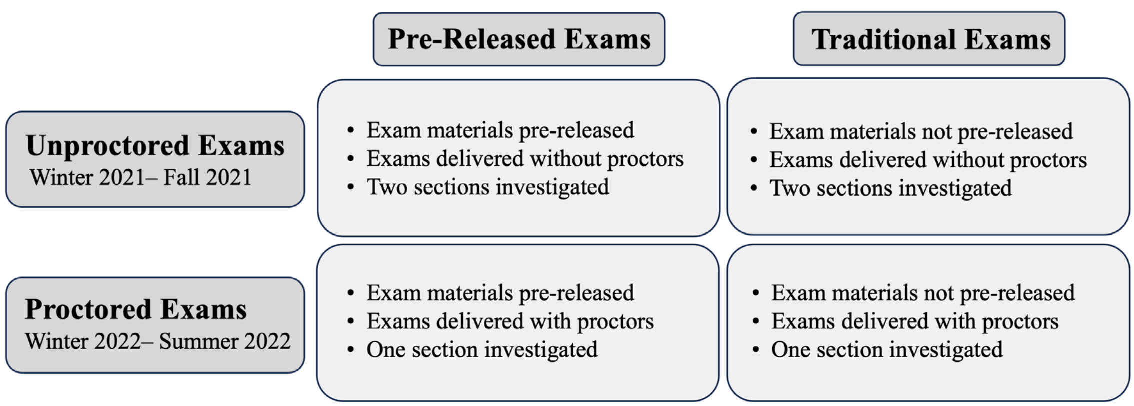
Proctoring Requirements

I conducted this study from Winter 2021 through Summer 2022. Initially, I planned to utilize physical on-site proctoring centers to administer the online exams. However, due to COVID-19 restrictions, these centers were unavailable at the start of the study. As a result, I conducted online exams for the first four investigated sections of the course remotely without proctoring.

During the latter part of the study, my institution adopted use of an automated remote proctoring system, Proctorio. This system records a student's exam session by accessing their webcam, screen, and microphone, enabling instructor review. I delivered online exams in the final two sections of the study—one section utilizing pre-released exams and the other using traditional exams—through this automated remote proctoring system (Figure 2).

Figure 2

The 2 x 2 Study Design: Exam Treatment and Proctoring Conditions Across Sections



Note. Except for exam treatment and proctoring conditions, all course elements were kept identical across the six investigated sections.

Treatment Conditions: Pre-Released vs. Traditional Exams

I used a quasi-experimental design to investigate whether the pre-release of exam materials improves outcomes for online biology students. Due to ethical considerations, I could not assign students within a single course section to different treatment groups, as the treatment condition was likely to influence student outcomes. Instead, I assigned treatment at the section level, so that all students within a given section experienced the same exam system – either pre-released or traditional exams.

To minimize confounding variables, I included multiple course sections in this study and randomized exam treatment across terms. Specifically, I ran three sections using pre-released exams and three using traditional exams. Given the incorporation of proctoring requirements only in the later sections, this resulted in a 2 x 2 study design (Figure 2). Except for exam treatment and proctoring requirements, I kept all course elements identical across the six investigated sections. To isolate the effects of treatment, I used an interrupted time series design (with surveys delivered in a pre/post manner) and included incoming student preparation as a covariate in statistical tests (see details below).

Under the pre-released exam system, an instructor shares portions of exam materials with students ahead of the actual test-taking period. Instructors can choose to pre-release exam material in various ways and to different degrees (see Wiggins et al., 2023). In the present study, I disclosed both the point value (e.g., “4 pts”) and general topic (e.g., “Genetic Linkage Maps”) for 100% of exam questions in sections utilizing pre-released exams. Additionally, I provided incomplete textual and/or visual information (e.g., scenarios, tables, or figures; see example in Figure 3) for 50% of exam questions. This included the three repeated exam questions used in this study as a proxy for exam performance (see the pre-released materials for these questions in Appendix B). I shared exam materials with students 13 days prior to the start of each test-taking period with the intent to clearly communicate the core concepts for which I would hold students responsible and to help students work through complex information ahead of the actual exam.

Figure 3

Example of Pre-Released Materials for an Exam Question

Question 3 **0 pts**

Topic 13: Genetic Linkage Maps (4 pts)

In a species of insect, the genes: *b* (black body), *pr* (purple eyes), and *c* (curved wings) are linked. You have been tasked to map these genes.

First, you decide to create triple heterozygotes. To this end, you cross a true-breeding *b, pr, c* female with a true-breeding wildtype male. You then conduct a testcross with one of the female triple heterozygotes to obtain [...more information about the results of the testcross will be revealed on the exam...].

Phenotype			Offspring number
pr	+	+	[# will be revealed on the exam]
+	*b*	*c*	[# will be revealed on the exam]
+	+	*c*	[# will be revealed on the exam]
pr	*b*	+	[# will be revealed on the exam]
+	+	+	[# will be revealed on the exam]
pr	*b*	*c*	[# will be revealed on the exam]
+	*b*	+	[# will be revealed on the exam]
pr	+	*c*	[# will be revealed on the exam]

Calculate the following distances (in map units):

1. The distance between genes *pr* and *b*: ______ map units

2. The distance between genes *b* and *c*: ______ map units

To encourage students to engage with pre-released exam materials in advance of exams, I incorporated a free-writing exercise (graded) into the course. I asked students to: (1) access the pre-released exam information via a link provided in the assignment prompt, (2) select one pre-released exam question, and (3) submit a free-writing response outlining their studying strategy for that question. As I determined in preliminary research, incorporating such a free-writing exercise into course design effectively motivates student interaction with pre-released exam materials. This approach to assessment is unfamiliar to most students, so many will not access pre-released materials unless prompted to do so through a point-based mechanism.

In sections using traditional exams, I assigned students a similar free-writing exercise. However, instead of focusing on pre-released materials, the exercise required students to reflect on and strategize their study approach based on weekly learning outcomes that I provided as a downloadable PDF link within the assignment prompt.

Student Participants

Students enrolled in the course had previously completed at least three introductory biology courses as prerequisites. An upper-division cell and molecular biology course was recommended but not required.

For each section of the course, over 65% of enrolled students consented to share their course data. The consenting students included undergraduate and graduate students, students of various socioeconomic status (SES), and students of various ethnic/racial and gender identities (see Table 1). I collected these demographic data using a 13-question multiple-choice survey (see Appendix C) while providing students with the option to opt out of any question.

Table 1

Demographic Data of Consenting Students

Category	% of students
Class standing	
Freshman	0.0 %
Sophomore	6.3 %
Junior	32.0 %
Senior	44.2 %
Graduate student	17.5 %
Socioeconomic status (SES)	
Higher SES	63.8 %
Lower SES	36.2 %
Racial/ethnic identity	
White or Caucasian	68.6 %
Asian	14.2 %
Latinx/Hispanic	10.3 %
Black/African American	1.5 %
Other	5.4 %

Gender identity	
Woman; or *cis*-gender woman	74.4 %
Man; or *cis*-gender man	19.7 %
Other	5.9 %

Note. Percentages are based on students who opted to answer survey questions.

All activities associated with this study were approved by the Human Research Protection Program (HRPP) and Institutional Review Board (IRB) at my institution's Research Office (study number: IRB-2020-0813).

Survey Instruments

Attitude shift (CLASS-Bio)

I used the Colorado Learning Attitudes in Science Survey—Biology (CLASS-Bio; Semsar et al., 2011) to quantitatively assess whether pre-released exams improved my students' attitudes toward the biological sciences. This survey consists of 31 Likert-item questions that I administered in a pre/post manner (Figure 1). The survey questions measure the extent to which students agree with experts on seven broad constructs relating to biology: "Real World Connection," "Enjoyment (Personal Interest)," "Problem-Solving: Reasoning," "Problem-Solving: Synthesis & Application," "Problem-Solving: Strategies," "Problem-Solving: Effort," and "Conceptual Connections/Memorization." Previous studies have successfully used the CLASS-Bio to examine how pedagogical strategies impact shifts in these seven constructs (e.g., Cleveland et al., 2017).

Motivation shift (BMQ)

I used the Science Motivation Questionnaire II-Biology © Shawn M. Glynn (BMQ; Glynn et al., 2011) to quantitatively examine whether pre-released exams improve the broad concept of motivation in my students. The BMQ consists of 25 Likert-item questions that I administered in a pre/post manner (Figure 1). The survey questions assess students' career motivation, grade motivation, intrinsic motivation, self-efficacy, and self-determination. Researchers have used the BMQ in biology contexts to measure differences in motivation between groups (Campos-Sánchez et al., 2014), as well as to assess longitudinal changes in motivation within a group (Cleveland et al., 2017).

Academic preparedness

Academic preparedness can strongly influence the performance of students in STEM (Salehi et al., 2020). To capture an aspect of academic preparedness in the present study, I asked students to complete a concept survey at the start of the course (see Figure 1) consisting of 10 multiple-choice questions (see Appendix D) related to content covered in the course. I based this pre-term concept survey on 10 questions from the Genetics Concept Assessment (GCA; Smith et al., 2008), which is designed to measure learning goals traditionally associated with undergraduate genetics courses. Preliminary data suggested that these 10 specific questions appropriately challenged my incoming students, without being too easy or too difficult.

I included an attention check question in each survey to identify students who were not responding carefully or honestly. I only retained student answers if they answered the attention check questions correctly.

Qualitative Survey Question: The Exam Experience

Given the positive feedback from students regarding pre-released exams at a different R1 institution (Wiggins et al., 2023), I hypothesized that a pre-released exam system would also be viewed favorably by my students. To gain a qualitative understanding of my students' exam experiences, I presented the following post-term open-ended survey question (Figure 1): "Did the style of exams in the [identifying word omitted] Genetics course work for you? Why or why not?" Cognitive testing of a similarly worded question by Wiggins et al. (2023) showed no significant confusion or alternative interpretations, suggesting that it is valid for its intended research use. I categorized qualitative responses from my students into one of five major emergent themes and then sub-coded responses as either "positive" or "negative" in relation to student outcomes (see below).

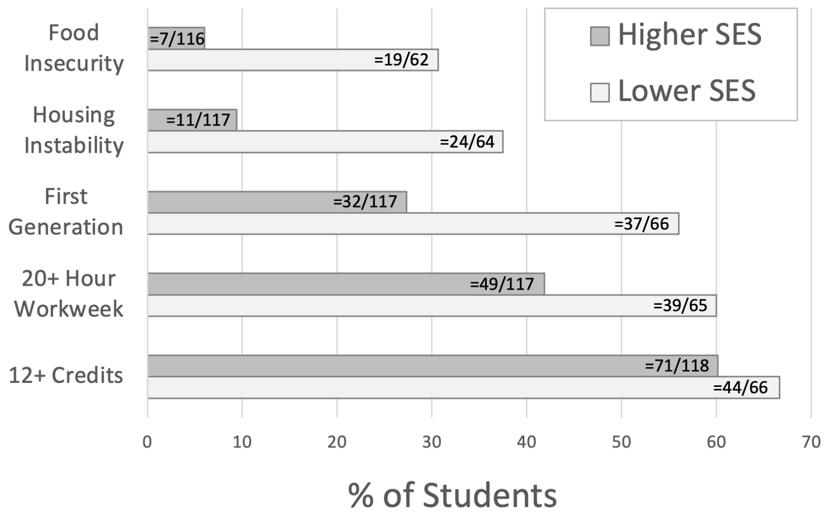
Analysis of Data

I investigated the effects of exam treatment (pre-released vs. traditional exams) on four learner outcomes: (1) exam performance, measured using the three repeated exam questions, (2) shifts in favorable attitudes toward the discipline, measured using the CLASS-Bio, (3) shifts in the broad concept of motivation, measured using the BMQ, and (4) self-reported qualitative experiences with the exam system, measured using the post-term open-ended survey question. In each of these four independent analyses, I included "proctoring" as an additional explanatory factor. Additionally, I included "academic preparedness" (measured using the pre-term concept survey) as a covariate, so that results of all analyses reflect differences in learner outcomes between students with a similar initial understanding of the content.

Students enrolled in the course self-identified with a variety of demographic factors (Table 1) that could influence learner outcomes. Based on past literature, I hypothesized that socioeconomic status (SES; Haak et al., 2011; Wright et al., 2016) might be a particularly strong mediator of the outcomes under investigation. To explore this prediction, I included "student SES" in all analyses as a third explanatory factor. I categorized SES into two levels: (1) higher SES, as represented by students who identified as middle class, upper-middle class, or wealthy, and (2) lower SES, as represented by students who identified as lower class or working class. Student SES was associated with various other demographic statistics, which suggests strong differences in cognitive loads between the higher and lower SES groups (Figure 4).

Figure 4

Self-Reported Data of Higher and Lower Socioeconomic Status (SES) Students



Note. Shown are the % of higher and lower SES students who identified with food insecurity over the past year, housing instability over the past year, first-generation status, a workweek of 20 or more hours, and a course load of 12 or more credits. Percentages are based on students who opted to answer survey questions. Sample size is shown.

Higher and lower SES students also showed significant differences in academic preparedness, as determined by the pre-term concept survey (*t*-test: $t(166) = 2.63$, $p = .009$, $d = 0.42$). Average scores on this survey were 47.1% ± 1.9% (± SEM) for higher SES students and 39.2% ± 2.3% for lower SES students.

In addition to SES, gender identity may have influenced the investigated outcomes (Ballen et al., 2017; Eddy et al., 2014). However, the low sample size of students who identified as a “man” (19.7% of students) constrained the investigation of gender-related effects. Therefore, I performed final statistical analyses on students who identified as a “woman” or “man,” but without including a gender-identity term. The omission of a gender identity term is unlikely to have caused bias in the results; a chi-square test of independence indicated that the proportion of students identifying as a “woman” or “man” was not significantly different between the pre-released and traditional exam treatment groups ($X^2(1, N = 173) = 0.03$, $p = .86$), between the proctored and unproctored exam groups ($X^2(1, N = 173) = 0.36$, $p = .55$), or between the lower and higher SES groups ($X^2(1, N = 173) = 2.84$, $p = .09$). I did not include students with other gender identities in the final data analyses (or students who chose not to share their gender identities) due to the extremely low sample size for these groups, which prevented statistical checks for equal representation between groups.

For the analysis of each separate learner outcome, I only considered students with a complete set of variables for that outcome. I conducted analyses using the R statistical package (freely available at http://www.r-project.org/).

Attitude shift (CLASS-Bio)

I collapsed CLASS-Bio scores from the original 5-point scale to a normalized 3-point scale (Semsar et al., 2011), with the three points on the scale representing: (1) a response *analogous* to the consensus response of experts, (2) a *neutral* response neither analogous nor opposite to the consensus response of experts, and (3) a response *opposite* to the consensus response of experts.

For each attitude category in the CLASS-Bio survey (i.e., “Real World Connection,” “Enjoyment,” “Problem-Solving: Reasoning,” “Problem-Solving: Synthesis & Application,” “Problem-Solving: Strategies,” “Problem-Solving: Effort,” and “Conceptual Connections/Memorization”) I calculated a % favorable response score for each student on both the pre-term and post-term CLASS-Bio surveys. I based this % favorable response score on the number of statements for which the student provided a response analogous to the consensus response of experts (in other words, when the student gave an expert-like response). To assess shifts (increase or decrease) in the % favorable response score, I calculated the difference between the post-term and pre-term % favorable response scores for each attitude category for each student.

Motivation shift (BMQ)

For each “motivation” category in the BMQ survey (i.e., career motivation, grade motivation, intrinsic motivation, self-efficacy, and self-determination), I determined the normalized change in % “motivation” for each student. First, I summed each student’s raw scores for questions in each motivation category separately for the pre-term and post-term BMQs. Next, I calculated the student’s % motivation score in each category by dividing the summed raw score by the maximum possible raw score for that category. Finally, I calculated each student’s normalized change in % motivation for each category using the formula: [100 * (post-course % motivation score—pre-course % motivation score)/ (100—pre-course % motivation score)].

Qualitative exam experience

I categorized qualitative responses to the open-ended survey question about exams according to themes that emerged from past investigations of student experiences with the pre-released exam system (Wiggins et al., 2023). Although six exam-related themes were originally identified by Wiggins et al. (2023), I found one of these themes irrelevant to the present study (my course did not include a student feedback phase, making the “Collaboration” theme irrelevant), and another theme was mentioned by only 11 students (i.e., “Language of Exam”). Thus, I categorized feedback from my students into only four specific themes: (1) “Helped with Anxiety” (e.g., helping with anxiety or confidence), (2) “Direction to Core Concepts” (e.g., knowing what to study), (3) “Deepening Thought” (e.g., ability to think critically and apply knowledge), and (4) “Authentic Engagement” (e.g., feeling trust/connection to exams). To capture feedback that did not fit into these themes, I also included a fifth category: (5) “Other.” This category consisted of comments relating to any of the following: “Language of Exam” (e.g., ability to understand exam questions), other specific comments about exams (unrelated to the previous themes), or unspecific comments about exams (e.g., an answer of “Yes” or “No” to the question: “Did the style of exams in the [identifying word omitted] Genetics course work for you? Why or why not?”).

In many cases, an individual student provided feedback that touched on more than one of the identified themes. In such instances, I recorded all relevant themes. I excluded comments unrelated to exams from the analysis.

After categorizing feedback into major themes, I sub-coded each response as being "positive" (100% beneficial) or "negative" (100% detrimental) in relation to student outcomes. I based this sub-coding on educational best practices (see Wiggins et al., 2023), rather than on students' subjective opinions or enjoyment. For example, I coded the response: "Exams were challenging but doable" as having a "positive" impact within the "Deepening Thought" and "Authentic Engagement" themes.

I coded blindly (please see the coding key in Appendix E). A second individual (also an academic faculty member at my R1 institution) independently coded 20% of the blinded responses and achieved a percent agreement statistic of .86.

I calculated a net feedback score for each student's experience with each major theme by taking the difference between the student's "positive" and "negative" experiences for that theme. For example, if a student indicated that their experience with the theme of "Deepening thought" was entirely "positive," I assigned this student a net feedback score of +100% for that theme. If the student indicated an entirely "negative" experience, I assigned a net feedback score of -100%. If a student indicated both "positive" and "negative" experiences for a theme, I assigned a net feedback score of 0% (neutral) for that theme. I considered students who did not comment on a theme to also be neutral for that theme.

Results

Performance on Exams

I conducted a three-way analysis of covariance (ANCOVA) to investigate how exam treatment, proctoring requirements, and student SES influenced student performance on exam questions. I included the covariate, content-specific academic preparedness, in the model to account for differences in initial understanding of course content. Student performance on exam questions had a significant positive correlation with this covariate ($F(1, 158) = 26.08$, $p < .001$), supporting previous studies that highlight incoming preparation as a key determinant of academic performance (Salehi et al., 2020).

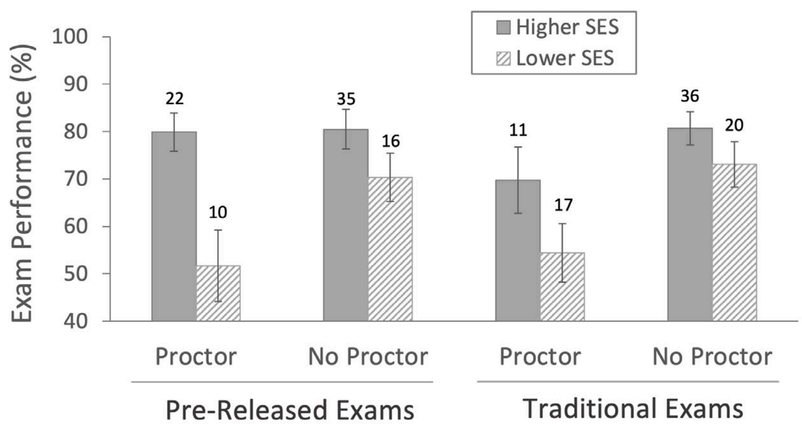
The ANCOVA model revealed no significant difference in student performance between pre-released and traditional exams ($F(1, 158) = 0.003$, $p = .95$). This suggests that, when students were exposed to different exam treatment conditions but had similar proctoring requirements, SES, and academic preparedness, there was no significant difference in their exam performance. The average scores (± SEM) for pre-released and traditional exam groups were 74.9% ± 2.6% and 72.1% ± 2.6%, respectively.

In contrast to the lack of a significant exam-treatment effect, proctoring significantly influenced student performance on exam questions ($F(1, 158) = 10.57$, $p = .001$). The average scores on exam questions for proctored vs. unproctored exams were 66.1% ± 3.2% and 77.6% ±

2.2%, respectively (Figure 5). The standardized effect size, measured by Cohen's *d*, was .49. This indicates that proctoring decreased student scores on exam questions by 0.49 of a standard deviation, which corresponds to a reduction of 11.8%.

Figure 5

Effect of Exam Treatment, Proctoring, and Socioeconomic Status (SES) on Exam Performance



Note. Exam performance is shown for higher and lower SES students taking pre-released and traditional exams under proctored and unproctored conditions. Exam performance was not significantly affected by exam treatment. However, proctoring and SES significantly affected exam performance and exhibited a significant interaction. Sample size is shown. Error bars represent SEM.

SES also significantly affected student performance on exam questions ($F(1, 158) = 10.21$, $p = .002$; Figure 5). Notably, the effects of SES remained significant even after I accounted for academic preparedness (included as a covariate). Average scores on exam questions for students identifying as higher SES vs. lower SES were 79.3% ± 2.2% and 64.0% ± 3.0%, respectively. The standardized effect size was $d = .67$, indicating that being in the lower SES group decreased student scores on exam questions by 0.67 of a standard deviation, which corresponds to a reduction of 16.1%.

The model also showed that the interaction between SES and proctoring was significant ($F(1, 158) = 4.78$, $p = .030$; Figure 5), suggesting that proctoring requirements exacerbated the achievement gap between SES groups.

All other interactions between factors were nonsignificant (with $p > .30$).

Attitude Shift (CLASS-Bio)

I conducted a multivariate analysis of covariance (MANCOVA) to examine shifts in % favorable response scores for the seven CLASS-Bio attitude categories as a group. The covariate, academic preparedness, did not significantly affect shifts in % favorable response scores ($V = 0.05$, $F(7, 157) = 1.14$, $p = .34$).

This MANCOVA model showed that exam treatment did not produce a significant multivariate effect on shifts in % favorable response scores ($V = 0.06$, $F(7, 157) = 1.40$, $p = .21$).

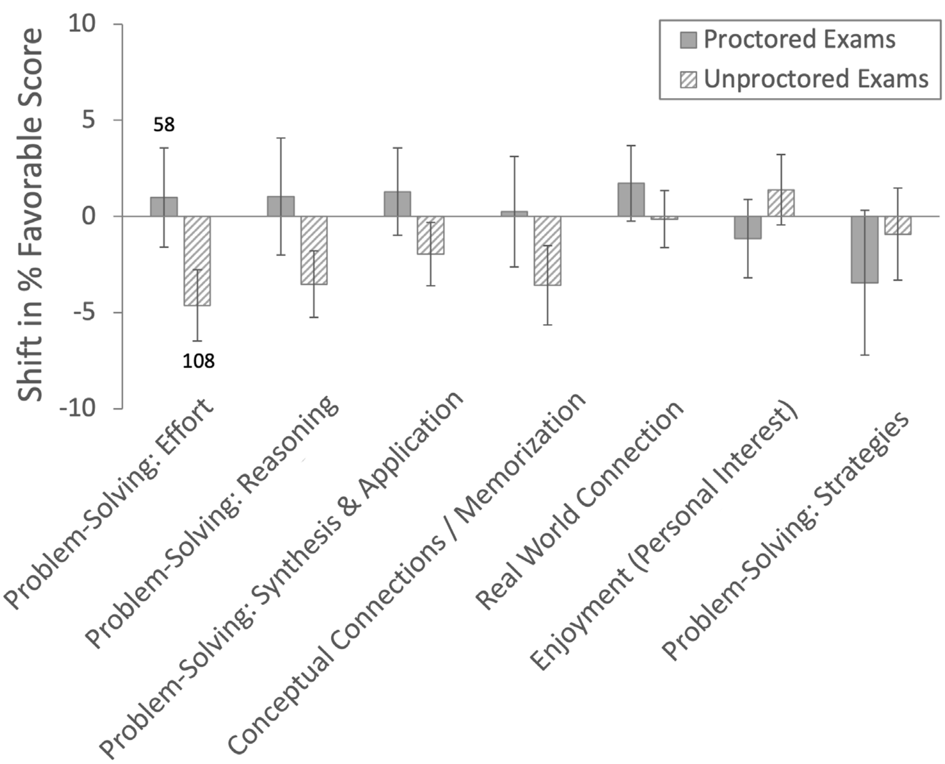
In other words, the pattern of change in expert-like attitudes was similar between students who took pre-released exams and those who took traditional exams.

In contrast, I observed a significant multivariate effect in response to proctoring: the way in which % favorable response scores changed across the seven attitude categories as a group differed for students who took proctored exams vs. unproctored exams ($V = 0.11$, $F(7, 157) = 2.59$, $p = .015$). Visual inspection of the data (Figure 6) showed that students taking proctored exams maintained % favorable response scores for all seven attitude categories, with standard errors that included the tendency of no shift (i.e., a shift of 0%). In comparison, students who took unproctored exams experienced an overall negative shift in % favorable response scores for four of the seven attitude categories: “Problem-Solving: Effort,” “Problem-Solving: Reasoning,” “Problem-Solving: Synthesis & Application,” and “Conceptual Connections/Memorization.”

I found no significant multivariate effect of student SES on % favorable response scores ($V = 0.03$, $F(7, 157) = 0.76$, $p = .62$). Additionally, all interactions between factors were nonsignificant ($p > .12$).

Figure 6

Effect of Proctoring on Shifts in % Favorable Attitude Scores



Note. Shift in % favorable scores of proctored and unproctored students are shown for the seven attitude categories measured by the Colorado Learning Attitudes in Science Survey – Biology. Proctoring significantly affected shifts in % favorable response scores. Sample size is shown. Error bars represent SEM.

Motivation Shift (BMQ)

I conducted a MANCOVA to examine the normalized change in % motivation scores across the five BMQ categories. The covariate, academic preparedness, did not significantly affect the normalized change in % motivation scores ($V = 0.04$, $F(5, 156) = 1.37$, $p = .24$). The model also found that exam treatment did not produce a significant multivariate effect ($V = 0.02$, $F(5, 156) = 0.61$, $p = .69$). Furthermore, this model found no significant multivariate effects for proctoring requirements ($V = 0.009$, $F(5, 156) = 0.27$, $p = .93$) or student SES ($V = 0.02$, $F(5, 156) = 0.71$, $p = .62$). All interactions between factors were nonsignificant ($p > .23$).

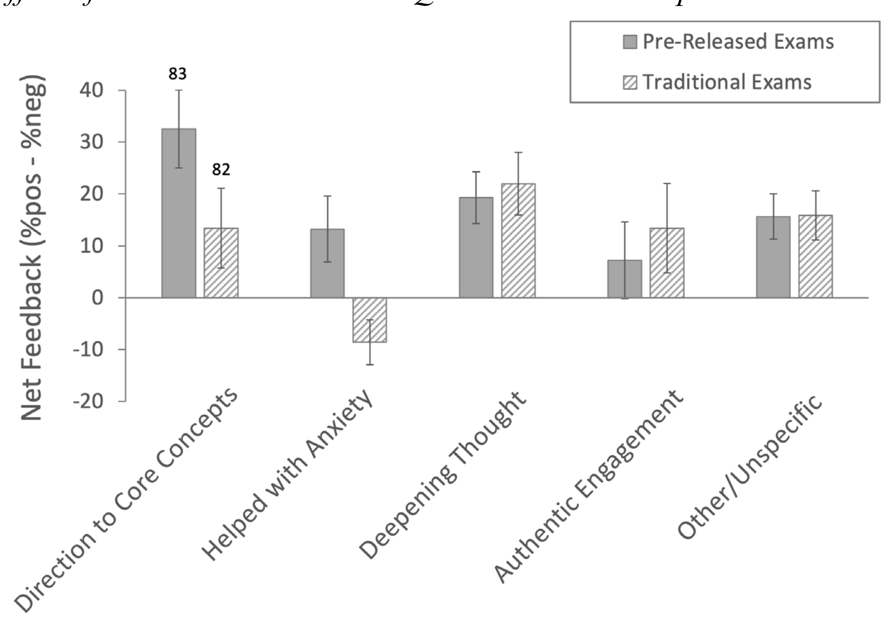
Qualitative Exam Experience

I conducted a MANCOVA to examine the net feedback scores of students on the open-ended survey question for all five major exam themes as a group. The covariate, academic preparedness, showed a significant positive correlation with net feedback scores ($V = 0.09$, $F(5, 156) = 3.17$, $p = .009$), suggesting that a stronger initial understanding of content led to a better qualitative exam experience.

This MANCOVA model revealed a nonsignificant trend in effect of exam treatment on net feedback scores ($V = 0.06$, $F(5, 156) = 2.03$, $p = .078$). In other words, with similar academic preparedness, students tended to rate their exam experiences differently under pre-released versus traditional exams. Visual inspection of the data indicated that for pre-released exams, average net feedback scores were positive for all five investigated themes (Figure 7). For traditional exams, average net feedback scores were positive for most themes, but appeared reduced for the theme of "Direction to Core Concepts" and were negative for the theme of "Helped with Anxiety."

Figure 7

Effect of Exam Treatment on the Qualitative Exam Experience



Note. Net feedback scores of students taking pre-released and traditional exams are shown for the five major themes captured by the open-ended survey question about exams. I found a trend for effects of exam treatment. Sample size is shown. Error bars represent SEM.

I found no significant multivariate effect on net feedback scores in response to proctoring requirements ($V = 0.02$, $F(5, 156) = 0.47$, $p = .80$) or student SES ($V = 0.02$, $F(5, 156) = 0.51$, $p = .77$). Additionally, all interactions between factors were nonsignificant ($p > .2$).

Discussion

Student attrition in online courses remains a significant concern, particularly in STEM disciplines. Common pedagogical practices in STEM, such as timed, high-stakes traditional exams may contribute to attrition by adversely affecting cognitive development, student attitudes toward their discipline, and various aspects of motivation. I hypothesized that the pre-release of exam materials could mitigate such undesirable effects. To investigate this hypothesis, I examined how the pre-release of exam materials impacted students in my upper-division online biology course, focusing on the following outcomes: performance on exam questions, attitudes about the biological sciences, motivational beliefs, and self-reported qualitative experiences with the exam system.

Pre-Released Exams Do Not Improve Exam Performance

I found that the pre-release of exam materials did not improve the exam performance of my upper-division online biology students. Given that pre-released materials allowed students to review parts of exam questions ahead of the actual test-taking period, this result was surprising. It suggests that, despite the well-documented challenges that online students face in managing time for college commitments (Shaikh & Asif, 2022; Xavier & Meneses, 2020), they may not have taken full advantage of pre-released materials to anticipate exam content. Instead, students may have primarily used pre-released materials to familiarize themselves with general exam structure (e.g., question number) in efforts to reduce test anxiety (discussed below). Notably, I included point-based assignments to force student engagement with pre-released exam materials, which counters the possibility that most students did not access these resources.

Pre-Released Exams Do Not Rescue SES-related Achievement Gaps

Past studies found that traditional exams in STEM are associated with an achievement penalty for students from economically disadvantaged backgrounds (Haak et al., 2011; Wiggins et al., 2023; Wright et al., 2016). My results confirm that low SES correlates with penalties for exam performance in online STEM students: students who self-identified as working/lower class displayed significantly lower scores on exam questions compared to middle/upper class students. This achievement penalty may relate to differences in content-specific academic preparedness: my lower SES students scored more poorly on a pre-term concept survey covering learning goals traditionally ascribed to undergraduate genetics courses. Past studies confirm that the underperformance of disadvantaged groups in STEM strongly relates to poorer incoming preparation (Salehi et al., 2020). Poorer preparation might arise, for example, due to limited educational resources in lower-income neighborhoods.

However, my analyses also indicate that the achievement gap related to SES persisted even after controlling for differences in academic preparedness. This suggests that the effects of incoming preparation may be exacerbated by other SES-associated factors (see Figure 4). For example, my lower SES students reported having a longer work week, which could have limited the time they could dedicate toward studying. Additionally, my lower SES students included a higher proportion of first-generation students, who often face family obligations and caregiving responsibilities that compete with their time and attention for college (Richardson & Skinner, 1992). Finally, my lower SES students were experiencing relatively greater cognitive loads (e.g., housing instability, food insecurity), which may have made them particularly sensitive to the additional cognitive demands of high-stakes exam questions (Portela-Parra & Leung, 2019).

I had originally hypothesized that the pre-release of exam materials could reduce SES-related disparities in achievement by, for example, engaging students in more efficient and cognitively-active studying behaviors (Haak et al., 2011; Stanger-Hall, 2012; Theobald et al., 2020), by reducing test anxiety that disproportionately affects minoritized and disadvantaged students (Putwain, 2008), and/or by supporting a more equitable understanding of complex questions across diverse student groups. However, my implementation of pre-released exams did not overcome SES-related performance gaps; I found similar SES-related penalties under the pre-released and traditional exam systems (see Figure 5). This mirrors results from a face-to-face introductory biology classroom that also found no SES-related effects of pre-released exams (Wiggins et al. 2023).

Given these results, alternative interventions are necessary to address SES-related performance gaps among STEM students. Support measures for at-risk students might include orientations covering topics related to learning strategies, time management, and self-efficacy (Hattie et al., 1996; Muljana & Luo, 2019; Shaikh & Asif, 2022; Tuckman & Kennedy, 2011). Support measures could also include course-level changes, such as the use of multiple, lower-stakes assessments—each requiring less preparatory time and reducing information overload—to reward students who engage in consistent, ongoing learning and practice (Cotner & Ballen, 2017; Haak et al., 2011). Self-affirmation interventions may also help to reduce demographic achievement gaps (Cohen et al., 2006; Harackiewicz et al., 2014), as they may directly address the perceived "fairness" of an exam (Good et al., 2008; Spencer et al., 1999).

Pre-Released Exams Do Not Benefit Attitudes or Motivation

The success of online students is tied to behavioral and psychological characteristics such as clear goals, motivation, academic self-efficacy, and self-determination (Cho & Shen, 2013; Muljana & Luo, 2019; Shaikh & Asif, 2022). However, students enrolled in STEM courses often show negative attitude shifts toward their discipline and a decline in various components related to self-regulated learning (Cleveland et al., 2017; Perkins et al., 2005; Redish et al., 1998; Semsar et al., 2011). I had hypothesized that these important socio-psychological factors might be bolstered in online learners through an assessment system that incorporates the pre-release of exam materials, because such a system could provide a more positive assessment experience and instill students with greater confidence in their academic abilities (Johnson & Crisp, 2009). However, my data indicate that pre-released and traditional exams similarly affected student attitudes and motivational beliefs. Taken together, these results suggest that a pre-released exam system is unlikely to yield significant benefits for the success of online STEM students by improving key socio-psychological factors.

Trend for a Unique Experience Under Pre-Released Exams

Qualitative feedback from a post-term open-ended survey question indicated that, when I took academic preparedness into account, there was a trend (nonsignificant) for exam treatment to affect the student exam experience. Under pre-released exams, student net feedback scores regarding exams were positive for all investigated themes. In contrast, under the traditional exam system, net feedback scores appeared reduced for the theme of "Direction to Core Concepts" and showed a negative trend for the theme of "Helped with Anxiety" (see Figure 7). Taken together with the significant effects of pre-released exams on student feedback in a face-to-face introductory biology course (Wiggins et al., 2023), the trends in my study corroborate the idea that pre-released exams may offer benefits for efficient studying and the reduction of test-taking anxiety, as predicted by Johnson and Crisp (2009).

The present study and Wiggins et al. (2023) show discrepancies in significance levels regarding student-reported benefits of pre-released exams. These may have resulted from differences in experimental design. For example, each exam in the single course section examined by Wiggins et al. included both pre-released and traditional questions, making it difficult to isolate effects of a pre-released exam system. Additionally, Wiggins et al. (2023) did not account for academic preparedness in their analysis, potentially introducing bias due to differences in students' initial understanding of course content.

Discrepancies in results between the present study and Wiggins et al. (2023) may also reflect course-level differences. Wiggins et al. (2023) investigated pre-released exams in a face-to-face introductory course, whereas I examined effects in an online upper-division course. Face-to-face and introductory students display lower levels of learning autonomy and may perceive pre-released materials as more helpful for determining what to study. Additionally, students in introductory courses are less familiar with college-level exams, so they may experience greater relief from test-taking anxiety after seeing parts of exams in advance. Thus, benefits of pre-released exams might depend on course level and learning modality.

Nevertheless, despite discrepancies in the degree to which pre-released exams may improve the qualitative exam experience for STEM students, both the results from my study and Wiggins et al. (2023) agree that student feedback for pre-released exam questions does not depend on student SES, suggesting that the experience with pre-released exams is equitable across socioeconomic groups in both online and face-to-face learning contexts.

Proctoring Decreases Exam Scores While Maintaining Mature Attitudes

As a result of the COVID-19 pandemic, I was initially unable to run course sections with proctors as planned. However, midway through the study, my institution adopted a remote online proctoring system, at which point I was able to implement this proctoring system for the remaining sections of my course (Figure 2). This required me to include "proctoring" as an explanatory factor in all statistical analyses, allowing me to coincidentally examine the effect of remote online proctors on learner outcomes of interest.

Student performance on exam questions was significantly lower when remote online proctors were present, as noted in previous research (Daffin & Jones, 2018). This correlation between proctoring and lower assessment scores is unlikely to be a pandemic-related effect because I introduced proctoring requirements only toward the tail end of the pandemic. Instead, I suggest that remote proctors decreased exam scores due to increased test-taking anxiety or restrictions on academic dishonesty.

Regarding the former, past studies have shown that remote online proctoring can negatively affect the exam performance of students with high trait test anxiety (Woldeab & Brothen, 2019). In corroboration, I observed that proctors imposed greater penalties on the exam scores of lower SES students, who may have been experiencing heightened test anxiety due to increased cognitive loads.

However, high trait test anxiety alone is unlikely to explain the observed negative effect of proctoring on exam performance. Responses to the open-ended survey question indicated that the qualitative exam experience, which included the theme "Helped with Anxiety," was similar for proctored and unproctored students. Thus, I propose that remote proctors also contributed to lower exam scores by restricting students' ability to share answers and/or use unauthorized resources (Harmon et al., 2008; Daffin & Jones, 2018). In support of this, students from unproctored sections of my course frequently uploaded exam questions to education technology platforms like Chegg.com, which provides students with answers to homework/exam questions in real time for a fee.

Interestingly, proctoring not only affected performance on exam questions but also significantly influenced students' attitudes toward their discipline. Students taking proctored exams maintained expert-like attitudes across all investigated categories. However, students who took unproctored exams showed noticeable declines in some attitude categories, including those related to problem-solving and conceptual connections in the field of biology (see Figure 6). I attribute these declines to a more relaxed studying approach and limited mastery of the content. Unproctored students knew they could access unauthorized resources during exams to help with questions. Thus, my data suggest that authentic engagement with course content is essential for building and maintaining mature attitudes toward STEM, such as through the practice of higher-order cognitive skills and acquisition of a deep conceptual understanding of the material (Jensen et al., 2014; Stanger-Hall, 2012).

Limitations

I employed a quasi-experimental design in this study, aiming to establish a cause-and-effect relationship based on exam treatment condition. Due to ethical considerations, I was unable to randomly assign participants within a given section to the treatment or control group. However, to minimize confounding variables, I ran multiple course sections and randomized the assignment of treatment conditions to each section. Additionally, I used an interrupted time-series design to isolate the effect of exam treatment on non-cognitive factors and included incoming preparedness as a covariate in all statistical analyses.

I conducted this research within my own courses, which could raise ethical concerns and introduce bias. To mitigate these issues, I asked a neutral third party to recruit students for the study. This party did not grant me access to student participation data until I had submitted final course grades. Furthermore, I anonymized all data prior to analysis.

My results and interpretations apply most directly to students who identified as a "woman" or "man." Due to low sample size, I did not include students who identified as a non-traditional gender or did not disclose their gender. Additionally, because this study was limited to students in my upper-division genetics course, results may have limited generalizability.

Conclusions and Implications

Pre-Released Exams

In conclusion, I found that the pre-release of exam information in my upper-division online biology course did not improve student performance on exam questions. Additionally, pre-released exams did not enhance favorable, expert-like attitudes toward the discipline and did not improve motivational components related to learning. On the positive side, the pre-release of exam materials did not exacerbate SES-related achievement gaps. Also, qualitative feedback indicated that students may have perceived pre-released exams as beneficial for reducing test-taking anxiety and for providing clearer direction to assessed concepts.

These findings have several implications for educators. My data suggest that the pre-released exam system could be used to improve the qualitative test-taking experience for online STEM students without disadvantaging students from lower SES backgrounds. In fact, the pre-release of exam material may increase the authenticity of exams, as this approach mirrors how students would interact with material in a real-life STEM career (Johnson & Crisp, 2009). Additionally, pre-released exam materials would allow educators to address the logistical constraints of timed exams and enable the inclusion of more higher-order Bloom's questions that enhance development of critical thinking (Jensen et al., 2014; Stanger-Hall, 2012).

Remote Online Proctors

With respect to proctoring requirements, remote online proctors negatively affected exam scores, with a more pronounced penalty for students of lower SES. Nevertheless, proctoring maintained favorable student attitudes toward the biological sciences, with scores in all attitude categories remaining expert-like only under proctored conditions. In contrast, in the *absence* of proctors, scores in four attitude categories declined.

My findings regarding the effect of remote online proctors carry important implications both for educators and researchers. For educators, the disproportionate SES-related penalties of remote online proctors suggest that proctoring should be implemented with caution, especially in the absence of additional support for at-risk students. However, removing proctoring requirements altogether may lead to academic misconduct and a decline in favorable student attitudes, potentially affecting overall academic success and retention (Perkins et al. 2005). As a compromise, educators might consider implementing proctoring requirements alongside more frequent, lower-stakes assessments that carry minimal risk and require less preparatory time from students (Cotner & Ballen, 2017; Haak et al., 2011).

For researchers, my findings suggest that further study of remote online proctoring is necessary, including its impact on cheating behaviors (e.g., use of tools like ChatGPT), cognitive learning outcomes, and socio-psychological factors affecting student success and retention. Research should also explore whether students with high levels of trait test anxiety are disproportionately disadvantaged by remote proctoring (Woldeab & Brothen, 2019), and whether underrepresented demographic groups face heightened risks under these conditions. Students already experiencing high cognitive loads or stereotype threat may be particularly vulnerable to proctoring-related anxiety (Beasley & Fisher, 2012; Cohen et al. 2006).

Acknowledgements

I am grateful to the "public exam" research group for their initial support: Carly Busch, Leah Lily, Tandi Ngwenyama, Gwen Schlichta, Tianhong Shi, and Benjamin Wiggins. I express my thanks to Mary Ellen Dello Stritto and Rebecca Thomas for creating and implementing the online student recruitment surveys. My gratitude extends to the students who consented to share their data for this study; to Lorenzo Ciannelli for his assistance with statistics, the R statistical package, and for coding 20% of the open-ended survey responses; and to Naomi Aguiar, Lorenzo Ciannelli, and Mary Ellen Dello Stritto for their critical feedback on earlier drafts of this manuscript. ChatGPT was used to enhance the grammar of the manuscript text.

Author Note

I have no known conflict of interest to disclose.

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Appendix A

Repeated Exam Questions Across All Sections

All investigated sections included the following three exam questions. Given the strong positive correlation between the average score on these repeated questions and the average score on the three exams, I used the average score on these repeated questions as a proxy for overall exam performance.

Shown below is a double-stranded **DNA sequence**.

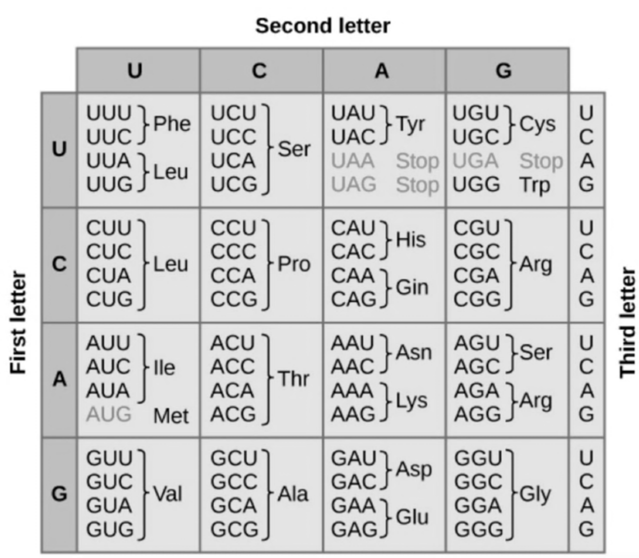
5' - ATGTCTGTATAACCA - 3'

3' - TACAGACATATTGGT - 5'

In this DNA sequence, transcription happens from left to right to produce an **RNA transcript**.

What is the identity and order of the **amino acids** specified by this RNA transcript?

Please use abbreviations for amino acids and separate with hyphens, e.g., Leu-Leu-Gly.



[Students enter their short answer here]

In a species of insect, the genes: *b* (black body), *pr* (purple eyes), and *c* (curved wings) are linked. You have been tasked to map these genes.

First, you decide to create triple heterozygotes. To this end, you cross a true-breeding *b, pr, c* female with a true-breeding wildtype male. You then conduct a testcross with one of the female triple heterozygotes to obtain 1000 F2 offspring. You divide these F2's into 8 phenotypic classes, as shown in the table below.

Based on the results in this table, you decide that genes must occur in this order: *pr-b-c.* (Thus, data in the table shows the ***correct*** gene order.)

Phenotype			**Offspring number**
pr	+	+	43
+	*b*	*c*	37
+	+	*c*	89
pr	*b*	+	81
+	+	+	360
pr	*b*	*c*	370
+	*b*	+	9
pr	+	*c*	11

Calculate the following distances (in map units):

1. The distance between genes *pr* and *b: [Students enter a numerical value here]* map units

2. The distance between genes *b* and *c: [Students enter a numerical value here]* map units

Indicate the field of study in each scenario below. [Students are provided with 2 scenarios from the list below and choose an answer from a drop-down menu: Metagenomics, Structural genomics, Comparative genomics, Functional genomics, Proteomics, or Transcriptome analysis].

1. Compares genomes of organisms; found that the DNA sequence of chimpanzees (*Pan troglodytes*) and humans differs by less than 2%.

2. Examines genetic material recovered directly from environmental samples; could investigate the diversity and relative abundance of microbes found in a river receiving drainage from surface coal mining.

3. Uses data from genomic projects to describe gene functions; for example, a nucleotide sequence can be used to predict the existence of a zinc-finger motif within a gene product, allowing researchers to categorize this gene product as a DNA-binding protein.

4. Examines the proteins expressed by a cell or tissue at a specific time point; anticipated to be helpful for the prescription of personalized drugs.

5. Attempts to find genomic structures; for example, a gene in the genome of a newly identified bacterial strain would be found using computational biology programs that look for the presence of a start codon.

6. Deals with the set of all mRNAs that are produced at a certain time-point; could find the mRNA profile that typifies early embryonic development.

Appendix B

Pre-Released Material for the Three Repeated Exam Questions

I provided these pre-released materials for the three repeated questions (used as a proxy for overall exam performance) during terms with pre-released exams. Pre-released materials were shared with students 13 days prior to the start of each test-taking period.

Topic 21: Genetic Code (4 pts)

Shown below is a double-stranded **DNA sequence**.

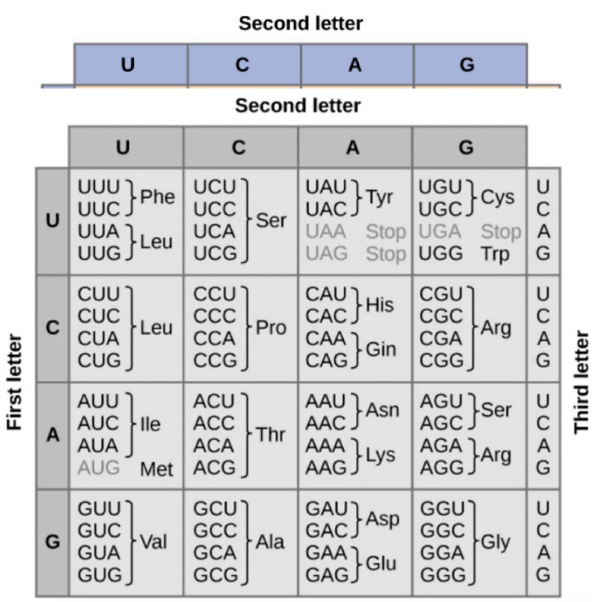
5' - [The bases in this strand of DNA will be revealed on the exam] - 3'

3' - [The bases in this strand of DNA will be revealed on the exam] - 5'

In this DNA sequence, transcription happens from left to right to produce an **RNA transcript**.

What is the identity and order of the **amino acids** specified by this RNA transcript?

Please use abbreviations for amino acids and separate with hyphens, e.g., Leu-Leu-Gly.



First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU, UUC Phe UUA, UUG Leu	UCU, UCC, UCA, UCG Ser	UAU, UAC Tyr UAA Stop UAG Stop	UGU, UGC Cys UGA Stop UGG Trp	U C A G
C	CUU, CUC, CUA, CUG Leu	CCU, CCC, CCA, CCG Pro	CAU, CAC His CAA, CAG Gln	CGU, CGC, CGA, CGG Arg	U C A G
A	AUU, AUC, AUA Ile AUG Met	ACU, ACC, ACA, ACG Thr	AAU, AAC Asn AAA, AAG Lys	AGU, AGC Ser AGA, AGG Arg	U C A G
G	GUU, GUC, GUA, GUG Val	GCU, GCC, GCA, GCG Ala	GAU, GAC Asp GAA, GAG Glu	GGU, GGC, GGA, GGG Gly	U C A G

Topic 13: Genetic Linkage Maps (4 pts)

In a species of insect, the genes: *b* (black body), *pr* (purple eyes), and *c* (curved wings) are linked. You have been tasked to map these genes.

First, you decide to create triple heterozygotes. To this end, you cross a true-breeding *b, pr, c* female with a true-breeding wildtype male. You then conduct a testcross with one of the female triple heterozygotes to obtain [...more information about the results of the testcross will be revealed on the exam...].

Phenotype			**Offspring number**
pr	+	+	[# will be revealed on the exam]
+	*b*	*c*	[# will be revealed on the exam]
+	+	*c*	[# will be revealed on the exam]
pr	*b*	+	[# will be revealed on the exam]
+	+	+	[# will be revealed on the exam]
pr	*b*	*c*	[# will be revealed on the exam]
+	*b*	+	[# will be revealed on the exam]
pr	+	*c*	[# will be revealed on the exam]

Calculate the following distances (in map units):

1. The distance between genes *pr* and *b: [*answer1] map units
2. The distance between genes *b* and *c: [*answer2] map units

Topic 31: Genomics (4 pts)

Indicate the field of study in each scenario below.

1. [The description of a specific field will be revealed on the exam]. [answer1]

2. [The description of a specific field will be revealed on the exam]. [answer2]

Appendix C

Demographic Survey

This demographic survey was posed to students during Week 3 of each course section. I used data from this survey to categorize students according to socioeconomic status (SES): (1) higher SES students – those identifying as middle class, upper-middle class, or wealthy, and (2) lower SES students – those identifying as lower class or working class. Survey data was also used to investigate factors that are associated with student SES (e.g., food insecurity over the past year, housing instability over the past year, etc.).

If you have given consent for your information to be used in the educational research study, all data on this questionnaire will be kept confidential by assigning a random code to the data. Only your Instructor (the Primary Investigator of the study) will have access to your identity. Analysis of the data will be done on an anonymous data set. Data will be used in research to improve future science courses at [identifying word omitted] and beyond.

Specifically, your answers will help us determine whether this course is equitable to students with different racial, ethnic, and socioeconomic backgrounds; diverse cultural and language perspectives; and varied physical abilities and life challenges.

Regardless of your participation in the educational research study, you will receive full credit for this questionnaire if you answer all questions; you will have the choice to opt-out of each question. This questionnaire should take you 6-8 min to complete. Thanks for your participation!

1. What best describes your current academic class standing? (Check one)
    - 1st-year
    - Sophomore
    - Junior
    - Senior
    - Non-degree seeking graduate student (post-bacc student)
    - Student in a graduate or professional degree program
    - Other
    - I prefer not to answer

2. How many credit hours are you taking this term? (Check one)
    - 4-8 credit hours
    - 9-11 credit hours
    - 12 credit hours or more
    - I prefer not to answer

3. If you took a break from academics prior to enrolling in [identifying word omitted], how many years ago were you last enrolled in a college-level course? (Check one)

- Less than 1 year ago
- 1-2 years ago
- 3 years ago or more
- This question does not apply to me; I have been continuously enrolled in courses since I started college/university
- I prefer not to answer

4. Are you currently employed (do you have a job that pays wages/salary)? (Check one)
- Yes, 20 hours or more each week
- Yes, 19 hours or less each week
- Not at the present time
- I prefer not to answer

5. Have one or more of your parents/guardians completed a Bachelor’s degree or higher? (Check one)
- Yes
- No
- I prefer not to answer

6. Is English your first language (i.e., mother tongue)? (Check one)
- Yes
- No
- I prefer not to answer

7. In what language do you find it easiest to communicate? (Check one)
- English
- A language other than English
- I communicate equally well in English and in another/other language(s)
- I prefer not to answer

8. Over the past year, have you experienced food insecurity (disruption of food intake because of lack of resources)? (Check one)
- Yes
- No
- I prefer not to answer

9. Over the past year, have you experienced housing instability (difficulty in paying rent, frequent moves, overcrowded living conditions, doubling up with friends/relatives, lacking a regular nighttime residence)? (Check one)
- Yes
- No
- I prefer not to answer

10. How would you describe your socioeconomic status? (Check one)
- Wealthy
- Upper-middle class

- Middle class
- Working class
- Lower class
- I prefer not to answer

11. Do you identify as a person with a disability? Do you have any long-lasting or chronic conditions (physical, visual, auditory, cognitive/mental, emotional, or other) that substantially limit one or more of your major life activities (your ability to see, hear, or speak; to learn, remember, or concentrate)? (Check one)

- Yes
- No
- I prefer not to answer

12. With what racial/ethnic identity do you most closely identify? (Check one)

- White or Caucasian
- Hispanic, Latinix, or Spanish Origin
- Black or African-American
- Asian
- Native American or Alaska Native or Indigenous or First Nations
- Hawaiian Native or other Pacific Islander
- Middle Eastern
- Other race, ethnicity, or origin
- I prefer not to answer

13. What term best describes your gender or gender identity? (Check one)

- Woman; or Cisgender woman
- Man; or Cisgender man
- Transgender woman
- Transgender man
- Non-binary; or Gender non-conforming; or Gender queer
- Intersex or other related terms
- Two-spirited (a person who has both a masculine and a feminine spirit; used by some First Nations people to describe their sexual, gender and/or spiritual identity)
- Other
- I prefer not to answer

Appendix D

Pre-Term Concept Survey Used to Assess Incoming Preparedness of Students

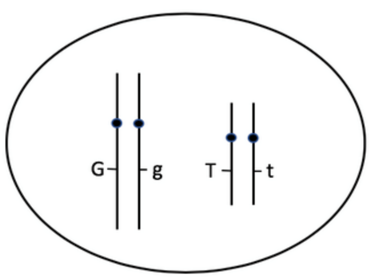
I based this pre-term concept survey on questions found in the Genetics Concept Assessment (GCA; Smith et al., 2008), which consists of 25 multiple-choice questions covering nine broad learning goals commonly associated with undergraduate genetics courses. For ease of delivery, I reduced the number of questions to 10, basing this decision on relevance to course content and preliminary data indicating that these 10 questions appropriately challenged my students. To prevent students from easily looking up answers, I also modified the wording of these questions, as the actual GCA questions and answers are freely available online.

Please answer the questions in this start-of-term knowledge assessment. This survey is designed to help your instructor assess your current understanding of genetics. You will receive full credit for this assessment if you answer all questions to the best of your ability.

This survey should take you 15-20 min to complete.

Thanks for your participation! Your answers will be very helpful in designing a more effective curriculum.

1. This germline cell contains two pairs of chromosomes on which are shown two different genes. One gene locus has the alleles G and g; and the other gene locus has the alleles T and t.



If this germline cell divides normally to produce sperm, what are the possible sperm genotypes?

- G, g, T, t
- Gg, Gg, Tt, Tt
- GT, gt, Gt, gT
- Gg, Tt, GT, gt, Gt, gT

2. If a single DNA base change of a G to a C occurs and then is copied during DNA replication, is this change necessarily a mutation?

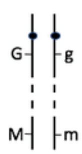
- Yes, it is a change in the DNA sequence
- Yes, if the base change occurs in a gamete (sperm or egg cell); otherwise no

- Yes, if the base change occurs in the coding part of a gene; otherwise no
- Yes, if the base change occurs in the coding part of a gene and alters the amino acid sequence of a protein; otherwise no
- Yes, if the base change alters the appearance of the organism (phenotype); otherwise no

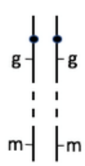
3. A tumor suppressor gene is located on chromosome 3 in humans; four different alleles for this gene have been identified. What is the maximum number of alleles that a single normal individual can have for this gene?
   - 1
   - 2
   - 3
   - 4

4. Two labs independently discover a wingless strain of *Drosophila*. Both wingless strains are due to a point mutation. You cross a mutant fly from one wingless strain to a mutant fly from the second wingless strain and find that *none* of their offspring are wingless. What can you conclude about the two mutant strains of flies?
   - The two strains have mutations in the same DNA base position within a particular gene
   - The two strains have mutations in the same gene, but not necessarily the same DNA base position
   - The two strains have mutations in two different genes

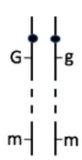
5. Two genes are located on the same chromosome in *Drosophila*. (In other words, the genes are linked). A particular female fly is heterozygous at both gene loci, with the allele arrangement within a chromosome pair shown below. (Researchers do not know the exact position of the genes on this chromosome pair, as indicated by the dashed lines.)



The female fly from above mates with a male fly in which the chromosome pair looks like this:



What is the likelihood that this mating will produce offspring with a chromosome pair that looks like this?

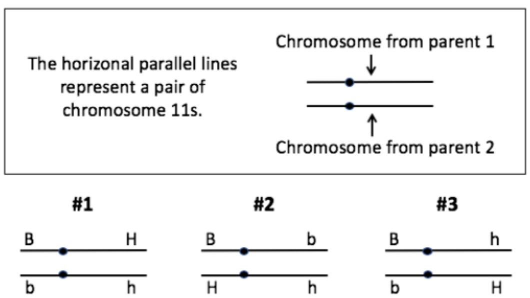


- Not likely, because the G and m alleles are not on the same chromosome in either parent

- Very likely, because the random assortment of chromosomes during cell division to make sperm or eggs allows for the mixing of all alleles
- More likely if the two genes are very close together on the chromosome
- More likely if the two genes are not very close together on the chromosome

6. In humans, which cells have a gene with instructions that determine the shape of the earlobe?
    - Cells in the ear
    - Cells in the heart
    - Gametes (sperm and egg)
    - Cells in the ear and gametes
    - All of the above

7. A woman is a carrier for Bumpy-foot disorder (Bb) and Helicopter-head syndrome (Hh). The genes involved in both disorders are located on chromosome 11. What representations of this woman's genotype (labelled #1, #2, and #3) could be correct?



- #1 only
- #2 only
- # 3 only
- #1 and #3 only
- #1, #2, and #3

8. A young woman develops a benign skin tumor that does not spread to any other tissues; the mutation responsible for the tumor arose in a single skin cell. If the woman and her male partner (with no skin tumors) have children after the woman's skin tumor diagnosis, what statement is true?
    - All of the woman's children will inherit the mutation
    - All of the woman's children will inherit the mutation if the mutation is dominant
    - Some of the woman's children may inherit the mutation depending on which of her chromosomes they inherit
    - None of the woman's children will inherit the mutation

9. Your lab identifies a human gene that seems to play a role in cystic fibrosis. Because the DNA sequence of this gene is similar to that of a known mouse gene, you suspect the two genes are evolutionarily related. You determine and compare the DNA sequences, the predicted mRNA sequences, and the predicted amino acid sequences corresponding to the two genes.
You would expect to find the greatest sequence similarity from comparisons of the two:
    - DNA sequences

- RNA sequences
- Amino acid sequences
- All three comparisons are likely to show the same degree of sequence similarity

10. Somatic body cells in the king cricket have 18 pairs of chromosomes. You have discovered another similar looking species of cricket (which you call the prince cricket) that has only 10 pairs of chromosomes in its body cells. What can you conclude?

- The king cricket has a larger genome than the prince cricket
- The king cricket has more genes than the prince cricket
- The king cricket evolved from the prince cricket
- All of the above
- There is not enough information to make any of the above conclusions

Thanks for participating in this start-of-term survey!

Appendix E

Coding Key for Categorizing Qualitative Student Responses to Exams

I categorized students’ qualitative responses regarding their exam experience into five major emergent themes and then sub-coded these responses as being either ‘positive’ or ‘negative’ in relation to student outcomes. This sub-coding was based on educational best-practices (see Wiggins et al., 2023), rather than students’ subjective opinions or enjoyment.

In response to the question: “Did the style of exams in the [identifying word omitted] course work for you? Why or why not?”			
Theme:	Sub-coding:	Positive Examples:	Negative Examples:
Theme #1: Helped with Anxiety	Helped/positive: Student felt that exams ***decreased anxiety*** or helped with ***confidence*** going into the exam (Harmed/negative: Student explains that exams induced anxiety/worry or that exams were “nerve-wracking;” student was overconfident going into exams)	• “They took the test anxiety out of the equation…” • “…helped me picture what I would be looking at on the exam so that when the tests did come around they weren't so daunting…” • “It made taking the test less scary…” • “…the spread and nature of the questions was enough to provide a lot of comfort psychologically…” • “Rather than stressing over whether I am interpreting a question right, I can focus on actually solving the problem...” • “It made me feel much more confident…”	• “Test anxiety hasn't helped…” • “I break out in hives on these exams and experience tunnel vision from the stress…” • …”my grade was impacted by my nervousness…” • “…unnecessarily nerve-wracking.” • “I'm worried about the final…” • “…left me feeling both overconfident and a little unprepared…”
Theme #2: Direction to Core Concepts	Helped/positive: Student could understand what content was going to be on exams and how to ***study***; student claims that exams were based on ***course***	• “It helped…focus my studying...” • “…helpful in preparing for the appropriate exam format and selecting learning outcomes on which to focus.” • "…I liked how [the instructor] gave us the	• “The style of exams where the questions are half published prior to the graded exam was probably not the best for me because while it was useful to study for some of the questions it left me at a loss on what else to focus on to prepare for the rest of the

	content; student felt ***prepared*** for exams (Harmed/negative: Student did not know what content would be on exams or how they should have studied; student felt unprepared for exams; student claims that exams were outside of the scope of course material)	opportunity to know the topics and styles of questions that would be on the exams…" • "…[the exams] were representative of course material." • "…the questions aligned with the study guides/learning outcomes…" • "Yes they did as they helped me put together the knowledge I have gained in this class…"	exam. [It] left me feeling…a little unprepared for the exam." • "…I did not find the early released part of the exam helpful in my studying." • "I…found it difficult to understand the expectations for the exams…I watched every lecture video while taking notes, did the homework and discussions but, did not perform as well as I had liked for how much time I put into studying." • "Sometimes I feel like there is so much material that I studied not on the test." • "I found the exams…not in sync with the textbook/lectures."
Theme #3: Deepening Thought	Helped/positive: Student could ***think critically*** and ***apply*** knowledge; questions reflected ***understanding*** rather than memorization; student references ***enjoyment***, interest, or being ***positively challenged*** (Harmed/negative: Student complains that exams were too simple and based on regurgitation or memorization; student references simply looking up	• "…the actual exams were challenging but doable." • "…helped me put together the knowledge I have gained in this class..." • "…I think they truly tested our knowledge and in order to get in that A range you had to know further then your notes, but it would not be impossible." • "…I was able to put stuff into my own words… you gave students a chance to explain their answer…" • "Utilizing a creative question made by students in the exam provides me to think of the same topic in a different way." • "…the student questions section is not only fun but also encouraging and rewarding."	• "I honestly thought they could have been a bit more challenging... the multiple choice questions felt too simple…" • "I think [the style of exams] made the course too easy." • "It makes it seem as though we're still stuck in the days of rote memorization…" • "They took the test anxiety out of the equation knowing that we are able to use our resources if a question trumps us" • "On the test itself, I easily had enough time to look up the answers I did not know, because it was an open note format." • "I had a really hard time with the exams in this class. Learning facts and regurgitating the information

	answers; student explains that they did not enjoy exams)	• "…it tested my skills by not only seeing what I remembered but by making me do problems…" • "…I wish that there were some more questions on the exam that involved general recall of facts rather than complex understanding of the material…"	has never been very easy for me."
Theme #4: Authentic Engagement	Helped/positive: Student feels exam questions were ***fair***, effective, "doable," manageable, not impossible; student indicates that there was a ***good balance*** of question types; student expresses ***trust*** in exams as assessments of knowledge; ***connection*** to exams (Harmed/negative: Student explains that exam questions were unfair; student claims that exams were unnecessarily difficult, overly challenging, or impossible; student explains that not enough time was given for	• "…the actual exams were challenging but doable." • "The exams felt fair and I like that it wasn't all one huge exam for all topics covered." • "…I didn't feel like the exams were meant to be needlessly tricky…" • "It wasn't intimidating and we did not have to provide huge answers for short-answer questions." • "…in order to get in that A range you had to know further then your notes, but it would not be impossible." • "I really like having a combination of multiple choice and short answer because I feel like that's a good way to cover a variety of problem solving skills." • "I…enjoyed being able to explain some reasoning in the short answer problems rather than all multiple choice with a "Sorry you got it wrong good day"." • "…they worked well because even when	• "The exams…had way too many subjective grades." • "I felt the exams were very difficult." • "I have ADHD and typical test structure is very hard for me to do well on. However, that is just how tests are for me and it is a part of academia...." • "I wish there had been more essay questions... multiple choice can be extremely difficult in biology (at least for me). Leaving open ended questions is usually more helpful for me to explain my knowledge." • "…we don't usually get partial credit simply because we cannot show our work." • "…the select all that apply questions aren't really helpful, especially when you lose all credit if you miss one or pick one wrong answer." • "I would have liked to have more questions on the exams... Each question had such a high point value that if I missed one question my grade would decrease by a significant amount."

	completion of exam; lack of trust in exams as true assessments of knowledge)	answering [a] question wrong for example a math problem, [partial] points are still given out when the instructor knows you were on the right path." • "I always felt I had enough time to really think about the questions..." • "Of all the styles seen throughout the last year, it is the closest one to real life…"	• "…I feel I would benefit from more time so that I can focus on the question I am completing without having to worry about rushing to the next question." • "I feel like weekly exams would have been easier rather than having two large exams and a final." • "I had some Canvas issues that caused me problems with the exams…"
Theme #5: Other e.g., Language of Exam	Helped/positive: Student could understand what was necessary to do in order to answer the questions; questions were ***well-written;*** student could ***understand instructions*** (Harmed/negative: Questions were not well-written or student could not understand instructions)	• "… questions and formatting were clear and concise, making it easier to understand what the question was truly asking…" • "I had no issues with the composition or organization of the exams." • "…exams were well crafted."	• "The first exam I struggled with small misunderstandings that I missed when reading the exam…" • "…I read the instructions for a question too quickly and I missed an important part…" • "The first exam had a weird student-written question with a mythological creature that made it more difficult for me to understand what the question was asking."
Theme #5: Other e.g., Specific comment about exams (unrelating to previous categories)	Student's positive comment about exams does not relate to one of the categories above (Student's negative comment about exams does not relate to one	• "Some aspects worked for me, such as…the Canvas format because I am used to using that platform."	• "I had some wildly unexpected issues on my second exam that really upset me. It wasn't the actual style of the exam, it was connection issues and a monitor issue." • "I had some Canvas issues that caused me problems with the exams…"

	of the categories above)		
Theme #5: Other e.g., Unspecific comment about exams	Student's positive comment about exams is unspecific (Student's negative comment about exams is unspecific)	• "I personally was fine with the style of exams." • "Yes they were good..." • "The exam style worked well for me..."	• "The style of the exams were sometimes difficult for me…" • "The style did not really work for me." • "No…"

Revisiting the Interrelationships Between Social and Cognitive Presences in Asynchronous Online Courses: Insights from Epistemic Network Analysis

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Abstract

Asynchronous online discussions (AODs) are a critical component of online learning, enabling students to exchange ideas and interact with peers in a flexible manner. To explore the interrelationships between social presence and cognitive presence, and how these two presences are connected across various instructional strategies used in AODs, this study involved twenty-two students from two fully online courses participating in AODs, and students' posts were coded and analyzed based on the Community of Inquiry framework. Utilizing the Epistemic Network Analysis (ENA) approach, this study uncovered the intricate connections and meanings behind students' interactions and engagements in AODs. Results indicated that the exploration phase of cognitive presence exhibited the strongest connections with social presence indicators, particularly affective and interactive categories. These findings highlight the importance of emotional and interactive engagement in fostering cognitive presence in AODs. Having compared the high-active and low-active classes, we concluded that learners in the high-active class reported higher social presence compared to those in the low-active class. Furthermore, a detailed week-by-week analysis showed that certain instructional strategies in AODs, such as debate, personalized tasks, and compare and contrast strategies, led to variations in student engagement and active participation. This study offers practical implications for instructional designers and educators in developing more engaging online courses and facilitating AODs. Additionally, it highlights the effectiveness of ENA as a valuable method for analyzing the relationships among CoI presences.

Keywords: Community of inquiry, asynchronous online discussions, social presence, cognitive presence, epistemic network analysis

Dong, L., Hsieh, C. J., Watson, S. L., Yu, J. H., Lowell, V. (2025). Revisiting the interrelationships between social and cognitive presences in asynchronous online courses: Insights from epistemic network analysis. *Online Learning, 29*(3), 417–448. https://doi.org/10.24059/olj.v29i3.4672 **Introduction**

Online education has become increasingly popular in the last two decades, evolving into an integral part of higher education due in large part to its accessibility and flexibility (Castro & Tumibay, 2021; Kebritchi et al., 2017). To enhance the effectiveness of online courses, asynchronous online discussions (AODs) are widely adopted (e.g., Cheng & Chau, 2016; Dumford & Miller, 2018; Rivera-Vargas et al., 2021). Analyzing the content of AODs may provide educators with information on how knowledge is constructed and how social interaction occurs in collaborative online learning environments (Anderson & Dron, 2011; Fehrman & Watson, 2021; Ferreira et al., 2018). One of the most widely validated frameworks for studying AODs is the Community of Inquiry (CoI) framework, which provides valuable methodological insights to examine meaningful learning experiences through the interplay of social presence, cognitive presence, and teaching presence (Garrison et al., 2000, 2001). Social presence refers to the extent to which participants in computer-mediated communication feel emotionally connected to one another; cognitive presence is the degree to which learners construct and confirm meaning through ongoing reflection and discussion; and teaching presence involves designing, facilitating, and guiding cognitive and social processes to support learning (Anderson et al., 2001; Garrison et al., 2000; Rourke et al., 1999). These elements work together to support deep and meaningful online learning.

Numerous studies have investigated the interrelationships among the three presences in CoI studies. However, most CoI studies examining relationships primarily rely on self-report CoI surveys and quantitative content analysis of discussion posts (e.g., Garrison et al., 2010; Kozan & Richardson, 2014; Shea et al., 2010), making it challenging to capture detailed information related to the dynamic interrelationships and the variations in group-level interaction patterns (Csanadi et al., 2018; Kapur, 2011). Moreover, studies showed that various instructional strategies used in AODs may impact students' social, cognitive, and teaching presences (e.g., Kilis & Yıldırım, 2019; Olesova et al., 2016). However, little attention was given to how various instructional strategies influence the dynamic relationships among CoI presences. Addressing this gap is essential for designing more effective AODs that promote deeper engagement and learning, as well as for advancing our understanding of how specific instructional strategies shape the dynamics of presences (Fiock, 2020). The purpose of this study is to apply Epistemic Network Analysis (ENA) to investigate the dynamic interrelationships among CoI presences, especially social and cognitive presences, in AODs across classes with varying levels of activity and different instructional strategies. By leveraging ENA's ability to offer statistical modeling and comparable network representations for understanding the relationships and co-occurrences among coded data (Chesler et al., 2015; Shaffer et al., 2016), this study aims to contribute to the growing body of CoI research that employs advanced learning analytics and offers practical insights for enhancing the design and facilitation of online discussions.

Literature Review

The Community of Inquiry Framework

The CoI framework is a widely used theoretical framework for understanding and analyzing learning experiences rather than learning outcomes in online and blended environments (Akyol et al., 2009; Caskurlu et al., 2021; Choo et al., 2020). Developed by Garrison et al. (2000), the CoI framework conceptualizes creating a deep and meaningful (collaborative-constructivist) learning experience by developing three interdependent elements: social, cognitive, and teaching presence.

Social presence can be defined as "the ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop interpersonal relationships by way of projecting their individual personalities" (Garrison, 2009, p. 352). Also, social presence facilitates learning by fostering a relaxed atmosphere where students feel free to share their thoughts and participate in insightful conversations (Lee, 2014; Martin et al., 2022), so it is widely discussed by researchers because of its importance for learning outcomes (Chen et al., 2018; Kim, 2011). Furthermore, social presence involves three categories: affective expression (affective), open communication (interactive), and group cohesion (cohesive), as evidenced by studies like Rourke et al. (1999). Specifically, affective expression is the ability to express emotions and attitudes, creating a sense of shared community and emotional connection. Open communication is students' willingness to engage in open, honest, and respectful dialogue, facilitating mutual understanding and trust. Group cohesion refers to the ability to build a sense of belonging and collaboration, promoting teamwork, and collective problem-solving (Rourke et al., 1999). Studies show that social presence is crucial in enhancing knowledge construction in online learning environments. It fosters a sense of connection among learners, which is essential for effective learning and collaboration (Galikyan & Admiraal, 2019; Lee, 2014).

Cognitive presence is essential for critical thinking and deep learning as it involves inquiry, reflection, and the integration of new knowledge (Akyol & Garrison, 2011; Garrison et al., 2001). Cognitive presence refers to the ability of a learner to create and evaluate meanings through essential, ongoing communication and thought (Garrison et al., 2001). Garrison et al. (2000) constructed a practical inquiry model for assessing cognitive presence in online environments, comprising four phases: triggering event, exploration, integration, and resolution. In the triggering event phase, students identify problems, while in the exploration phase, they brainstorm and exchange information. This exploration leads to the integration phase, where students construct meanings through the gathered ideas and information. Finally, in the resolution phase, the newly acquired knowledge is applied in a real-world context (Garrison et al., 2000). Overall, cognitive presence entails the identification of problems, the exploration of relevant information, the construction of new meanings, and the application of solutions to those problems, which is closely related to academic achievements (Cakiroglu, 2020; Kozan & Richardson, 2014; Sadaf et al., 2021).

Anderson et al. (2001) defined teaching presence as "the design, facilitation, and direction of cognitive and social processes to realize personally meaningful and educationally worthwhile learning outcomes" (p. 5). It has three categories: design and organization, facilitating discourse, and direct construction (Anderson et al., 2001). Teaching presence is a key determinant of student satisfaction, perceived learning, and sense of community (Akyol & Garrison, 2008; Arbaugh, 2008). So far, many researchers have investigated the intricate relationships among social, cognitive, and teaching presences, and results showed these components are strongly and positively interrelated, collectively contributing to developing an interactive and supportive learning environment that facilitates deep understanding and critical thinking (Wilson & Berge, 2023). More specifically, social presence is a mediating factor between teaching and cognitive presence, serving as a prerequisite for developing cognitive presence within the context of collaborative inquiry (Garrison et al., 2010). Although teaching presence is critically important in shaping the learning environment, our study is grounded by student-generated discussion data alone, and instructors are minimally involved in AODs. Therefore, this exploratory study intentionally excluded teaching presence and focused on the relationships between social and cognitive presence.

The Relationship Between Social Presence and Cognitive Presence

Prior research has consistently highlighted the critical role of the interplay between social and cognitive presences in fostering effective and supportive online learning environments that enhance academic success and learning outcomes (e.g., Akyol & Garrison, 2008; Lee, 2014; Tirado Morueta et al., 2016). Additionally, understanding the interrelationships helps educators implement strategies and interventions that address both the social and cognitive needs of students, leading to more satisfying and meaningful learning experiences (Holbeck & Hartman, 2018). A prior study demonstrated that social presence was significantly correlated with cognitive presence and had a positive linear correlation between indicators of social and cognitive presence (Pellas, 2017). Moreover, social presence creates a supportive environment that encourages cognitive engagement (Armellini & De Stefani, 2016). Students who feel connected and comfortable are more likely to participate in discussions, share ideas, ask questions, challenge each other's thinking, and engage in deeper cognitive processes (Costley, 2019; Garrison & Arbaugh, 2007; Rovai, 2002). Social presence has also been found to be positively related to the quality of cognitive presence and could be regarded as a mediating variable between teaching and cognitive presence (Garrison et al., 2010; Kozan, 2016; Shea & Bidjerano, 2009). Furthermore, social presence not only facilitates higher-order thinking by providing a context for critical discourse (Lee, 2014), it also fosters open communication and a sense of belonging to a community, which are associated with higher levels of cognitive presence in learners to improve knowledge understanding and application (Akyol & Garrison, 2008; Lee, 2014). However, the dynamic nature of social and cognitive presences has not been explicitly addressed, highlighting the need to analyze their temporal progression to capture the evolving interactions and developmental trajectories throughout the learning process (Elmoazen et al., 2024; Saqr & López-Pernas, 2023).

Epistemic Network Analysis in CoI Analysis

The interrelationships among social and cognitive presences have been examined by several researchers using a variety of instruments and methodologies (e.g., Kozan & Richardson, 2014; Morueta et al., 2016). One approach is the CoI survey which was widely accepted and used to observe and assess the relationships among different indicators of these three presences in order to investigate students' learning experiences (Stenbom, 2018). The CoI survey developed by Arbaugh et al. (2008) has been widely employed to examine the interrelationships among two or more presences, as well as their associations with other variables such as perceived learning (Rockinson-Szapkiw et al., 2016). This instrument facilitates the application of statistical analyses to ensure the reliability and validity of the data (Stenbom, 2018). However, the survey results reveal little information regarding the discussion process, making it difficult for instructors to understand what students are learning (Ba et al., 2023). Quantitative content analysis of online discussion transcripts is another frequently employed method to examine relationships among presences, frequencies of occurrence, and posting patterns (e.g., Kilis & Yıldırım, 2019; Shea et al., 2010). However, coding and counting can only provide limited information and may lose the temporal associations hidden behind three presences (Csanadi et al., 2018).

In recent years, ENA has emerged as a powerful tool for examining how social and cognitive presences are intricately related in online collaborative environments, because it allows researchers to visualize and analyze the dynamic interactions among these presences over time (Rolim et al., 2019; Shaffer et al., 2016). For instance, researchers utilized ENA to analyze AODs to investigate the associations between the individual phases of cognitive presence and the indicators of social presence, as well as their temporal progression across different contexts (Fathali, 2024; Rolim et al., 2019). ENA has also proven effective in uncovering patterns and developmental trajectories of cognitive presence at both the individual and group levels (Ba et al., 2023, 2024). Additionally, Iqbal et al. (2022) used ENA to examine the associations between cognitive presence and speech acts, emphasizing the potential of speech acts to expand the cognitive presence classification. Some researchers also adopted ENA to explore the relationships between social or cognitive presence and course topics. For example, Ferreira et al. (2018) explored the interplay between social presence and course topics using ENA. Their study found that different course topics influenced the expression and development of social presence, revealing the critical role of topic selection in fostering social interactions. This demonstrates how important it is to choose course topics carefully when designing online courses to improve social interaction and develop more dynamic learning environments.

Instructional Strategies in AODs Within CoI Framework

Online discussion prompts, shaped by various instructional strategies, play a crucial role in helping instructional designers and educators to understand how these differing strategies used in AODs impact students' levels of social and cognitive presence within online learning environments. For example, Richardson and Ice (2010) investigated students' critical thinking levels across three instructional strategies: case-based, debate, and open-ended strategy. Their findings revealed that the exploration phase occurred most frequently in open-ended discussions, followed by debate and case-based discussions. However, the integration phase appeared frequently in case-based discussions, followed by debate and open-ended discussions. Lowenthal and Dunlap (2018) examined student perceptions of various strategies for establishing and maintaining social presence and found that instructors can establish social presence by using strategies such as personal video introductions, sharing personal stories, and actively participating in discussion forums. Additionally, Kilis and Yıldırım (2019) concluded that high levels of social presence and cognitive presence are often observed when the discussion topics are based on sharing real-life experiences. In summary, various instructional strategies in online discussions would affect the levels of cognitive presence and social presence. However, existing studies have primarily focused on the types of instructional strategies and their effectiveness in fostering cognitive presence and building social presence (e.g., Kilis & Yıldırım, 2019; Olesova et al., 2016; Richardson & Ice, 2010). Limited research explored how the relationships between social and cognitive presences were influenced by various instructional strategies. For this study, the following types of instructional strategy were explored: *compare and contrast*, where students were expected to compare and contrast different theories and discuss how they are similar or different; *debate*, where students were expected to defend their ideas; *personalized tasks*, where students were asked to select and share their own reading. Therefore, the following research questions were investigated in this study:

- What are the interrelationships between the indicators of social presence and the phases of cognitive presence?
- Do these interrelationships between social and cognitive presence differ between the high-active class and the low-active class?
- How do the interrelationships between social and cognitive presence evolve over time, as reflected in detailed weekly analyses, across various instructional strategies used in AODs?

Methodology

Context and Participants

This study was conducted in two eight-week fully online courses titled "*Foundations of Learning Design and Technology: An Introduction to the Field*" in Summer 2022. This course served as a core and required course in the first semester of an online master's degree program in *Learning Design and Technology* at a midwestern university in the U.S. It provided a historical overview and outlined the fundamental information, abilities, and attitudes required of professionals working in the fields of instructional design and educational technology. Each class consisted of 11 students, resulting in a total of 22 participants in this study. Those students were all first-year online master students, and they all have working experiences and diverse professional backgrounds.

Discussions occurred asynchronously each week. A guiding question was developed by the instructor for each week, and post prompts and objectives were provided for students. During the first five weeks, students are asked to generate an original post and respond to at least two peers each week. However, the instructor did not require students to respond to specific peers. Furthermore, students were expected to participate throughout the week in the discussions. As Week 6, 7 and 8 did not require any interactions and the formats were completely different from week 1 to week 5, therefore, we excluded Week 6, 7 and 8 from this study. Table 1 presents the weekly discussion topics, post prompts and objectives.

Table 1

Weekly Topics

Week	Discussion Topic	Instructional Strategy Types	Discussion Prompt
Week 1	Definition of LDT	Compare and contrast	Students are required to create a complete definition of LDT and compare and contrast their definitions of the field to other definitions identified in the textbook.
Week 2	Instructional Design Timeline	Debate	This debate will require students to create a history of Instructional Design Timeline and defend what they select to be the best decade.
Week 3	ID Model	Create and post	Students will create a job aid in the format of a horoscope about a specific ID model.
Week 4	Learning Theory Comparison	Compare and contrast	Students will compare and contrast two learning theories and discuss how they are similar or different.
Week 5	Bring Your Own Reading	Personalized task (select and summarize)	Students will select and summarize their own reading.
Week 6	Group Project		Students will sign up and establish groups of 2-3 individuals and each group submit a single post representing the contributions of two or three students
Week 7	Preparing the Final Course Assignment		

Week 8	Self-reflections	No responses required	Students will self-reflect on your final definition of the field (LDT) as well as discuss the role of ethics in instructional design practice.

Data Collection

Data was collected through a series of asynchronous discussion posts from week 1 to week 5. All posts were securely stored in the learning management system, and measures were taken to ensure data integrity, including regular backups and encryption. As shown in Table 2, the posts from week 1 to week 5 were collected and analyzed with a total of 635 posts, and 5,358 sentences were generated. Among them, Class 1 had 360 posts with 3,169 sentences, and Class 2 had 275 posts with 2,189 sentences. Since both classes had an equal number of participants, Class 1 demonstrated a higher number of posts compared to Class 2. We used the quantity of discussion posts as an indicator of activity level in this study, as it directly reflects the frequency and volume of student contributions to AODs. Therefore, we labeled Class 1 as the "high-active" class and Class 2 as the "low-active" class in this study.

Table 2

The Number of Posts per Week

Week	High-active Class (Class 1)		Low-active Class (Class 2)	
	Posts	Sentences	Posts	Sentences
Week 1	61	521	46	487
Week 2	81	685	74	577
Week 3	65	589	57	367
Week 4	78	556	48	285
Week 5	75	818	50	473
Total	360	3,169	275	2,189

Data Processing and Coding

Social and cognitive presence coding themes were adapted from previous studies (Garrison et al., 2000, 2001; Rourke et al., 1999). The original coding themes of social presence included affective (3 indicators), interactive (6 indicators) and cohesive categories (3 indicators). In this study, we removed the indicator "continuing a thread" under the interactive category, since it refers to technical replies on discussion boards, which are not necessarily indicative of meaningful interaction (Lee, 2014). We also decided to remove "use of humor" under the affective category, because there were no sentences indicating it, and its effects could be ignored and did not influence the results. The final coding frameworks were presented in Table 3 and 4.

The data and coding process included three main steps. Firstly, we used Excel to collect and sort the data before we coded. Secondly, we split all discussion posts into sentences to understand more detailed information in their postings, enabling deeper insight despite the small sample (e.g., Ba et al., 2023, 2024; Fahy et al., 2000). Following coding up and coding down principles (Garrison et al., 2001), when the distinction between phases was unclear, we coded the sentences as belonging to an earlier phase. Conversely, if clear evidence of multiple phases was present, we coded them as a later phase. Thirdly, using binary coding, two coders annotated 1 for presence and 0 for absence for each sentence reflecting these themes of social and cognitive presence. To ensure reliability, the coders first established an initial common understanding and coded one-week data independently first, and then met together to resolve any differences, and inter-coder reliability was assessed regularly, finally achieving a Cohen's Kappa of 0.9235, indicating high reliability (McHugh, 2012).

Table 3

Categories and Indicators of Social Presence

Categories	Indicator	Definition	Example
Affective	Expression of Emotions (AF.Emotion)	Conventional expressions of emotion, or unconventional expressions of emotion, include repetitious punctuation, conspicuous capitalization, emoticons	"I'm excited to see all the definitions that everyone came up with!"
	Self-disclosure (AF.SD)	Presents details of life outside of class, or expresses vulnerability	"I have had the same experience speaking to my friends and family and even teaching colleagues about LDT."
Interactive	Quoting from other's messages (IN.Quote)	Using software features to quote other's entire message or cutting and pasting selections of others' messages	"You made an excellent point that "[e]ven though technology has continued to advance leaps and bounds beyond this period of time, the foundational learning design publications by Bloom and Skinner are still widely valued and used in teacher education programs."

	Referring explicitly to others' messages (IN.Refer)	Direct references to the contents of others' posts	"I like that you addressed where the two aspects of LDT meet each other."
	Asking questions (IN.Question)	Students ask questions of other students or the moderator	"Can you elaborate?"
	Complimenting, expressing appreciation (IN.Appr)	Complimenting others or the contents of others' messages	"I really liked the creativity and thought you put into your timeline!"
	Expressing agreement (IN.Agree)	Expressing agreement with others or the content of others' messages	"I agree with you completely."
Cohesive	Vocatives (CO.Vocatives)	Addressing or referring to participants by name	"Hi Jeffrey"
	Addresses or refers to the group using inclusive pronouns (CO.Group)	Addresses the group as we, us, our, group	"We talk a lot about having Constructivist elements, which is a better descriptor."
	Phatics, salutations (CO.Salute)	Communication that serves a purely social function; greetings, closures	"I look forward to reading everyone's comparisons!"

Table 4

Cognitive Presence Coding Template

Phases	Definition	Example
Triggering Event (CP.TE)	Sense of Puzzlement	"What do you think about AI in LDT?"
Exploration (CP.EX)	Information Exchange	"Learning is an active process that involves engagement."
Integration (CP.IN)	Connecting Ideas	"I really like the wording of your definition because it does a good job of highlighting the intersection

		of instructional design and instructional technology.”
Resolution (CP.RE)	Applying New Ideas	“I think it is very important to be able to identify what your students are supposed to learn at the end of instruction, to make sure you are including content that will enable them to reach that goal.”

Epistemic Network Analysis

The ENA web tool (https://www.epistemicnetwork.org/) was used to analyze and visualize the coded results. It is a methodological approach for quantifying and identifying the relationships between elements within coded data, subsequently representing these relationships in dynamic network models (Shaffer et al., 2016). It is specifically tailored for analyzing problems that involve a limited set of concepts characterized by highly dynamic and densely interconnected interactions (Rupp et al., 2010; Shaffer et al., 2016), and it is particularly useful for comparing different networks visually and through summary statistics based on weighted connections between networks (Shaffer & Ruis, 2017).

The process of generating ENA models and performing the ENA analysis begins by making decisions based on the three basic concepts: units, conversations, and codes (Shaffer et al., 2016). Units in ENA models can refer to people, groups, concepts, or any elements of interest that are used to build networks. These units help organize sequences of stanzas into groupings that summarize the relationships between them. Conversation in ENA refers to the set of lines used to represent the relationships between concepts. Codes represent the concepts whose association patterns are modeled as nodes within the ENA network representation.

This study was analyzed according to the following settings in the ENA web tool. For Research Question 1, we selected the column “StudentName” as the unit of analysis. For Research Questions 2 and 3, we employed a hierarchical approach by selecting two columns: “Class” or “Week,” further subdivided by “StudentName” as the units of analysis. Therefore, we can generate class and weekly comparison networks. “StudentName” also serves as the conversation unit, as it encompasses the collection of sentences posted by each student. The codes listed in Tables 2 and 3 were used with indicators of social presence and phases of cognitive presence set as the codes. The ENA algorithm builds a network model for every line in the data by using a moving window, illustrating the relationships between codes that occur in the current line and codes that happened in earlier lines (Ruis et al., 2019; Siebert-Evenstone et al., 2017). Therefore, we defined the moving stanza as eight (each line plus the seven previous lines), which is the average line of each post. In the ENA models, the edges between two codes indicate how frequently these codes occur together. The size of the nodes shows how important each node is for this group.

Results

The ENA method was used in this study to pinpoint the details of the interrelationships between social and cognitive presences. As previously noted, the resulting networks were aggregated for all sentences across all discussion posts for every unit of analysis based on the "StudentName" in the model. Since each student's post contained several sentences, different phases of cognitive presence could be represented within the same moving stanza. As listed in Tables 3 and 4, our ENA model finally included the following 14 codes: CP.TE, CP.EX, CP.IN, CP.RE, AF.Emotion, AF.SD, IN.Quote, IN.Refer, IN.Question, IN.Appr, IN.Agree, CO.Vocatives, CO.Group, and CO.Salute. Finally, we constructed ENA models and presented all students within the relationships between indicators of social presence and phases of cognitive presence.

RQ1: Interrelationships Between the Indicators of Social Presence and the Phases of Cognitive Presence

In Figure 1, 15.9% of the variance in the data was explained by the Y-axis, whereas 45.8% is explained by the X-axis. There was a strong goodness of fit observed between the underlying patterns in the data and the epistemic networks, as indicated by the Pearson (1.00) and Spearman (1.00) in the X-axis and the Pearson (1.00) and Spearman (0.99) in the Y-axis from the model (Bowman et al., 2021; Tan et al., 2024). Additionally, Table 5 presented an ENA weight matrix pertaining to the correlation between social and cognitive presences. The indicators of social presence are mainly distributed on the left-hand side, the AF.Emotion and AF.SD in the category of affective expression was over the X-axis. The X-axis makes a distinction between the initial phases of cognitive presence (trigger event and exploration) and the higher phases (integration and resolution) based on their relative distance.

Figure 1

Overall Network for the Relationship Between Social Presence and Cognitive Presence

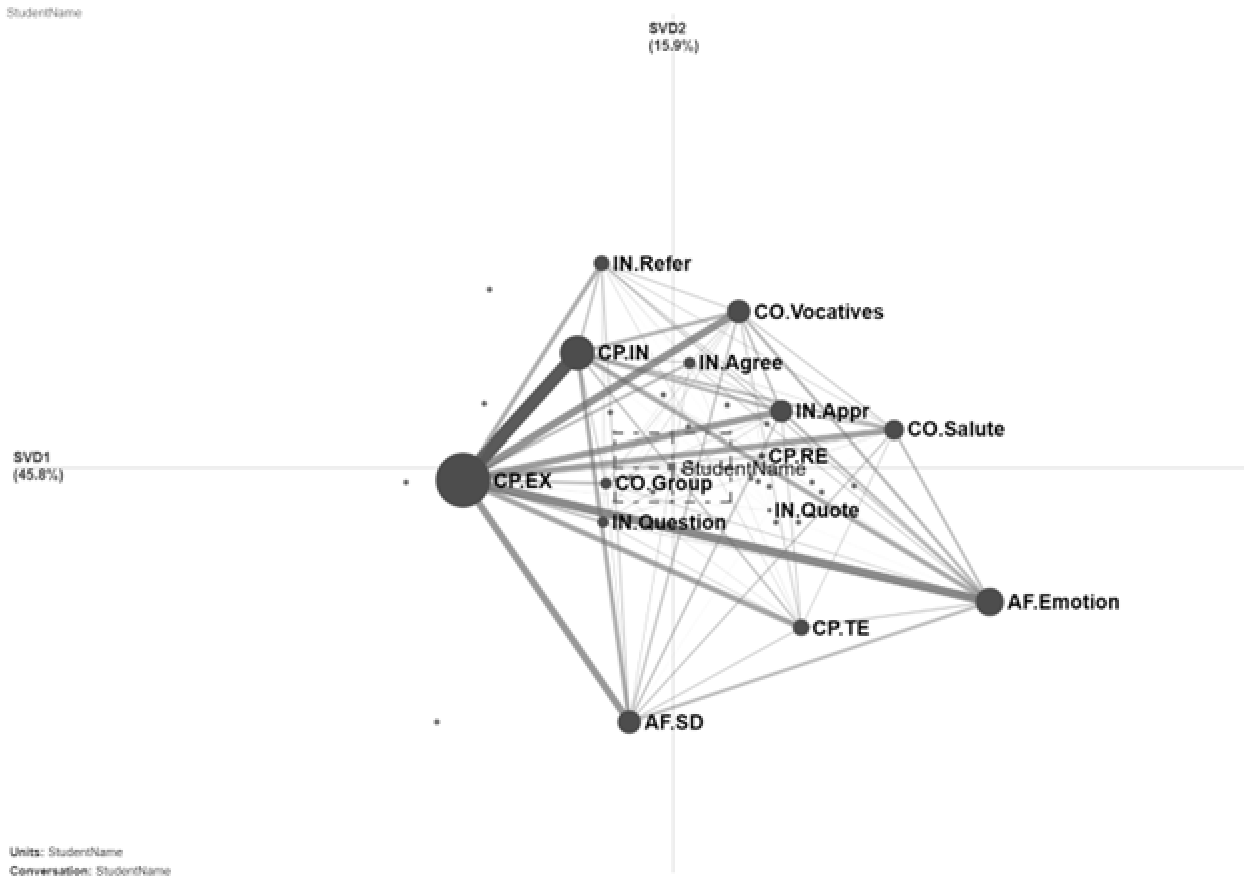


Table 5

Symmetric Matrix of ENA Weights for the Interrelationship Between Social Presence and Cognitive Presence

	CP.TE	CP.EX	CP.IN	CP.RE	AF. Emotion	AF.SD	IN. Quote	IN. Refer	IN. Question	IN. Appr	IN. Agree	CO. Vocatives	CO. Group	CO. Salute
CP.TE	0.00	0.19	0.08	0.00	0.06	0.06	0.00	0.03	0.04	0.05	0.02	0.05	0.02	0.04
CP.EX	_	0.00	0.46	0.04	0.30	0.24	0.01	0.15	0.10	0.23	0.10	0.26	0.10	0.20
CP.IN	_	_	0.00	0.03	0.17	0.14	0.00	0.09	0.04	0.12	0.06	0.13	0.05	0.11
CP.RE	_	_	_	0.00	0.02	0.02	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
AF. Emotion	_	_	_	_	0.00	0.11	0.00	0.06	0.04	0.11	0.05	0.11	0.05	0.10
AF.SD	_	_	_	_	_	0.00	0.01	0.06	0.03	0.07	0.04	0.08	0.03	0.07
IN. Quote	_	_	_	_	_	_	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IN. Refer	_	_	_	_	_	_	_	0.00	0.02	0.05	0.02	0.05	0.02	0.04
IN. Question	_	_	_	_	_	_	_	_	0.00	0.03	0.01	0.03	0.01	0.03
IN. Appr	_	_	_	_	_	_	_	_	_	0.00	0.03	0.09	0.03	0.07
IN. Agree	_	_	_	_	_	_	_	_	_	_	0.00	0.04	0.02	0.03
CO. Vocatives	_	_	_	_	_	_	_	_	_	_	_	0.00	0.03	0.06
CO. Group	_	_	_	_	_	_	_	_	_	_	_	_	0.00	0.03
CO. Salute	_	_	_	_	_	_	_	_	_	_	_	_		0.00

CP.TE had a relationship with IN.Question (0.04), as the trigger event is a phase of a sense of puzzlement and asking questions. For example, this student stated,

> I wonder what the correlation between age and cognitive load is, and if younger students with less developed schemas would be able to benefit from the use of this instructional model? In my experience, behavior, emotional maturity (especially post-covid) and an overall lack of independence can make it challenging to accomplish this sort of learning with our youngest students.

Students mostly asked questions and then they went on to the exploration phase of cognitive presence in a moving stanza, so the relationship between CP.TE and CP.EX (0.19) was much stronger compared to CP.TE with IN.Question (0.04). Furthermore, the network showed a strong relationship between CP.EX and indicators of social presence, for instance, CP.EX-AF.SD (0.24), CP.EX-AF.Emotion (0.30), CP.EX-IN.Refer (0.15), CP.EX-IN.Appr (0.23), CP.EX-CO.Salute (0.20), and CP.EX-CO.Vocatives(0.26). Also, CP.IN had a weaker connection with those indicators of social presence than CP.EX, for instance, CP.IN-AF.SD (0.14), CP.IN-AF.Emotion (0.17), CP.IN-IN.Refer (0.09), CP.IN-IN.Appr (0.12), CP.IN-CO.Salute (0.11) and

CP.IN-CO.Vocatives (0.13). However, there was no significant relationship between CP.RE and the social presence indicators like CP.RE-AF.Emotion (0.02).

CP.EX was the biggest node, which represented most of the students' discussions in the second phase of cognitive presence, as they preferred knowledge sharing and brainstorming. In contrast to CP.EX, CP.TE had a weak connection to the affective category of social presence, which demonstrated that students may prefer to raise questions and express their puzzlement at the beginning of the discussion rather than express their emotions. On the other hand, AF.SD had a close relationship with CP.EX and CP.IN. For instance, this student said, "I've been teaching middle school for over a decade, and something I have noticed in my experience that is lacking in this definition, but in my opinion, an important factor in learning is motivation." This indicated that students would like to share their personal experiences in the second and third phases of cognitive presence to connect and demonstrate their ideas. Besides, the interactive category had much closer relationships in the exploration phase of cognitive presence, showing the participants were actively involved in online interaction as the interactive category in social presence included IN. Question, IN.Refer, IN. Quote, IN.Appr and IN.Appr, and IN.Agree in this study. Additionally, according to the findings, CP.EX and CP.IN were closely related to CO.Vocatives and CO.Salute in the cohesive category of social presence. However, CO.Group had weak connections with cognitive presence, suggesting that students did not address groups very often. As illustrated by the student's post, "We picked the same decade, but for different reasons," the student demonstrates the use of we, addressing the group collectively. However, this expression of group reference was not evident in any of the phases of cognitive presence.

RQ2: Interrelationships Between Social Presence and Cognitive Presence Differ Between the High-Active Class and Low-Active Class

Regarding research question 2, we compared the visualizations for the low-active and high-active classes' mean networks. Based on the group mean network visualization, we interpreted as follows: thicker lines between nodes indicate more connections, while nodes positioned closer together indicate fewer variances. We also performed a quantitative comparison of the mean networks using t-tests along the X- and Y-axis dimensions. For the first dimension in our model, the co-registration correlations were 1 (Pearson) and 1 (Spearman), and for the second dimension, they were 1 (Pearson) and 0.99 (Spearman). The model itself is shown to be a visually accurate representation of the underlying data by these measurements, which showed a strong goodness of fit between the visualization and the original model. Along the X axis, a two-sample t-test assuming unequal variance showed 1 ($M = 0.16$, $SD = 0.11$, $n = 11$) was statistically significantly different at the alpha=0.05 level from 2 ($M = -0.16$, $SD = 0.24$, $n = 11$; $t(13.80) = 4.11$, $p = .001$, Cohen's $d = 1.75$).

From the comparison plot in Figure 2 and the individual class plot in Figures 3 and 4. Figure 3 represents high-active class, while Figure 4 represents low-active class. Students in the high-active showed more centralized connections, whereas students in the low-active were more dispersed. In addition, there are also some apparent differences between high-active class and low-active class. The line between CP.EX and AF.Emotion in high-active (0.25) was stronger than the low-active class (0.20). Similarly, the line between CP.EX and CO.Salute in high-active (0.28) was stronger than low-active class (0.12). The line between CO.EX and IN.Appr in high-active (0.25) was stronger than low-active class (0.20). Unexpectedly, the line between CP.EX and AF.SD in low-active class (0.28) was stronger than high-active (0.20), suggesting that low-active classes may exhibit stronger individual connections in certain contexts. The line between CP.EX and IN.Refer in the low-active class (0.18) was stronger than high-active (0.13). Overall, more social presence was observed in the high-active class, which means the high-active class has more sense of community than the low-active class.

Table 6 summarized the frequencies of codes in high-active class and low-active class. For cognitive presence, it was evident that high-active class showed a higher frequency across all phases of cognitive presence compared to low-active class. This suggested that the high-active class might have more active cognitive engagement and possibly more in-depth discussions. Regarding social presence, the high-active class demonstrated a greater frequency of emotional expression, suggesting that the students in this class were more emotionally engaged and expressive. Additionally, the high-active class was more active in quoting, questioning, and appreciating contributions, which pointed to a more interactive and participative classroom environment. Moreover, the high-active class showed higher usage of vocatives, group references, and salutations, reflecting a stronger sense of community and connection among the students. Overall, the high-active class demonstrates higher frequencies in all measured areas compared to the low-active class, suggesting that high-active class is characterized by a more engaged, interactive, and cohesive classroom environment.

Table 6

Frequency of Codes in High-Active Class and Low-Active Class

	CP.TE	CP.EX	CP.IN	CP.RE	AF. Emotion	AF.SD	IN. Quote	IN. Refer	IN. Question	IN. Appr	IN. Agree	CO. Vocatives	CO. Group	CO. Salute
High-active Class	246	1396	624	55	564	361	20	145	165	332	100	264	141	314
Low-active Class	130	1169	452	26	230	348	2	135	70	156	69	151	71	67

Figure 2

Comparison Plot Between High-Active Class and Low-Active Class

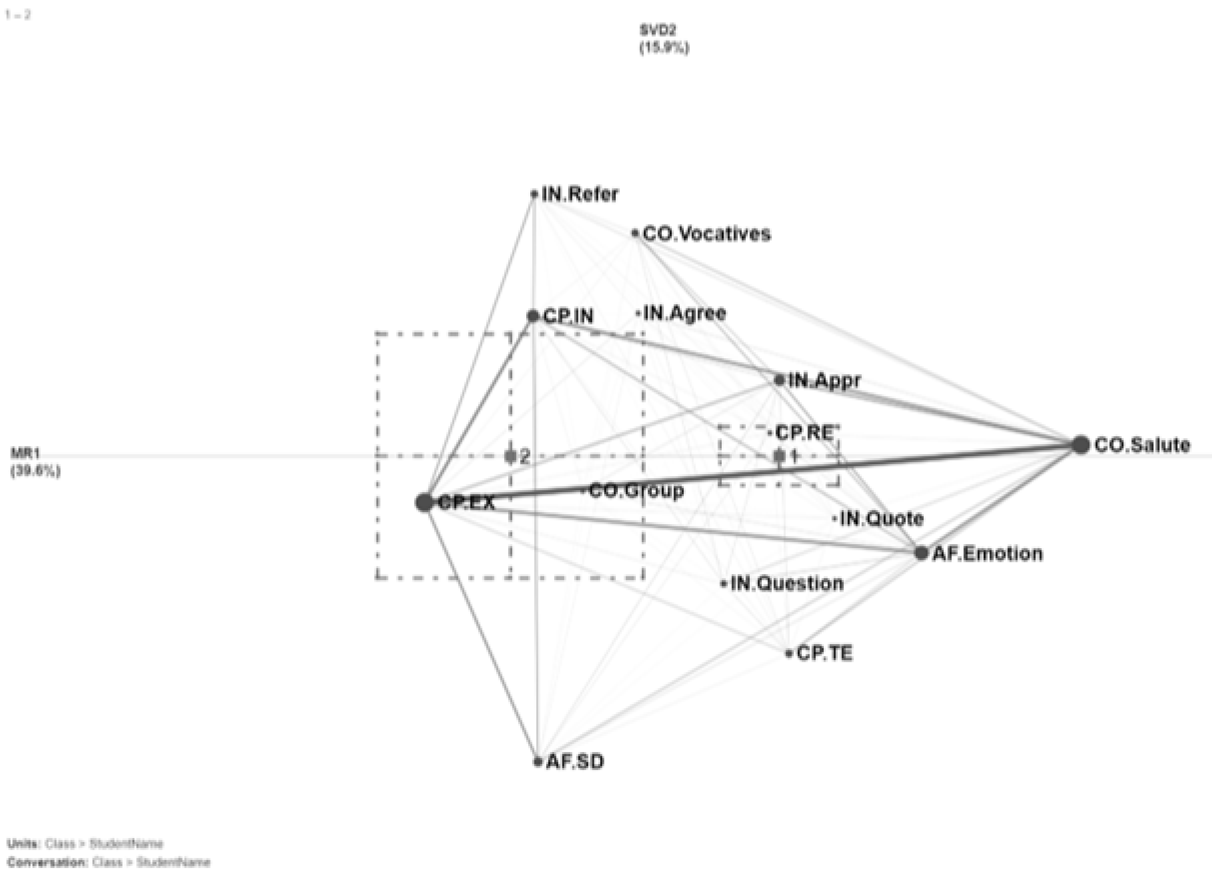


Figure 3

High-Active Class Plot

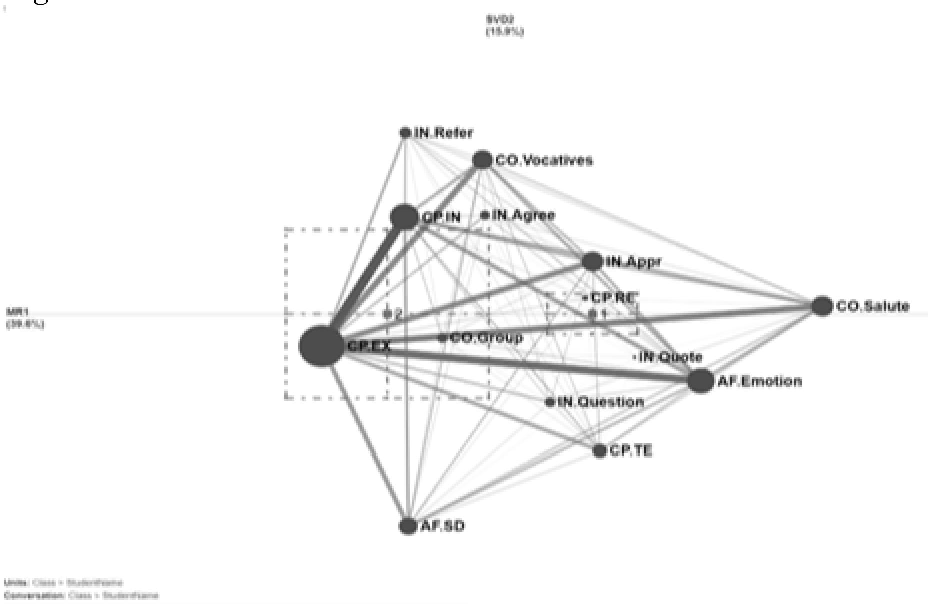
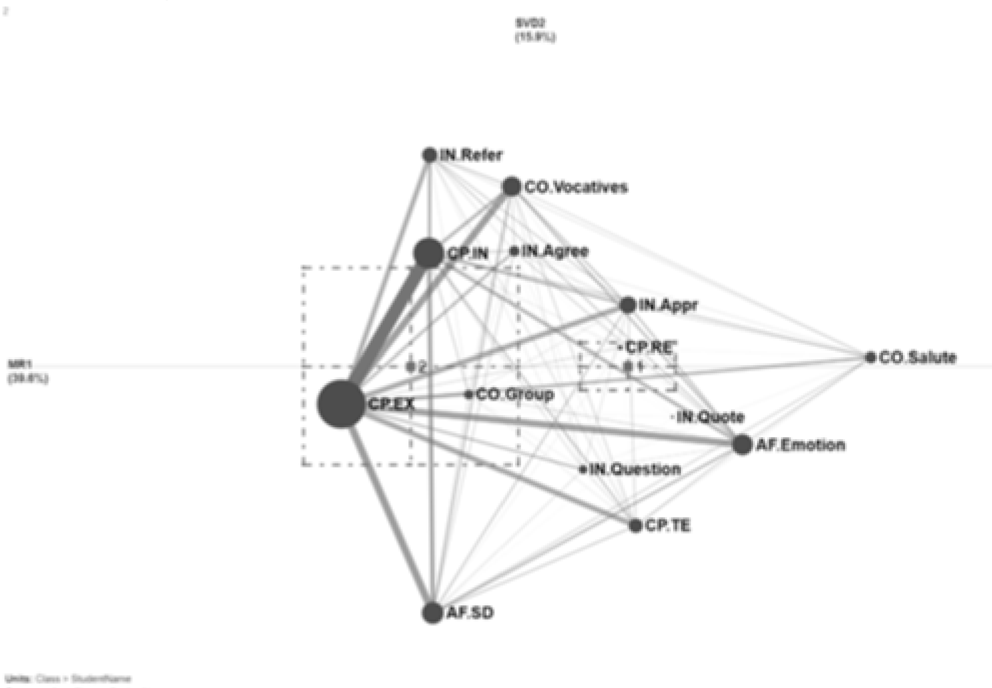


Figure 4

Low-Active Class Plot



RQ3: Interrelationships Between Social and Cognitive Presence Evolve Over Time Across the Various Instructional Strategies Used in AODs

To answer this question, we summarized the weekly frequency of posts of indicators of social presence and phases of cognitive presence (Table 7) and generated the weekly ENA plots (Figure 5). Interestingly, the number of posts by students did not decrease over the week, indicating sustained engagement throughout the course. As illustrated in Figure 5, we discussed the students' performance of each week as below:

Table 7

Frequency of Indicators of Social Presence and Phases of Cognitive Presence in Every Week

	CP.TE	CP.EX	CP.IN	CP.RE	AF. Emotion	AF.SD	IN. Quote	IN. Refer	IN. Question	IN. Appr	IN. Agree	CO. Vocatives	CO. Group	CO. Salute
Week 1	75	476	228	28	98	193	11	63	41	72	30	60	42	78
Week 2	54	636	246	10	201	166	7	84	33	130	61	104	75	90
Week 3	51	434	179	19	184	81	2	44	36	118	22	91	22	73
Week 4	81	347	159	5	145	93	0	38	46	90	28	80	33	76
Week 5	115	672	264	19	166	176	2	51	79	78	28	80	40	64

In Week 1, students were required to create a definition of LDT and then compare and contrast their own definition with those in the textbook. The instructional strategy used in this discussion topic encouraged active engagement in cognitive presence through exploration, integration, and the development of higher-order thinking skills. However, students are not very active in both high-active class and low-active class in contrast to the quantity of posts in other weeks. This may be attributed to students' low engagement during the first week, their unfamiliarity with one another, and the difficulty of the compare-and-contrast strategy. As first-year master's students, they lacked sufficient knowledge to effectively connect ideas and complete the activity. We also found that there are some apparent correlations between social presence and cognitive presence, including CP.IN-AF.SD (0.20), CP.EX-AF.Emotion (0.21), and CP.EX-IN.Refer (0.16). This correlation suggests a moderate positive relationship between cognitive presence in the integration phase and social presence in affective expression category. Students who share personal experiences and have emotional engagement may find it easier to integrate new knowledge effectively and facilitate exploratory activities. Moreover, IN.Refer appeared a lot this week, which indicates that students are moderately likely to refer to the definitions in the textbook when defending their ideas.

Similarly, in Week 4, students were required to compare and contrast two theories. The analysis showed that CP.EX was correlated with AF.Emotion (0.24), CO.Vocatives (0.23), and IN.Appr (0.24), while CP.IN was moderately related to AF.Emotion (0.16). Despite being more emotionally engaged than in Week 1, likely due to discussion prompt, students remained relatively inactive during this week. Their participation in the exploration and integration phases of cognitive presence was limited, and few students reached the resolution phase. The codes of IN.Quote and IN.Refer also had the lowest occurrence during this week, suggesting that the task of comparing and contrasting theories appeared to be cognitively demanding. Students found it difficult to meaningfully build on their peers' original posts. As a result, the number of sentences in their posts was lower compared to other weeks.

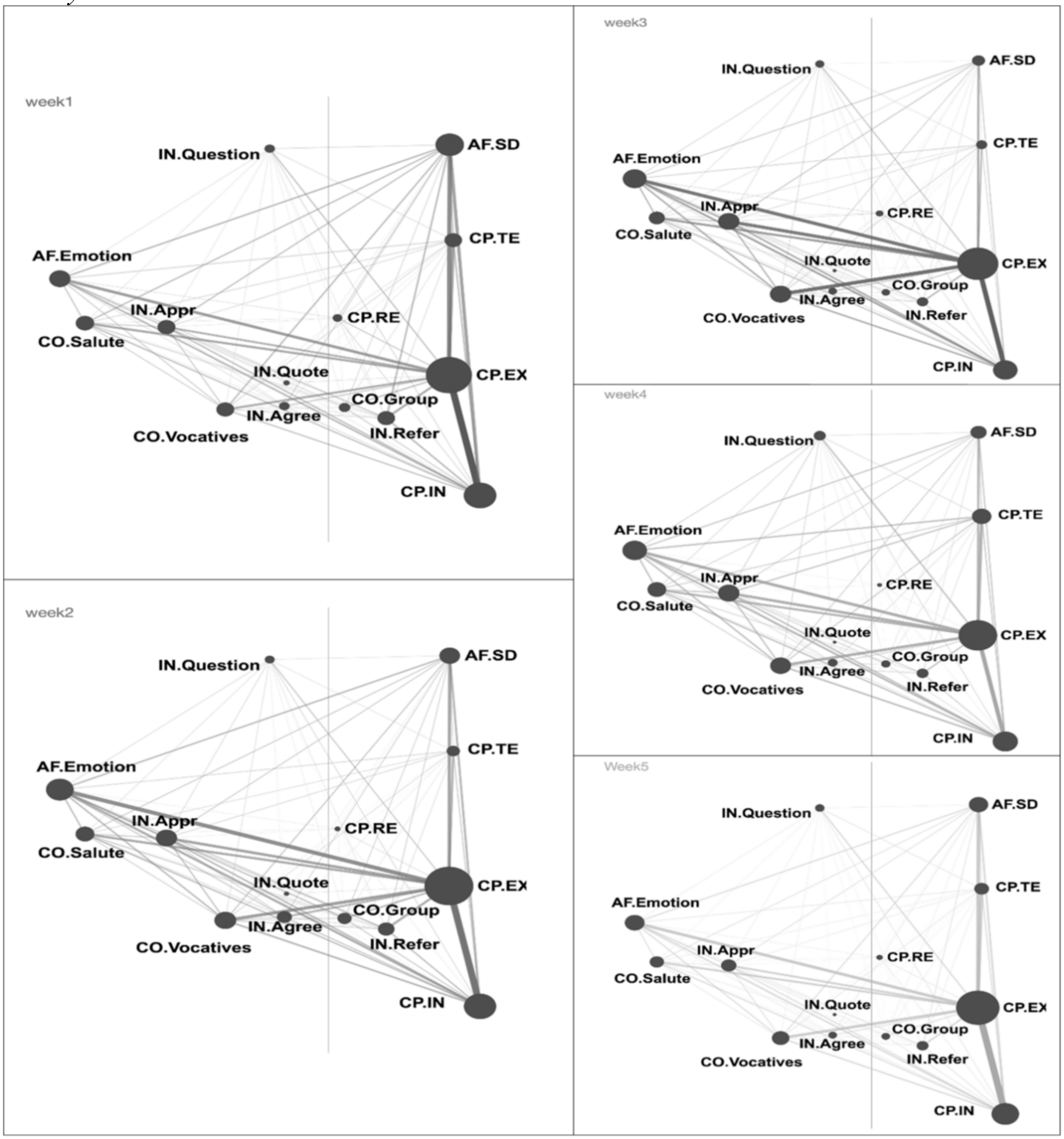
In week 2, there was a notable rise in the quantity of comments posted by students in both the low-active and high-active classes, which indicated higher levels of engagement. As the topic this week is to discuss the instructional design timeline and defend your choice for the best decade. Students were more emotionally engaged in the discussions, as CP.EX has a higher link with AF.Emotion (0.30). Additionally, CP.EX and CP.IN had a very strong link (0.43), indicating that students who engaged deeply in exploring ideas were also effectively integrating and synthesizing this information. IN. Refer occurred most frequently compared to other weeks, suggesting that students were more likely to build on their peers' statements and connect their ideas to additional resources during this week.

In Week 3, students were just required to post a description of their assigned model, which gave them much freedom to express their ideas. CP.EX has a strong link with AF.Emotion (0.30), IN.Appr (0.30), IN.Refer (0.11), CO.Salute (0.19) and CO.Vacatives (0.32). This demonstrated that the instructional strategy in this discussion topic encourages sharing personal insights and experiences in order to enhance cognitive and emotional engagement.

In Week 5, students were required to bring their own reading and summarize it to their peers. This discussion topic allowed students to select readings that interest them, potentially increasing motivation and engagement. Additionally, summarizing and presenting information promoted active learning and deeper cognitive engagement. CP.EX and CP.IN had the strongest links (0.49) than in other weeks, and both appeared more frequently than in previous weeks. This suggests that students who engage deeply in exploring ideas are also effectively integrating and synthesizing this information. AF.SD had a higher frequency because students could present more details of life outside of class or express vulnerability. Although it was Week 5, students still participated actively in this week.

Figure 5

Weekly Plot



Discussion and Implications

This study employed the ENA approach to investigate the interrelationships and evolution of social and cognitive presence indicators within the CoI framework across classes with varying levels of activity and various instructional strategies used in AODs, offering in-depth insights into these dynamics. The ENA models related to research question 1 reveal that the exploration phase of cognitive presence showed the strongest connections with social presence indicators, particularly affective expression (AF.Emotion) and interactive indicators (IN.Refer and IN.Appr), suggesting that emotional engagement plays a crucial role in facilitating cognitive activities and enhancing cognitive processing and engagement (Maguire et al., 2017; Molinillo et al., 2018; Saadatmand et al., 2017). During the exploration phase, students are more likely to engage emotionally and interactively as they brainstorm ideas and exchange information, often employing sociolinguistic politeness to facilitate open and respectful communication. Moreover, the majority of students' cognitive presence was at the exploration level (Garrison & Arbaugh, 2007; Guo et al., 2021). It was noted that IN.Question has a close relationship with the trigger event and exploration phase, similar to findings by Rolim et al. (2019). However, the resolution phase (CP.RE) does not exhibit a significant relationship with social presence indicators, aligning with Rolim et al. (2019). These findings highlight that the resolution phase emphasizes the practical application of ideas and tends to be less socially interactive compared to the earlier phases of cognitive presence, such as exploration and integration. Moreover, fewer students can reach the resolution level (Akyol & Garrison, 2008; Garrison & Arbaugh, 2007; Olesova et al., 2016). However, it is also important to consider that this may have been influenced by the instructional strategies, as students were not explicitly required to generate any solutions.

Our results also indicated that social and cognitive presence and their interrelationships are also presented differently in different active levels of class. The social presence and cognitive presence indicators showed more and stronger correlations in high-active class, suggesting a higher social interaction and cognitive engagement (Lee, 2014) In addition, learners in high-active class reported higher social presence compared to those in low-active class, which was also demonstrated in the Poquet et al. (2018). Moreover, the high-active class preferred using more cohesion indicators, like vocatives or addressing others by name and salutation, which is consistent with Guo et al. (2021). Finally, high-active class also showed a higher frequency across all phases of cognitive presence, suggesting that high-active class might have more active cognitive engagement and possibly more in-depth discussions. Therefore, higher levels of social presence can positively correlate with cognitive presence (Costley, 2019; Gutiérrez-Santiuste et al., 2015).

While prior literature suggests an increase in posts over time (Akyol & Garrison, 2008; Fathali, 2024; Rolim et al., 2019), our findings revealed a different result, likely due to the influence of different instructional strategies used in discussion topics (Darabi et al., 2011). For example, debate (Week 2) and personalized tasks (Week 5) led to higher levels of cognitive presence and increased participation, because these instructional strategies encourage students to articulate their ideas, consider multiple perspectives, and support their arguments with evidence (Olesova et al., 2016). This is in line with existing literature that suggests "debate" requires students to critically analyze their ideas and foster higher-order thinking skills, and this kind of strategy appears to be effective in promoting active participation and deeper engagement with the content (Darabi et al., 2011; DeNoyelles et al., 2014; Zare & Othman, 2015). Personalized tasks, such as selecting their own reading materials (e.g., Week 5), also promoted higher cognitive engagement and active participation (Cornelisz & van Klaveren, 2018). Future online discussion designs should incorporate more debate and personalized strategies to enhance engagement and foster cognitive presence. However, compare and contrast is one of the difficult instructional strategies as it requires students' higher level of cognitive connections among topics to address similarities and differences (Hammann & Stevens, 2003). Therefore, Week 1 and Week 4 were less active than other weeks. Educators should ensure students have the necessary cognitive resources to support students to engage in meaningful comparisons (Rittle-Johnson et al., 2020). By providing a detailed, week-by-week analysis of how social and cognitive presence indicators interact and evolve, the design of online courses can benefit from this deeper comprehension in order to encourage continued participation and in-depth study.

Limitations

While our study provides a novel approach to analyzing CoI presences and suggests strategies for designing AODs, several limitations must be considered. First, the study involved a small sample of 22 graduate students from a single course, which limits the generalizability of the findings. Future research should replicate the study across different disciplines and course levels. Secondly, while this study focuses on a 5-week period and provides valuable insights into the short-term dynamics of AODs, it is important to acknowledge that many online learning environments span much longer durations. Future research should examine the longitudinal impact of instructional strategies on the development of social and cognitive presences over the course of an entire semester or academic year. Lastly, this study did not account for the influence of teaching presence, which may significantly affect student interaction and engagement. Future research should place greater emphasis on examining the role of teaching presence to better understand its potential impact on students' course interactions and overall engagement.

Conclusion

In conclusion, this study serves as a methodological demonstration of applying ENA in CoI research and offers valuable insights into the interrelationships between social and cognitive presence. The findings provide practical implications for instructional designers and instructors by informing the development of more engaging online courses and optimizing the use of AODs. Recognizing the strong correlation between social and cognitive presence can assist instructors in fostering a sense of community and designing more interactive and effective online learning environments (Han et al., 2022). By strategically implementing instructional practices that support both cognitive and social presence, educators can create a more inclusive and supportive environment that enhances cognitive engagement and improves student learning outcomes.

Conflict of Interest Statement

The authors declare no potential conflict of interest in the work.

Ethics Approval

The data for this study was approved by Purdue University Institutional Review Board with number: 1502015791.

Acknowledgement

We would like to express our sincere gratitude to Yuanru Tan for her valuable guidance on the methodological approach employed in this study.

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