COLLABORATIVE ONLINE LEARNING MEDIATED THROUGH CONCURRENT UPDATE TECHNOLOGY IN ASYNCHRONOUS AND SYNCHRONOUS ENVIRONMENTS

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ABSTRACT

This dissertation investigates how collaborative modality (asynchronous versus synchronous) and collaborative technology (standard tools versus concurrent update tools) affect academic performance, perceived learning outcomes, and collaborative experiences in fully online higher education. Grounded in the Theory of Transactional Distance, the Community of Inquiry framework, and Social Presence Theory, the research addresses gaps in understanding how technology and instructional modality interact to shape collaboration when instructional content, assessments, and group tasks are held constant. Using a quasi-experimental 2×2 factorial design, undergraduate business students (n = 242) completed two small-group collaboration assignments in one of four conditions: asynchronous standard, asynchronous concurrent, synchronous standard, or synchronous concurrent. Data sources included objective performance scores, post-assignment surveys measuring perceptions of academic performance and collaborative experience, and demographic information. Analyses using ANOVA, Welch's ANOVA, Games-Howell post hoc tests, and independent samples t-tests revealed that concurrent update tools were consistently associated with higher academic performance, particularly in asynchronous conditions, and with improved perceptions of group functioning, structure, and tool support. Synchronous conditions supported greater trust, affective connection, and engagement, while asynchronous concurrent conditions demonstrated notable performance advantages. Results indicate that neither collaboration alone nor concurrent update technology in isolation consistently improved outcomes; the most substantial benefits occurred when collaborative activities were purposefully structured and paired with concurrent update tools aligned with task demands and learning objectives. These findings refine and extend existing theoretical frameworks by showing how co-editing platforms can bridge structure, presence, and

learner interaction across modalities. Practical implications include designing intentional collaborative activities supported by real-time tools in both synchronous and asynchronous environments, alongside institutional investments in platform access, student training, and learning management system integration. By centering both outcomes and the processes that shape collaboration, this dissertation advances empirical and theoretical understanding of technology-mediated collaboration in online higher education and offers actionable strategies for creating equitable, engaging, and effective digital learning environments.

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CHAPTER I

INTRODUCTION

Online learning has become an essential infrastructure in higher education, evolving from a flexible alternative to a foundational instructional modality (Garrison & Akyol, 2009; Garrison & Vaughan, 2008; Marinoni et al., 2020). This transformation accelerated rapidly during the COVID-19 pandemic, which pushed institutions to adopt online formats at scale (Czerniewicz et al., 2020; Fabriz et al., 2021). Although many early efforts focused on emergency remote teaching, recent years have seen the rise of more intentional, well-designed online courses that incorporate both asynchronous and synchronous elements (Rapanta et al., 2020; Zawacki-Richter, 2021). As a result, educators are grappling with how best to support collaboration in online settings, especially when students must work together across differences in time, location, and technological familiarity. This dissertation addresses those challenges by examining how collaborative technologies shape small-group interaction in asynchronous and synchronous online environments, with special attention to concurrent update tools.

The pandemic served as a catalyst, accelerating trends that were already underway and shifting both pedagogical practices and student expectations (Garrison & Akyol, 2009; Garrison & Vaughan, 2008). As higher education continues to evolve, online learning has become not merely an alternative, but a foundational component of modern teaching and learning. This shift brings both opportunities and challenges, especially when it comes to fostering meaningful collaboration in environments where students and instructors may never meet face-to-face (Fabriz et al., 2021; Qiao et al., 2021; Czerniewicz et al., 2020).

Instructors now face the dual challenge of sustaining academic rigor while cultivating

meaningful interaction among students in digital spaces. At the same time, students bring a wide range of preparedness into online courses, including varying degrees of comfort with collaboration tools and uneven experience with group work in digital settings (Shea et al., 2006; Janus et al., 2019). As both the technological and pedagogical landscapes continue to evolve, understanding how collaboration functions across different instructional modalities becomes increasingly important. This dissertation addresses that need by examining how concurrent update technologies influence small-group collaboration in asynchronous and synchronous online environments.

Historical Context of Online Learning

To better understand the present-day challenges and opportunities of online collaboration, it is important to examine how online learning has evolved and how foundational models continue to influence digital pedagogy.

Online learning, often referred to as web-based or internet-mediated learning, represents a transformational shift in how higher education delivers instruction. While its roots lie in earlier distance education models such as correspondence courses and instructional television, foundational scholars like Wedemeyer (1971) and Keegan (2013) outlined key pedagogical principles that still influence online learning today. These include learner autonomy, structured instructional design, and the use of media to support interaction. Such early frameworks laid the foundation for the development of Internet-mediated learning in the late 20th century and informed contemporary models such as Moore's (1993) Theory of Transactional Distance. These frameworks continue to shape the design of online courses and the interpretation of learner engagement, particularly in fully online environments. In recent decades, rapid advances in

digital tools, high-speed Internet, and learning management systems (LMS) have expanded the reach and scalability of online education. As a result, institutions are now able to serve broader and more diverse student populations around the world (Stone et al., 2016).

Today, online learning is more than a convenience; it is embedded within the core infrastructure of modern education. As universities continue to expand online offerings, instructors are increasingly encouraged to design flexible, student-centered, and interactive learning experiences. Technologies such as LMS discussion forums, collaborative documents, and video conferencing tools now support dynamic exchanges of ideas between students and faculty, regardless of location (Garrison & Vaughan, 2008; Blayone et al., 2017). These tools help cultivate critical academic skills such as digital literacy, communication, and independent learning while also fostering collaborative learning and a sense of virtual community (Hrastinski, 2009; Garrison & Vaughan, 2008).

Changes in online learning continue to create conversations around its role in higher education. No longer simply a supplement to in-person instruction, online learning now serves as a primary mode of delivery for many programs. This shift raises important questions about how digital tools mediate collaborative learning and whether instructional design can keep pace with technological innovation. Understanding how learners collaborate, communicate, and succeed infully online environments is now central to advancing equity, engagement, and academic achievement in higher education.

Online Learning Modalities

As online learning has expanded, two primary instructional modalities have emerged as dominant in higher education: asynchronous and synchronous delivery formats. These modalities

not only differ in timing and communication style but also shape how students engage with peers and instructors. Synchronous online learning occurs in real time, typically using video tools to facilitate live interaction (Raes et al., 2020; Lowenthal et al., 2020). In contrast, asynchronous learning allows students to engage with course content and classmates on their own schedule, often through an LMS that hosts discussion forums, file sharing, and recorded lectures (Hrastinski, 2008; Garrison & Vaughan, 2008). Each modality offers distinct strengths and constraints, particularly when students are required to collaborate. These distinctions and their implications for collaborative learning are explored more fully in Chapter 2.

Collaborative Learning

Collaborative learning is a widely used pedagogical approach in higher education that applies across instructional modalities. Rooted in social constructivist theory, it emphasizes active student engagement, peer interaction, and knowledge construction through group-based activities (Vygotsky, 1986; Barkley et al., 2014). Rather than treating learning as a solitary pursuit, collaborative learning encourages students to work together to scaffold ideas and achieve shared academic goals (Hakkarainen et al., 2013). These activities aim to develop communication and teamwork skills, enhance critical thinking, promote self-regulated learning, foster intercultural competence, increase adaptability, and encourage ownership over learning (Loes, 2022; Warsah et al., 2021; Cabrera et al., 2002; Fakomogbon & Bolaji, 2017). In addition to performance outcomes, collaborative learning also shapes how students experience their group work, including perceptions of cognitive engagement, peer contributions, and overall learning gains, which are central to this dissertation's third research question.

Instructional modality plays a significant role in shaping the structure and experience of

collaborative learning. In face-to-face settings, group discussions and cooperative tasks are supported by verbal exchanges, non-verbal communication, and immediate feedback. Synchronous online learning replicates many of these features using video conferencing tools that allow students to engage in live group interactions from different locations (Mullen, 2020). In contrast, asynchronous online learning separates collaboration from fixed schedules, offering students greater autonomy and flexibility to participate at times that work best for them. This model allows collaboration across time zones and personal obligations, but it requires additional planning and structure to maintain interaction and group cohesion (Jung et al., 2023; Martin et al., 2023).

Regardless of the modality, clear and effective communication is essential to successful collaboration. Students and instructors must find ways to intentionally set expectations around communication norms, participation, and response time (Lowenthal et al., 2020). Today's online modalities offer a wide range of digital tools to support group interactions, including email, chat applications, discussion boards, video messaging, and platforms that enable real-time document editing and collaboration. In contrast to traditional face-to-face courses where communication often relies on informal in-class interactions, online environments require more deliberate planning. Students must navigate multiple channels to build shared understanding and maintain momentum within their groups (Blanchard et al., 2011). These tools shape not only how students communicate but also how they experience presence and construct meaning together, reflecting the importance of both cognitive and social dimensions of group work (Garrison et al., 2000; Hrastinski, 2009). As collaborative learning increasingly occurs in digital formats, understanding how communication tools shape group interaction is critical for effective course design. To fully understand and support learning in online environments, it is essential to examine the group

collaboration processes that create successful learning interactions. These collaborative processes, often described in the literature as group dynamics, help explain how collaboration happens and how it influences learning outcomes (Borup et al., 2014; Roseth et al., 2013; Krejins et al., 2022; Levi & Askey, 2020).

Group Dynamics

Group dynamics builds on the concept of collaborative learning by focusing on the interpersonal and structural processes that shape how students interact, communicate, and complete tasks in group settings. The term group dynamics refers to the underlying processes that govern how individuals interact and work together in a group, including the effectiveness of (a) communication, (b) cooperation, and (c) coordination among group members (Levi & Askay, 2020). When students feel connected to their peers and perceive a sense of belonging within their groups, they are more likely to participate actively, share ideas, and contribute meaningfully to group tasks (Dornyei, 1997). These types of social and cognitive exchanges influence not only overall group performance but also the quality of students' collaborative experiences. They affect how learners perceive group functioning, interpersonal dynamics, the communication climate, and their own engagement with peers. These perceptions are closely tied to social presence, which refers to the degree to which students feel connected, supported, and engaged with others in an online environment (Short et al., 1976; Kreijns et al., 2022). When students feel a sense of trust and support within their groups, they are more likely to contribute meaningfully, experience higher levels of satisfaction, and perceive gains in their own learning (Roseth et al., 2013; Stenbom, 2018).

Beyond fostering participation, strong group dynamics also promote the development of

critical academic and professional skills. These skills include effective communication, teamwork, leadership, and conflict resolution, all of which are essential for success in higher education and professional environments (Barkley et al., 2014). In the context of higher education, group dynamics are often evaluated through measures such as group cohesion, communication patterns, leadership roles, participation levels, group norms, and approaches to conflict resolution and task completion (Merlin et al., 2020; Levi & Askay, 2020). In online learning environments, these dynamics are mediated by both instructional modality and the technologies used to support group work. Fraher (2012) found that the success of online student groups often depends on how well they coordinate and communicate using digital tools, particularly in asynchronous contexts where students must manage time delays, distributed tasks, and limited real-time interaction.

Concurrent Update Technology

In online learning environments, a wide range of technologies are used to support collaborative learning activities across different instructional modalities (Kebritchi et al., 2017). One such tool is concurrent update technology. Throughout this dissertation, the terms concurrent update technology and concurrent update tools are used interchangeably to refer to platforms that allow multiple users to edit or contribute to shared digital documents or workspaces in real time. Concurrent update technology stands out for its ability to reshape group interaction in both synchronous online and asynchronous online settings, by enabling students to collaborate without needing to be in the same physical location or even online at the same time. These tools reduce logistical barriers and foster a shared sense of presence. Concurrent update technology also eliminates confusion around file versions and streamlines group workflow (Mallon & Bernsten, 2015). Common concurrent update platforms used in higher education

include Google Drive, Microsoft OneDrive, and collaborative tools such as Google Sheets and LucidChart.

Research has shown that the affordances of concurrent update technologies influence students' engagement, sense of ownership, and perceptions of collaboration. Reguera and Lopez (2021) found that real-time features such as shared editing and immediate feedback enhanced learners' agency and contributed to more positive attitudes toward group work. These same features can help build a stronger sense of community and mitigate the isolation often associated with online learning (Garrison et al., 2000; Hrastinski, 2009; Redmond et al., 2018), highlighting their relevance to both social presence and learner autonomy. When students can see their peers' contributions unfold in real time, they are more likely to remain engaged and feel accountable to the group (Reguera & Lopez, 2021; Borup et al., 2014; Hrastinski, 2009).

Concurrent update technology platforms are also designed to promote a variety of pedagogical benefits such as real-time problem-solving, peer review, and the co-construction of knowledge (Barkley et al., 2014; Reguera & Lopez, 2021). These tools allow students to interpret one another's ideas, provide feedback, and negotiate meaning in a shared digital space without the need to meet face-to-face or in a synchronous online environment. This type of interaction is meant to support critical thinking, social interaction, and deeper understanding (Barkley et al., 2014; Reguera & Lopez, 2021).

Problem Statement & Significance of this Study

Although collaborative learning tools are widely used in online education, there is limited empirical evidence on the specific impact of concurrent update technologies on student collaboration and performance, particularly across different collaboration modalities (Reguera &

Lopez, 2021; Wang et al., 2009). Much of the existing literature lacks instructional consistency across groups, which refers to alignment in instructional content, assessments, and collaborative tasks across each group. This lack of consistency makes it difficult to isolate the effects of collaboration in different modalities and of the use of concurrent update technologies. Without this consistency, it remains unclear whether observed differences in group outcome stem from learning modality, the tool itself, or unrelated instructional variation (Alavi & Leidner, 2001; Roseth et al., 2-13). Understanding how different online modalities and the use of concurrent update technology influence group dynamics, perceived performance, collaborative experiences, and learning outcomes across synchronous and asynchronous online environments is essential for designing effective online learning experiences, especially those requiring collaborative learning. Research by Peterson et al. (2018) has raised concerns that asynchronous collaboration alone may not support the same levels of cognitive engagement or group dynamics often associated with collaborative learning. These findings highlight the need to examine how instructional modality affects learning outcomes, particularly when comparing asynchronous and synchronous formats in the context of collaborative tool use. As post-pandemic higher education increasingly embraces flexible instructional models, it becomes even more critical to understand how collaboration tools function within and across modalities to support student engagement (Rapanta et al., 2020; Boettcher & Conrad, 2021).

This dissertation explores the impact of collaborative learning activities using concurrent update technology in synchronous and asynchronous online collaboration modalities. It focuses on how concurrent update technologies affect learning outcomes, group dynamics, and student perceptions in a higher education setting. Although prior research has examined technology's role in collaborative online learning (Hew & Cheung, 2014; Roseth et al., 2013), much of that

research literature centers on whole-class interaction rather than small group collaboration. This is a critical limitation, as small-group dynamics involve different patterns of communication, coordination, and accountability that are not well captured in whole-class studies (Scager et al., 2016; Kreijns et al., 2022). This dissertation addresses that gap by offering new insights into how concurrent update technologies affect group cohesion, task performance, and learner engagement across different modalities. By investigating both synchronous and asynchronous collaborative settings, this dissertation contributes to a more nuanced understanding of how real-time collaboration tools function across varied online environments.

In addition to examining performance and perceived outcomes, the study explores learners' collaborative experiences, including perceptions of group functioning, cognitive engagement, and the role of tools in shaping group work. These process-oriented elements are critical, as learners' experiences often shape their motivation, willingness to engage, and perceptions of group success (Borup et al., 2014; Kreijns et al., 2013). Rather than focusing solely on end products or grades, this research considers how learners interact within their groups and respond to the technological conditions in which collaboration occurs. In doing so, it responds to broader calls in the literature to examine both outcomes and processes in technology-mediated learning environments (Means et al., 2013; Lee & Hassell, 2021). This layered approach helps explain not only what students accomplish together but also how they experience and interpret collaborative learning online.

As digital technologies continue to influence instructional design, educators need clearer evidence about the conditions under which real-time collaboration tools enhance learning. By analyzing group dynamics, student perceptions, and learning outcomes across different

modalities, this dissertation offers insights that extend beyond tool adoption to inform how and when these technologies should be integrated into course design. These findings contribute to ongoing efforts to improve online learning environments by supporting more interactive, equitable, and pedagogically grounded collaborative experiences. Ultimately, this dissertation research aims to provide evidence-based insights that inform instructional decisions and support improved engagement in both asynchronous and synchronous collaborative online learning environments.

This dissertation employs a quasi-experimental design within a business course in which all students receive identical instructional content, assessments, and group assignments. Participants were placed into asynchronous online and synchronous online sections and completed collaborative work either with or without concurrent update technology, resulting in a 2x2 factorial structure. A primary strength of this design is its instructional consistency, which minimizes variation across groups and enhances the dissertation's internal validity. This level of control supports more confident interpretations of differences in group dynamics, learner perceptions, and performance outcomes. As a result, this dissertation allows for clearer comparisons not only across modalities but also between technology-enhanced and standard collaboration formats.

CHAPTER 2

LITERATURE REVIEW

This chapter provides an in-depth review of the literature relevant to this dissertation. It begins by tracing the evolution and definitions of distance learning and online learning. It then examines collaborative online learning, with particular attention to group dynamics and the influence of instructional modality. Next, the chapter introduces the theoretical frameworks that ground this dissertation study: the Theory of Transactional Distance, the Community of Inquiry framework, and Social Presence Theory. Finally, it identifies key gaps in the literature and presents the research questions that guide this dissertation.

Distance Education

To situate this dissertation within the broader instructional landscape, this section begins by tracing the development and definition of distance education. Distance education has evolved significantly over the past century, offering increased flexibility and access to students balancing academic, work, and personal responsibilities (Johnson et al., 2020; Radford, 2012; Kahu, 2013). Historically rooted in correspondence and broadcast formats, distance education has transitioned into today's digital platforms that support fully online degree programs (Moore & Kearsley, 2012; Saba, 2011). While early models focused on access and content delivery, modern distance education increasingly emphasizes engagement, interactivity, and learning outcomes, especially in collaborative environments. This evolution is accompanied by changes in how interaction, autonomy, and structure are conceptualized, aligning with Moore's (1993) Theory of Transactional Distance.

For the purposes of this dissertation, the term distance education refers to learning experiences where students and instructors are geographically separated and rely on technology for interaction and instruction. As defined by the Higher Education Opportunity Act (2008) and supported by Johnson et al. (2022), distance education includes both synchronous and asynchronous modalities supported by tools such as video conferencing, cloud-based platforms, and shared document editors.

Despite evidence that learning outcomes in distance education can match or exceed those in traditional settings (Johnson et al., 2000; Wetzel et al., 1994), skepticism about its legitimacy has persisted, sometimes shaped by socioeconomic divides in access and perceived prestige (Saba, 2011; Keegan, 2013; Tate, 2008). The COVID-19 pandemic brought these tensions to the forefront, highlighting ongoing disparities in how learners experience distance education (Hodges et al., 2020).

Online Learning

Online learning, a subset of distance learning, has become an increasingly dominant form of instruction in higher education, especially as students show an increased need for flexibility and increased access to digital technologies. While the term online learning has been defined in numerous ways, this study adopts the definition supported by Johnson et al. (2022) where all instruction and interaction is fully online (synchronous or asynchronous). Online learning in this context refers specifically to higher education courses delivered through Internet-based platforms, often involving collaborative tools and LMSs.

As outlined in Chapter 1, online learning in higher education is most often delivered through two different modalities, synchronous and asynchronous, which structure how time,

interaction and instructional support are experienced by students. Prior research has examined the affordances and challenges of each modality, with asynchronous environments offering greater autonomy and flexibility, while synchronous settings support immediacy and real-time feedback (Hrastinski, 2008; Johnson et al., 2022). These differences are especially relevant in collaborative contexts, where modality shapes how students coordinate, communicate, and engage in group work.

This dissertation builds on existing research by examining how asynchronous and synchronous modalities affect collaborative learning when used with or without concurrent update technologies. It focuses on small-group collaboration within these two formats. The dissertation seeks to understand how each modality shapes student interaction and how these interactions affect student perceptions and performance. In doing so, it contributes to the broader goal of understanding how instructional design and technology choices influence collaborative learning processes and outcomes.

Collaborative Learning in Online Environments

Collaborative learning in higher education emphasizes active participation, where students work interdependently to construct knowledge rather than passively receiving information. Grounded in theories such as social constructivism (Vygotsky, 1986), social learning theory (Bandura, 1977), and social interdependence theory (Deutsch, 1949), collaborative learning is most effective when students engage in structured, purposeful group work aligned with learning objectives (Suthers, 2012; Gokhale, 2012). Research consistently supports the benefits of collaboration for improving academic performance, critical thinking, and retention (Johnson & Johnson, 1996; Springer et al., 1999; Slavin, 2011; Ruhl et al., 1987).

Instructors play a key role in guiding collaborative work by designing tasks that are well-scaffolded and clearly defined. Studies suggest that effective collaboration requires not only goal clarity but also instructional scripts that structure learner roles and dialogue while allowing room for student autonomy (Kollar et al., 2006; Dillenbourg, 2002; King, 2007). These scripts and clearly defined instructions help manage the complexity of group work, particularly in environments that emphasize critical thinking and problem-solving.

With the widespread use of digital platforms in higher education, collaborative learning is increasingly mediated through technology. This has given rise to Computer-Supported Collaborative Learning (CSCL), which refers to the use of online tools to support peer-to-peer learning interactions. CSCL occurs in both synchronous and asynchronous settings and often includes technologies such as discussion boards, shared documents, and video conferencing tools (Ng, 2012; Suthers, 2012). The growing adoption of real-time collaboration tools has further expanded the CSCL landscape, enabling new forms of interaction, accountability, and shared authorship that align with evolving instructional modalities (Reguera & Lopez, 2021; Mallon & Bernsten, 2015). These platforms are most effective when they integrate educational, social, and technological affordances for meaningful collaboration (Herrera-Pavo, 2021).

Collaborative online learning has been shown to offer a wide range of benefits. It enables learners from diverse backgrounds to contribute multiple perspectives, supports learner autonomy, fosters critical thinking, and enhances engagement, motivation, and persistence (Cox & Cox, 2008; Ragoonaden & Bordeleau, 2000; Gokhale, 1995; Johnson & Johnson, 1989; Loes, 2022). These benefits are particularly important in fully online environments, where collaboration tools and thoughtful instructional design are essential to replicating the cognitive

and social dynamics of in-person learning.

Asynchronous and Synchronous Collaborative Online Learning

Collaborative learning in online environments takes two primary forms: asynchronous and synchronous. Each modality offers distinct opportunities and challenges for group interaction, and these differences are particularly important when technologies, such as those enabled with concurrent update features, mediate the collaboration. Tools that support real-time or asynchronous co-editing, such as Google Docs or Microsoft OneDrive, can be adapted to function in either modality depending on instructional design (Mallon & Bernsten, 2015; Reguera & Lopez, 2021). Understanding how modality and technology shape group experiences is essential to designing effective online learning environments.

Synchronous collaborative online learning supports immediate feedback, dynamic discussion, and a sense of shared presence among participants (Lowenthal et al., 2020; Raes et al., 2020; Hodges et al., 2020). These features have made it a widely used approach in higher education, especially in disciplines and programs emphasizing interaction and collaboration. Synchronous environments tend to facilitate real-time decision-making and rapid clarification of misunderstandings, which can strengthen group cohesion and enhance collaborative problem-solving. These synchronous benefits are particularly pronounced when paired with concurrent update tools that allow students to visually track peers' thinking and respond in the moment (Hrastinski, 2008; Reguera & Lopez, 2021).

On the other hand, asynchronous modalities offer a different set of affordances and constraints that also shape group interaction. Asynchronous collaborative online learning allows students to engage with course content and peers on their own schedules. This format emerged

alongside the development of the World Wide Web and was originally known as the Asynchronous Learning Network (Hiltz & Welman, 1997; Carr & Seel, 2012). Asynchronous modalities offer broad flexibility, enabling students to learn at their own pace and from any location (Hrastinski, 2008; Whalley et al., 2021). These courses often rely on LMS, discussion boards, and shared documents to support instruction and peer interaction.

Asynchronous collaborative online learning can enhance student autonomy, allowing individuals to progress through course materials at a pace suited to their needs. Studies show that this self-directed model can support deep learning and reflective engagement (Boling et al., 2012; Northey et al., 2015; Varkey et al., 2023). However, the flexibility of asynchronous learning also introduces challenges, particularly for students who struggle with self-regulation or time management (Artino, 2008; Kaufman, 2015). Learners may experience frustration, diminished motivation, or reduced engagement when working in isolation or without timely feedback (Buck, 2016).

Instructors often design asynchronous courses to encourage collaboration through tools like discussion forums, group projects, and peer review mechanisms (deNoyelles et al., 2014; Ivankova & Stick, 2005). Despite the absence of real-time interaction, these design strategies aim to foster a sense of community and maintain student engagement (Hrastinski, 2008). The CoI framework suggests that asynchronous design must deliberately cultivate teaching and social presence in the absence of temporal cues (Garrison et al., 2000; Akyol & Garrison, 2011).

These contrasts between synchronous immediacy and asynchronous flexibility are central to understanding how instructional modality interacts with collaborative tools. Both synchronous and asynchronous online modalities offer distinct advantages and limitations. Synchronous

learning enhances immediacy and fosters a sense of community among learners; however, it may present challenges such as scheduling conflicts or limited access to reliable technology (Lowenthal et al., 2020; Raes et al., 2020). In contrast, asynchronous learning provides greater flexibility, allowing students to engage with content at their own pace, but it can lead to disengagement if collaborative elements are not carefully designed (Hrastinski, 2008; Artino, 2008; Buck, 2016; Jung et al., 2023).

However, asynchronous collaboration also faces several practical challenges. Without real-time interaction, students may lack a clear sense of interdependence, leading to lower engagement or uneven participation (Peterson et al., 2018). Delayed communication can hinder momentum and make it difficult for instructors to provide timely feedback (Jung et al., 2023). While leadership may emerge organically (Waters, 2012), meaningful interaction often requires deliberate facilitation and structured design (Hernández-Sellés et al., 2019). Students have reported frustration with unequal effort distribution and difficulty building trust in asynchronous teams (Jones, 1995; Bukenmyer, 2000; Markulis et al., 2006). When asynchronous groups use concurrent update tools, the visibility of peer contributions may help mitigate some of these barriers, but only if expectations and participation are well structured (Borup et al., 2014; Suthers, 2006).

In contrast, synchronous collaborative learning leverages real-time interaction tools to enable immediate group communication and decision-making. These environments foster immediacy, participation, and interpersonal connection, often resulting in higher group engagement, stronger social presence, and increased satisfaction (Jung et al., 2023; Fadhilah et al., 2021; Peterson et al., 2018). Teams that meet synchronously demonstrate more planning,

cohesion, and shared responsibility, even when meeting for a short duration (Wicks et al., 2015). While offering those benefits, synchronous collaboration also introduces constraints. Learners may feel pressure to respond quickly, which can lead to shallow engagement or reduced participation, particularly for nontraditional or marginalized students (Hrastinski, 2008; Salmon, 2012; Hew & Cheung, 2008). Scheduling real-time meetings across time zones or with varied responsibilities can also create barriers to full group participation. Designing equitable and inclusive synchronous collaboration requires attention to diverse learner needs and the potential amplification of time-based or access-related barriers (Barbour et al., 2020; Martin et al., 2020). Although prior studies have compared synchronous and asynchronous collaboration in online learning, few have examined how these experiences are shaped by the presence or absence of concurrent update technologies. This dissertation addresses that gap by analyzing how technology-mediated collaboration influences group dynamics, student perceptions, and learning outcomes across modalities. As collaborative learning increasingly occurs in both modalities, emerging tools like concurrent update technologies play a central role in shaping group dynamics and learner presence. The next section explores how these tools function within online environments.

Concurrent Update Technology in Collaborative Learning

While much of the research on online collaborative learning has focused on instructional design, group formation, and communication strategies, there has been relatively little theoretical and empirical attention given to the specific tools that mediate collaboration. In particular, technologies that support simultaneous, real-time contributions, referred to in this study as concurrent update technologies, offer unique affordances for group interaction in both

synchronous and asynchronous environments. These tools differ substantially from traditional discussion boards or file-sharing methods because they allow learners to construct meaning together in real time. They can also shift the structure and autonomy within the learning environment, aligning with a core dimension of the Theory of Transactional Distance (Moore & Kearsley, 2012). CSCL research has long emphasized that joint problem solving relies on shared workspaces that support co-construction and mutual awareness among participants (Roschelle & Teasley, 1995; Dillenbourg, 1999b). The following section reviews key studies on concurrent update technologies and identifies specific gaps that the present research seeks to address.

Concurrent update technology refers to digital platforms that allow multiple users to view and edit shared workspaces at the same time. These tools, such as Google Docs, Microsoft Teams, and shared digital whiteboards, have gained increasing popularity in higher education due to their ability to reduce version control problems, increase visibility into peer contributions, and support new forms of interaction. They are also well-suited to collaborative tasks that require idea generation, peer feedback, and the co-construction of knowledge across time and space (Zheng et al., 2016; Reguera & Lopez, 2021). In these environments, effective collaboration depends not only on access to the tool, but also on how the tool supports mutual visibility, turn-taking, and shared focus (Dillenbourg, 1999b). Jeong and Hmelo-Silver (2016) further emphasize that the effectiveness of collaborative tools is shaped by their affordances, including interactivity, modifiability, and visibility. Their framework highlights the importance of aligning tool capabilities with task structure and social goals to support productive collaboration in digital settings. Although widely adopted, relatively little is known about how these tools influence group dynamics, social presence, or learning outcomes in different types of online instruction.

The potential for these tools to support immediacy and connection in asynchronous settings is especially underexplored (Hrastinski, 2008; Lee & Hassell, 2021).

Two studies provide foundational insight into the use of collaborative tools in online learning. Reguera and Lopez (2021) conducted a quantitative study examining the impact of a digital whiteboard on student engagement in a synchronous medical immunology course in Mexico. Their sample included 39 fourth-semester medical students who participated in interactive diagram-based sessions via Zoom and the Goodnotes app. Using a 12-item survey grounded in Kirkpatrick's Level 1 framework, the authors evaluated interaction with peers and faculty, structure and educational environment, and emotional and behavioral responses. Results indicated strong student satisfaction, particularly with how the whiteboard supported understanding of abstract concepts ($M = 4.83$) and sustained interest through visual resources ($M = 4.72$). Students also emphasized the importance of structure and preparation in online settings. However, peer interaction was reduced in the digital format, and some students found the transition from physical to digital tools challenging. The authors concluded that while digital tools support active learning, future implementations should better address interpersonal connection and deeper group collaboration, especially in asynchronous environments.

In a mixed-methods pilot study, Caleya et al. (2024) investigated how Microsoft Teams supported collaborative learning in a fully online pediatric dentistry course involving 23 students. Participants engaged in group assignments using video conferencing, shared files, and real-time editing tools. Data from post-course surveys and weekly reflective journals revealed high levels of satisfaction, particularly with peer feedback and task management. However, students noted challenges with uneven participation and limited familiarity with the platform.

While the study illustrated practical benefits of real-time tools, it did not isolate which features (e.g., concurrent editing versus video conferencing) contributed most to outcomes. Like Reguera and Lopez (2021), it also focused solely on synchronous interaction and did not examine asynchronous applications or long-term group processes. Together, these studies suggest that concurrent update tools can enhance engagement and collaboration, but they also highlight several gaps. Neither study directly compared synchronous and asynchronous modalities, and both relied primarily on self-reported data without systematically measuring group dynamics, social presence, or performance outcomes (Redmond et al., 2018). Additionally, neither study accounted for instructional consistency, limiting the ability to attribute observed outcomes to the tools themselves. While many CSCL environments assume social interaction will naturally occur through tool use, research indicates that social presence and collaboration must be intentionally supported by task design and facilitation (Kreijns et al., 2003). This is especially relevant given concerns that asynchronous collaboration may not support the same levels of cognitive engagement or group functioning as synchronous interaction (Peterson et al., 2018; Hrastinski, 2009). These limitations underscore the need for further research using theory-informed instruments aligned with established frameworks such as the CoI to assess the role of real-time collaboration tools across varied online instructional formats (Garrison et al., 2000).

Additional studies offer further context regarding the use of concurrent update technologies in collaborative online learning. Demissie et al. (2025) conducted a quasi-experimental A-B-A-B reversal design with 10 Ethiopian EFL students to evaluate the impact of Google Docs on collaborative writing in an advanced writing course. Their mixed-methods analysis showed statistically significant improvements across all writing sub-skills, including

task achievement, coherence, lexical range, and grammar, and highlighted student appreciation for real-time feedback, ease of access, and increased engagement. However, the single-group design and small sample size limit generalizability, and the study did not explicitly compare different modalities or isolate individual features of Google Docs, such as comment threads or real-time editing. Similarly, Lee and Hassell (2021) reported that undergraduate students valued Google Docs for enabling collaboration across time zones, particularly in asynchronous settings. Their study used reflection surveys and qualitative responses from students at three universities and found that while many students viewed the tool as effective for organization and peer input, some encountered challenges managing group equity and coordination. A broader synthesis by Zheng, Warschauer, and Lin (2016), which analyzed 36 studies on technology-supported writing, found consistent evidence that collaborative tools improve writing fluency, attitudes, and engagement, although results for standardized performance measures were more variable. The authors emphasized the importance of context and instructional design in shaping the effectiveness of collaborative tools. Scager et al. (2016) added that group dynamics, task authenticity, and learner autonomy are critical to successful collaborative learning, regardless of the technology used. Together, these studies reinforce the potential of concurrent update software to enhance online collaboration but also highlight the need for research that examines how instructional structure, tool features, and group processes interact in different learning environments. This dissertation addresses that need by applying a theory-informed, quasi-experimental design to compare both instructional modality and tool use while holding instructional content constant. The present dissertation builds on this foundation by systematically measuring students' collaborative experiences and perceived learning outcomes using a set of composite variables aligned with both theory-based constructs and practical tool

functionality.

Group Dynamics

Group dynamics refers to the behavioral, cognitive, and social processes that influence how individuals interact within a group. These dynamics shape collaboration, communication, leadership, conflict resolution, and performance. In the context of education, group dynamics are especially relevant to collaborative learning, where small groups of students work together to complete tasks and construct meaning (Shaw, 1976; Suthers, 2012). Group interactions are central to achieving the learning objectives of collaboration, making the study of these dynamics essential to understanding student success in group-based tasks. Recent scholarship continues to affirm that how groups function, whether through effective coordination or breakdowns in interactions, directly affects learner engagement and outcomes (Borup et al., 2014; Belbaly et al., 2022).

The field of group dynamics has evolved from early experimental studies in psychology and sociology (e.g., Triplett, 1898; Lewin, 1943; Tuckman, 1965) to more context-sensitive investigations in education, business, and organizational behavior (McGrath et al., 2000). Researchers have examined key group processes including leadership, cohesion, identity, conflict, and role formation (Bass, 1997; Hackman, 1992; Jehn, 1997). While early research often relied on laboratory-based methods that lacked ecological validity (Moreland et al., 1998), recent work has shifted toward more complex, real-world group settings, including academic teams (Fraher, 2012; Markulis et al., 2006). Within online academic environments, group functioning is often complicated by varying levels of digital literacy, time zone differences, and lack of informal communication opportunities that occur naturally in face-to-face environments

(Wicks et al., 2015).

McGrath et al. (2000) proposed a multilevel systems framework for analyzing group behavior, which includes three interrelated domains: local dynamics (the group's internal interactions and use of tools), global dynamics (the group's relationships with external systems and shared norms), and contextual dynamics (institutional structures, support systems, and group longevity). This framework expands earlier concepts such as McGrath's Time, Interaction, and Performance (TIP) theory by accounting for the layered complexity of group functioning within organizations and institutions. It is especially applicable to online collaborative learning, where students must coordinate across digital platforms while adhering to institutional structures, assignment parameters, and varying levels of instructor involvement (Fiore et al., 2010; Salas et al., 2005). In collaborative educational settings, group effectiveness is also shaped by interdependence among members and the clarity of assigned roles. These factors influence participation, accountability, and task cohesion, which are particularly important in asynchronous environments where opportunities for spontaneous clarification are limited (Johnson & Johnson, 1996; Slavin, 2011; Shea et al., 2013; Hrastinski, 2009). Studies have shown that well-functioning online groups often depend on pre-established norms, clarity of task structure, and consistent communication tools that support mutual visibility and real-time coordination (Borup et al., 2014; Thomas et al., 2017). When these elements are absent or unclear, group cohesion and learner satisfaction may suffer (Borup et al., 2014; Kreijns et al., 2003).

In online education, group dynamics are shaped by the constraints and affordances of the modality itself. Synchronous online groups may benefit from immediacy and real-time dialogue

but can also face coordination and equity challenges. Asynchronous online groups, while offering more flexibility and time for reflection, may struggle with delayed feedback and lower engagement (Jung et al., 2023; Mejia, 2020). Prior studies have examined online group communication, participation, and satisfaction (Crawford & Weber, 2010; Dixon, 2015), but few have explored how collaboration tools like concurrent update technology mediate group processes such as leadership, cohesion, or decision-making across modalities. This gap in the literature is significant, as the tools that facilitate group interaction may influence whether students feel accountable, engaged, and supported in their collaborative efforts (Borup et al., 2014; Kirschner et al., 2011).

This dissertation extends current work in group dynamics by focusing on small-group collaboration in asynchronous and synchronous online settings, with and without the use of concurrent update technology. By comparing learner perceptions and performance across these conditions, this research contributes to a deeper understanding of how specific instructional designs and technologies affect group functioning in fully online higher education. Recent research continues to demonstrate the importance of trust, role clarity, and engagement in virtual student teams, showing how group dynamics directly influence collaborative outcomes in online academic settings (Belbaly et al., 2022; Borup et al., 2014). Chapters 4 and 5 of this dissertation provide empirical findings that illuminate how collaborative experiences differ by modality and tool use, particularly in terms of group cohesion, perceived equity of participation, and group satisfaction. Understanding group dynamics in online collaborative learning environments requires a conceptual framework that accounts for learner interaction, autonomy, and presence. The next section outlines three foundational theories that guide the design and interpretation of

this study.

Theoretical Frameworks

This dissertation draws upon three interrelated theories to explore collaborative learning in online environments: the Theory of Transactional Distance, the CoI framework, and Social Presence Theory. Together, these perspectives help explain how students interact, engage, and learn in both asynchronous and synchronous settings. The Theory of Transactional Distance (Moore, 1993; Moore, 2013) highlights the psychological and communicative space that can exist between learners and instructors as a result of variations in structure, dialogue and learner autonomy in online formats. The CoI framework (Garrison et al., 2000) builds on this by emphasizing the roles of social presence, cognitive presence, and teaching presence in shaping meaningful online learning experiences. Social Presence Theory (Short et al., 1976) adds a complementary lens by focusing on how communication mediums affect students' perceptions of one another, which is especially relevant for understanding group dynamics and collaborative engagement remote teams. Collectively, these theories offer a strong foundation for examining how instructional modality and technology use affect group dynamics, perceived learning and the collaborative experiences of online learners.

Theory of Transactional Distance

When distance education emerged into online learning, there was no theory on which to build online learning pedagogies and curricula or to do scholarly research on the development of these types of courses (Xiao, 2025; Moore & Diehl, 2019). At that time, the accepted assumption was that instruction was activities that occur within a classroom setting (Association of Supervision and Curriculum Development, 1968). Even then, when learners were presumed to

all be meeting face-to-face, it was known that creating a sense of community is critical to advanced learning (Moore & Diehl, 2019; Saba, 2011). The transition from face-to-face environments to digital platforms required new frameworks to guide the design and evaluation of remote learning. The movement from traditional face-to-face settings to online learning created a new paradigm. One of the earliest models addressing these issues and endeavoring to create and measure social presence in online learning environments is Michael Moore's (1993) Theory of Transactional Distance (Xiao, 2025), which remains foundational in understanding how psychological and communicative gaps can emerge in online education.

Taking the term transactional distance from Boyd and Apps's (1980) *Handbook of Adult Education* teaching theories, Moore's Theory of Transactional Distance was inspired by Boyd's teaching theories that included ideas of dialogue, structure, and transaction (Moore & Diehl, 2019). Originating with John Dewey, transactions happen at the intersection of the environment, individuals, and behaviors (Boyd & Apps, 1980). Moore translated this term to online learning to mean that a transaction is the combination of the behaviors of teachers and learners when they are separated by time or place and must use technology to communicate (Moore & Diehl, 2019; Saba, 2011). Transactional distance is not absolute but instead is measured in relative terms and is more related to pedagogical distance than physical distance (Xiao, 2025; Moore & Diehl, 2019). This concept of a transaction has enabled the Theory of Transactional Distance to become a guiding force in the design and pedagogy of online courses (Saba, 2011; Moore & Diehl, 2019; Xiao, 2025).

The Theory of Transactional Distance also focuses on the individual student as the catalyst for instruction and proclaims the need for instruction to be personalized instead of

directed at an entire class of students. Actual learning, Moore (2013) argues, can only occur at an individual level. Therefore, online learning and distance education are uniquely situated in their ability to facilitate mastery as the student is set to take on a more invested role in the process (Moore & Diehl, 2019). Moore's insistence on the role of the student in learning was predicated on work by Wedgemeyer (1971), Rogers (1969), and Maslow (1968). Instruction must be well thought out and planned and responsive to the learner's needs. This planning and responsiveness is called structure in the Theory of Transactional Distance (Moore & Diehl, 2019; Xiao, 2025). While most teaching comes from a set plan of lessons, Moore (2013) points out that for online education there must be careful planning to ensure the timing and stratification of each assignment, assessment, and activity (Xiao, 2025). Courses can be developed on a continuum from high structure to low structure depending on the individualization of the learning outcomes for each student (Moore & Diehl, 2019; Xiao, 2025). Measures of structure are researched using quantitative methods and variables showing the extent to which a course can be responsive to a learner's needs in terms of learning objectives, teaching strategies, and evaluation methods (Moore, 2013).

The third idea of the Theory of Transactional Distance is dialogue. Called interaction in some other theories and frameworks, the term dialogue is used here because it is by nature positive and constructive and is used to describe an activity by two or more participants that is directed at discovery or new understanding and the achievement of learning objectives (Moore, 2013; Moore & Diehl, 2019; Burbules, 1993; Xiao, 2025). Dialogue can be dialogic, between learner and teacher, or non-dialogic, between learner and content, and courses are typically designed to focus on one or the other. (Xiao, 2025; Moore, 2013). When the Theory of

Transactional Distance was first developed, learner-to-learner dialogues were not possible due to the technological constraints of the time in distance education (Xiao, 2025). Like structure, courses use dialogue to varying degrees from none to continuous and everything in between based on factors like the number of students and the overall structure of the course (Moore & Diehl, 2019). Dialogue is a measure that should be researched using qualitative methods as its effects are not adequately captured by quantitative measures (Xiao, 2025). However, in the context of large-scale studies, researchers have effectively used survey instruments to capture students' perceptions of dialogue, particularly when measuring learner-instructor and peer communication patterns (Chen, 2011; Jung, 2006; Zhang, 2003). This provides a practical approach to assessing how course design and tools influence interaction.

Although dialogue is often studied through qualitative analysis, this dissertation uses survey instruments to capture students' perceptions of instructional communication and interaction. Likert-style items were selected to reflect learners' experiences with instructor and peer communication during collaborative work. These items function as quantitative indicators of perceived dialogue, aligning with prior research that has operationalized the dimensions of dialogue in survey-based studies (e.g., Chen, 2011; Moore & Kearsley, 2012; Xiao, 2025). This approach enables the examination of how instructional communication patterns may differ across asynchronous and synchronous modalities, and how these differences relate to collaborative group processes. Chapter 3 provides details of the surveys used in this dissertation, including **Table 4**, which maps specific questions to the Theory of Transactional Distance.

In addition to dialogue and structure, the Theory of Transactional Distance also accounts for learner autonomy based on a learner's ability to manage their own learning through measures

such as objective setting, implementation, and evaluation (Xiao, 2025; Saba, 2011; Rogers, 1969; Tough, 1979; Moore & Diehl, 2019). Courses showed wide degrees of effectiveness related to structure and dialog based on the degree of learner autonomy showing that regardless of the structure and dialog present, it is imperative to know how the student works to create their own learning (Moore, 1973; Moore, 1976). It is important to note that not all learners are the same and courses must be designed with the appropriate levels of autonomy for the given participants (Moore & Diehl, 2019; Xiao, 2025).

The emergence of personalized learning in online learning has led to a resurgence of studies focused on Moore's Theory of Transactional Distance (Moore & Diehl, 2019; Johnson et al., 2016). Additionally, the development of artificial intelligence (AI) and its use in online learning from both student and instructor perspectives calls for more studies on lowered transactional distance and higher learner personalization and autonomy (Saba, 2011; Moore & Diehl, 2019). While technology does not explicitly define distance in education, it is an important mechanism to regulate dialogue, structure, and learner autonomy so as technology changes and evolves, it is important to see how these changes affect the theory (Xiao, 2025).

While some researchers have called for a new theory to replace the Theory of Transactional Distance, due to lack of validity or its failure to adapt to new emerging developments in education, Moore himself has issued updates and adaptations as the landscape changes keeping the theory relevant and useful to today's educational environment (Xiao, 2025) Studies have been done to test the efficacy and validity of the Theory of Transactional Distance by testing how changes in structure, dialogue, and autonomy affect the other dimensions (Saba, 1988; Saba & Shearer, 1994; Saba, 2011). Other studies have worked to create instruments that

will measure the transactional distance of course delivery (Shinkle, 2011; Braxton, 1999). Since 2000, more studies have begun to focus directly on online web-based learning (Jung, 2006; Chen, 2011; Clouse, 2001; Dron, 2002; Zhang, 2003). While emerging technologies consistently enable higher levels of interaction, their impact on dialogue can be either positive or negative and continues to be a needed area of study (Xiao, 2025).

This theory supports the dissertation's focus on how distance, learner autonomy, structure, and dialogue function differently in asynchronous and synchronous online environments. The constructs measured in this study, particularly dialogue, structure, and learner autonomy, are drawn directly from this framework and operationalized through composite and individual survey items described in Chapter 3. Learner autonomy is especially relevant in online contexts where students must self-direct their learning and manage competing responsibilities with less immediate instructor support. Because asynchronous settings typically have lower immediacy, this framework helps explain how tools like concurrent update technology may reduce transactional distance by enabling real-time collaboration. This theory also informs the interpretation of students' perceptions and experiences gathered through the survey instruments.

Community of Inquiry Framework

The CoI framework was originally published by Garrison, Anderson, and Archer in 2001 to model three factors of an educational experience: cognitive presence, social presence, and teaching presence (Garrison et al., 2001). Since its publication, CoI has become a popular tool for analyzing and conceptualizing the online learning process (Garrison & Arbaugh, 2007; Arnold & Ducate, 2006; Shea, 2007; Stodel et al., 2007; Junus et al., 2022; Castellanos-Reyes, 2020; Alavi & Taghizadeh, 2013; Fiock, 2019). While manystudies using the CoI have been in

general education, the framework's reach is expanding to business (Arbaugh & Benbunan-Fich, 2006; Arbaugh & Rau, 2007), information systems (Heckman & Annabi, 2005; Alavi & Taghizadeh, 2013), mathematics (Junus et al., 2019), and foreign languages (Arnold & Ducate, 2006).

Social presence refers to the degree to which learners are perceived as real people in mediated communication and online communities (Gunawardena & Zittle, 1997; Garrison & Arbaugh, 2007). A strong connection has been found between social presence and learning outcomes, with increased social presence linked to greater satisfaction with online collaborative (Garrison & Arbaugh, 2007). Social presence can be developed in many ways. Collaboration activities bolster social presence and help to create a greater sense of online community (Rovai, 2002; Richardson & Swan, 2003; Garrison & Arbaugh, 2007). This sense of community increases communication and support among learners in collaborative learning environments (Hernández-Sellés et al., 2019; Rovai, 2002) In an online community, social presence must be established and nurtured as the community develops. Students understand that they are not merely engaged in classes for social reasons, so they must be given a reason to interact with others and to actively participate in forming the community (Garrison & Arbaugh, 2007). In 2001, adding to the CoI, Brown identified three stages of belonging to a community including making acquaintances, conferment, and camaraderie (Brown, 2001). These stages, like the social presence of CoI, will be achieved more quickly through more intense engagement (Brown, 2001; Garrison & Arbaugh, 2007).

Cognitive presence is the extent to which learners can make meaning through discourse and reflection (Garrison et al., 2000). This concept is rooted in the construction of practical

inquiry (Dewey, 1933). The ability to make meaning from learned concepts is a long-standing hallmark of the success of higher education (Dauer, 1989; Dewey 1959; Garrison & Arbaugh, 2007). This process of meaning-making was conceptualized in the CoI with a four-phase process that included a triggering event, exploration, integration, and resolution (Garrison et al., 2001).

Research suggests that social presence can formulate a foundation for cognitive presence by creating a backdrop by which learners can actively add to another student's thoughts or ideas (Celani & Collins, 2005). Although social presence is often measured by counting the number of iterations in a discussion board or similar technology, more sophisticated measures now examine affective and relational elements (Garrison & Arbaugh, 2007; Richardson & Swan, 2003). Cognitive presence is supported by many techniques in online learning because the composition of a collaborative learning group or community could be more important than the interaction format of those participants (Lee & Lee, 2006; Garrison & Arbaugh, 2007). Studies show that it is difficult to move the cognitive presence four-phase process past the exploration stage in many CoI studies (Garrison & Arbaugh, 2007). Some studies suggest that learners' difficulty progressing beyond the exploration phase of cognitive presence may be more strongly influenced by the instructor's teaching presence than by other contextual factors such as the communication medium or course design (Meyer, 2003; Garrison et al., 2001; Luebeck & Bice, 2005).

Teaching presence refers to the design, facilitation, and direction of courses so that students can make meaningful connections and achieve learning outcomes. Of the three factors of CoI, teaching presence is the most recently conceptualized and has been shown in many studies to be a significant source of student-perceived learning, satisfaction, and sense of community (Garrison & Arbaugh, 2007). It is made up of three components: instructional design,

discourse, and direct instruction (Garrison et al., 2000). These components are particularly important in online environments where instructors must be more intentional in guiding and sustaining dialogue (Pawan et al., 2003). Particularly in asynchronous online discussions, students tend to have a group of serial monologues if not engaged in a meaningful way by the instructor to challenge them to form cohesive ideas or guide them to more complete dialogues (Pawan et al., 2003; Meyer, 2003; Finegold & Cooke, 2006; Murphy, 2004; Garrison & Arbaugh, 2007).

Another concept accentuated by teaching presence drawn from the CoI is that the quality of discourse and learning may be influenced by metacognitive awareness (Garrison & Arbaugh, 2007; Garrison & Vaughan, 2008). Metacognitive awareness occurs when learners are aware of the changes in their thinking thus producing a deep learning state (Campos et al., 2005). As students rarely progress to this stage on their own, a solid teaching presence is needed to help students learn to iterate and progress in their ideas (Garrison & Arbaugh, 2007).

While most studies to date have tested social presence, teaching presence, and cognitive presence separately, Redmond and Lock (2006) have proposed a sequential relationship between the three tenets of the CoI. Their conceptualization suggests that successful online learning endeavors begin with building social presence which is then enabled by teaching presence to move into cognitive presence. The created cognitive presence then interacts with social presence to produce meaningful learning (Redmond & Lock, 2006).

The CoI framework has made significant contributions to the field of online learning, but several research gaps persist. Garrison and Arbaugh (2007) emphasized the need for more studies examining variables such as course content, learner characteristics, and the technologies

used to deliver courses. Garrison and Arbaugh (2007) highlighted the need to explore the differences between synchronous and asynchronous online learning modalities and their impact on CoI measures. Similarly, Stenbom (2018) noted the need for larger sample sizes in CoI research to increase the validity of findings related to teaching, social, and cognitive presence. It is well established that engaging learners in complex tasks such as problem-solving requires rich media that offer immediate feedback and multiple cues (Moallem, 2009). However, the role of collaborative tools such as concurrent update technologies in supporting CoI constructs remains underexplored, particularly in comparative studies across different online learning modalities (Stenbom, 2018).

The CoI framework offers a multidimensional lens for analyzing collaborative online learning by focusing on cognitive, teaching, and social presence. This dissertation draws most heavily on the constructs of social and cognitive presence to examine how learners experience collaboration and construct meaning within online groups. The survey instruments include items designed to measure these forms of presence, enabling analysis of how instructional modality and technology use interact to shape collaborative learning. A detailed mapping of these survey items to CoI constructs is presented in Chapter 3, specifically in **Table 5**.

Social Presence Theory

While social presence is a core element of the CoI framework, Social Presence Theory offers a broader perspective focused on how communication media shape interpersonal perceptions. The CoI approach defines social presence in terms of its role in instructional design and learning outcomes, particularly within structured educational environments (Garrison et al., 2000). In contrast, Social Presence Theory emphasizes the capacity of a medium to convey a

sense of personal connection, immediacy, and co-presence (Short et al., 1976). This dissertation draws on both perspectives. The CoI framework helps explain how social presence supports collaboration and meaning making within learning groups, while Social Presence Theory provides a foundation for understanding how specific tools, such as concurrent update platforms, influence students' sense of being seen and heard in mediated environments.

Social Presence Theory was developed in 1976 by John Short, Ederyn Williams, and Bruce Christie as a way to define the way that a person is perceived as real in technology-mediated communication by combining concepts of intimacy from Argyle and Dean (1965) and immediacy from Wiener and Mehrabian (1968) (Short et al., 1976; Gunawardena, 1995). Short et al. (1976) developed the idea of social presence as a quality of the communication medium itself and showed that variations in the social presence of a medium would impact how individuals interacted within the medium (Short et al., 1976; Gunawardena, 1995; Kreijns et al., 2022). The world of online communication differs from communications that take place face-to-face and social presence works to reconcile these differences by comparing how well as computer-mediated communication (CMC) tool can mimic face-to-face interactions in aspects of interpersonal communication, collaborative learning, and group dynamics (Kreijns et al., 2022). Even interactions that occur in video-conferencing technologies such as Zoom or Microsoft Teams where participants can see and hear each other in real-time vary from true face-to-face interactions and create different interaction patterns (Gunawardena, 1995). While the tone of voice, facial expressions, and gestures can be seen in video conferencing tools, many aspects of face-to-face communication like the direction of gaze, posture, dress, and physical presence are missing or inhibited and are artificially replaced by moderators who attempt to move

conversations along (Gunawardena, 1995). The ability of technology to mimic these aspects of face-to-face interaction indicates its degree of social presence (Short et al., 1976). Research shows that technologies affording more cues, such as video, audio, and synchronous communication, are associated with feelings of greater social presence (Cherney et al., 2017). Additionally, more recent research confirms that social presence is shaped not only by the technology being used, but also by how students and instructors engage with one another during the learning process (Richardson et al., 2017).

Before online instruction was commonplace, studies were conducted to measure the social presence of instructors in face-to-face classrooms (Gunwardena, 1995). Instructor social presence was considered a potential predictor of institutional effectiveness and several studies showed positive outcomes associated with instructor social presence created by immediacy in face-to-face instruction (Powell & Harville, 1990; Burgoon et al., 1984; Gorham, 1988; Kelly & Gorham, 1988). Additional studies were done related to instructor immediacy in distance education that also produced positive correlations to student satisfaction and learning (Hackman & Walter, 1990). In these studies, instructor immediacy was shown through verbal and nonverbal actions such as smiling, humor, vocal variation, addressing students by name, praising, encouraging feedback, personalizing examples, etc. (Gunawardena, 1995).

Studies conducted in early online communities showed complex social interactions and attempted to simulate social interactions in group activities through text-based communication technologies (Gunawardena, 1995; Feenberg, 1989; Harisim, 1993; Jones, 1995; Rheingold, 1993; Walther, 1992). Other studies showed the development of social presence could be created by the participants themselves instead of being a direct attribute of the medium (Walther, 1992;

Gunawardena, 1995). In these studies, social presence was created by the communication of nonverbal cues in verbal ways by expressing emotion through phrases or with emoticons (Johansen et al., 1988; Walther, 1992; Gunawardena, 1995). More recent studies in online learning environments have shown that social presence impacts online collaborative learning and online group dynamics (Kreijns et al., 2022; Tu & McIsaac, 2002; Zhao et al., 2014). Social presence is now understood as a dynamic construct that can be co-constructed by learners and instructors, particularly through the use of supported communication strategies and shared social norms (Lowenthal & Snelson, 2020; Richardson et al., 2017).

Social Presence Theory complements the CoI framework by focusing specifically on the learner's sense of being real and seen in mediated environments (Short et al., 1976; Rovai, 2002). In this dissertation, social presence is measured using survey items that assess students' comfort communicating with group members, their perception of being recognized and understood by peers, and their ability to express themselves authentically during collaborative work. While the construct of social presence includes subtle interpersonal cues that are sometimes difficult to quantify, these perception-based indicators have been validated in prior online learning studies using survey methodologies (Gunawardena & Zittle, 1997; Tu & McIsaac, 2002). Because one of the core challenges in asynchronous online learning is reduced immediacy, this theory helps frame the investigation of how concurrent update technologies might enhance students' sense of connectedness and co-presence. Several survey items explicitly measure social interaction and comfort with group communication, grounded in this theoretical perspective and mapped in **Table 6** in Chapter 3.

While CoI provides a systems-level model of online learning, Social Presence Theory

offers a more focused lens for analyzing interpersonal connection and group cohesion, two elements essential for effective collaboration. Together, these perspectives help clarify how students experience presence, responsiveness and belonging in online environments. These factors are crucial to successful group engagement (Borup et al., 2014; Lowenthal & Dunlap, 2020). Using both the CoI framework and the Social Presence Theory allows this dissertation to evaluate how design elements and peer interactions shape group success in distinct but complementary ways.

Together, these theoretical frameworks provide a multi-layered foundation for the present dissertation study. The Theory of Transactional Distance informs how course structure, learner autonomy, and interaction shape the experience of online collaboration. The CoI framework provides a systems-level understanding of how cognitive, teaching, and social presence intersect to support meaningful learning, while Social Presence Theory offers a more focused lens to examine how students connect with one another in group settings. Together, the Theory of Transactional Distance (Moore, 1993), the CoI Framework (Garrison et al., 2001) and the Social Presence Theory (Short et al., 1976) guide the development of survey instruments and the interpretation of group processes and outcomes across instructional modalities and tool use. They also provide a lens for analyzing how instructional modality and digital collaboration tools shape students' experiences and learning outcomes in online environments. The combination of these theories ensures that both the design and interpersonal aspects of online collaborative learning, which are measured in this dissertation, are conceptually grounded.

Research Gaps in the Literature

Recent scholarship on collaborative online learning, group dynamics, and instructional

modalities highlights several unresolved questions and emerging opportunities. While both asynchronous and synchronous online environments can support student engagement and achievement, their effectiveness depends heavily on how group work is structured and supported. The role of technology, particularly tools that allow for real-time, shared interaction like concurrent update platforms, emerges as a key factor in shaping how students collaborate.

As concurrent update systems become more widely used, further investigation is needed into how these platforms shape group interaction and learner performance in digital environments. Although the importance of structured interaction in distance education is well established (Moore & Diehl, 2019; Saba, 2011), questions remain about which design elements, particularly technological and pedagogical, most effectively support collaboration using concurrent update technologies (Ragoonaden & Bordeleau, 2000). Prior studies often treat technology use as a secondary factor or fail to differentiate between standard tools and those that allow real-time shared editing, limiting the field's ability to pinpoint the specific features that contribute to enhanced group functioning and learning (Fiock, 2019; Borup et al., 2014).

A second critical gap involves differences between synchronous and asynchronous online collaborative environments. Peterson et al. (2018) emphasize the need to examine whether real-time interactions, such as those supported by video conferencing or live chat, are necessary for achieving meaningful collaboration and learning outcomes. Their findings suggest that asynchronous collaboration may not, on its own, produce cognitive engagement or group dynamics often associated with collaborative learning. This raises important questions about the conditions required for online collaboration to be effective, particularly in relation to instructional modality and tool selection. Recent research also calls for more comparative studies

that hold instructional content constant while isolating the effects of modality and tool use on group dynamics and learner experiences (Lowenthal & Moore, 2020).

Additionally, there is limited empirical work that directly maps theoretical constructs such as transactional distance, social presence, and cognitive presence onto learner perceptions and experiences in collaborative online settings. While the supporting frameworks have been widely cited, few studies use validated instruments to examine how these dimensions manifest across different modalities and technology conditions (Shea & Bidjerano, 2009; Xiao, 2025). This gap limits both theoretical and practical understanding of how online group processes function in higher education.

These gaps are particularly important given the increasing prevalence of group-based assignments in online courses and the growing reliance on peer collaboration to support active learning (Lee & Hassell, 2021; Kreijns et al., 2022). Yet, questions remain about how collaboration tools affect students' ability to coordinate efforts, build trust, and perceive academic value in their group work, especially when interactions are not occurring in real time. The present dissertation study addresses these gaps by investigating how collaborative online group work is shaped by both instructional modality (online synchronous vs. online asynchronous) and the presence or absence of concurrent update technology. Unlike prior research that often conflates multiple variables or lacks instructional consistency, this study uses a quasi-experimental design with consistent course content, assessments, and group tasks across the four conditions. This approach enables the study to isolate the effects of instructional modality and collaboration tool usage, offering clearer insights into how concurrent update technologies influence student perceptions, group dynamics, and academic outcomes. Survey

instruments in this study were aligned with key constructs from the Theory of Transactional Distance, the CoI framework, and Social Presence Theory, allowing for a conceptually grounded and empirically rigorous investigation of learners' experiences. By directly comparing collaborative experiences across these two key dimensions, the study provides empirical evidence that advances our understanding of technology-mediated collaborative learning in online higher education.

Research Questions

This study uses a 2x2 factorial design to group collaboration modalities (synchronous vs. asynchronous), both with and without the use of concurrent update technology. The following research questions are designed to empirically test the relationships explored in this review:

- RQ1: Do students' academic performance measures change based on:

a) group collaboration modality?
b) use of concurrent update technology?
c) the interaction of these two factors?

- RQ2: Do learners' perceptions of performance change based on:

a) group collaboration modality?
b) use of concurrent update technology?
c) the interaction of these two factors?

- RQ3: Do learners' collaborative experiences change based on:

a) group collaboration modality?
b) use of concurrent update technology?
c) the interaction of these two factors?

Research Questions 2 and 3 are conceptually grounded in the Theory of Transactional Distance, the Community of Inquiry framework, and Social Presence Theory. These frameworks collectively inform the constructs used to assess students' perceptions of dialogue, presence, and group functioning. RQ2 focuses on perceived academic outcomes, while RQ3 emphasizes the relational and cognitive dimensions of group collaboration.

Table 1 summarizes how each theoretical framework informs this study's design, including key constructs, measurement focus, and alignment with the research questions. While all three theoretical frameworks provide strong conceptual foundations for understanding learner experiences, perceptions, and group dynamics in online collaboration, none of the theories directly predict or explain objective academic performance outcomes. As such, Research Question 1 is examined empirically but is not grounded in a specific theoretical framework. This distinction allows the study to assess actual performance differences across conditions while using theory to interpret how students experienced and made meaning of their collaborative work.

Table 1:

Alignment of Theoretical Frameworks with Study Design and Research Questions

Theory	Key Constructs	Relevance to Study	Measured Variables or Concepts	Aligned Research Questions
Theory of Transactional Distance (Moore, 2013)	Dialogue, Structure, Learner Autonomy Tool Enabled Learning	Explains how instructional design and communication affect collaborative learning across group collaboration modalities	Perceived dialogue (via instructor and peer communication), perceived structure	RQ2a–c, RQ3a-c

Table 1: Continued

Theory	**Key Constructs**	**Relevance to Study**	**Measured Variables or Concepts**	**Aligned Research Questions**
Community of Inquiry (CoI) (Garrison et al., 2000)	Social Presence, Cognitive Presence, Teaching Presence	Provides a lens for examining how collaborative learning and meaning making emerge in online groups	Social presence (e.g., trust, support, group interaction); cognitive presence (e.g., group functioning, peer learning, idea resolution)	RQ2a–c, RQ3b-c
Social Presence Theory (Short et al., 1976)	Immediacy, Interpersonal Connection	Helps interpret how communication media affect learners' perceptions of being seen and heard in group settings	Comfort with group communication; perceptions of social interaction and immediacy	RQ2a–c, RQ3a-c

CHAPTER 3

METHODS

This chapter outlines the quasi-experimental research design, instructional context, measurement instruments, and analytical procedures used in the dissertation. The purpose of this chapter is to provide a comprehensive overview of the study's implementation, including data collection methods, survey development, and analytical approach. The chapter is organized into the following sections: study context, participant assignment and instructional structure, assignment scoring and performance measures, survey instruments, construct development and theoretical alignment, data preparation procedures, and data analysis plan.

Study Context

This section provides an overview of the instructional environment, student population, and course structure in which the dissertation was conducted. A clear understanding of the setting is essential for interpreting results and evaluating ecological validity. To support the rationale for the methodological design, this section outlines the course's instructional design features, delivery modalities, group assignment structure, and assessment framework.

Participants were drawn from four instructional conditions defined by a 2×2 factorial design, combining collaboration modality (asynchronous or synchronous) and collaborative tool use (standard or concurrent update technology). These conditions structured the online learning environments in which students completed their group assignments. Students enrolled in the course were assigned to one of four collaboration conditions as part of the study, with further demographic details provided in the Participant Description section.

The dissertation study was conducted in a required undergraduate business course focused on the foundational principles of information management. The course served all business majors at the institution and enrolled a large, diverse student population. This context provided a professionally relevant setting for examining collaborative learning in fully online environments.

Course Context

The dissertation study took place within an undergraduate course focused on introductory principles of information management, offered through the College of Business. All students pursuing business majors are required to complete this course unless they have a qualifying transfer credit from another institution. As a result, enrollment in the course each semester is assumed to closely reflect the demographic composition of the College of Business overall.

During the Spring 2025 semester, when this dissertation research was completed, this two-credit hour course was offered in ten sections, all taught by the same instructor. Students registered for two distinct components: one hour of asynchronous online instruction, listed in the course catalog as “online flexible,” and one hour of lab, listed as an in-person class with assigned meeting times and classroom locations.

All instructional content for the course was delivered asynchronously, including lectures, readings, and preparatory materials. The only difference among students was how they participated in the lab component, where collaborative group assignments were completed. These lab sessions, which occurred weekly, were the site of collaborative learning and group task completion. While these lab sessions persisted throughout the semester, two of these collaborative assignments served as focal measures for this dissertation.

Due to high enrollment and physical space constraints, multiple lab sections were scheduled concurrently in different rooms. To accommodate these limitations, the instructor implemented a HyFlex teaching model that allowed students to choose from three lab participation modalities: (a) in-person attendance as listed in the catalog, (b) synchronous online participation via video conferencing during their scheduled time, or (c) asynchronous online participation, reflecting Beatty's (2019) model of flexible, student-directed hybrid instruction. Although three modalities were available, this dissertation excluded data from students who chose the in-person lab modality, focusing instead on the comparison between synchronous and asynchronous online modality formats.

Students who attended lab in a synchronous online format participated in group work during their scheduled class time using video conferencing software. These students were randomly assigned to groups at the beginning of each assignment using the Zoom breakout feature. Group membership was temporary and varied across the two assignments. After the Zoom sessions were launched, group membership was transferred into corresponding LMS homepages to facilitate communication and file sharing. Students in the asynchronous online lab received assignment instructions on Friday afternoons and were randomly assigned to LMS-based groups composed of other asynchronously participating students. These groupings were created by the instructor using a spreadsheet that ensured unique group compositions for each assignment. Students were responsible for coordinating group communication independently, using LMS features such as announcements, discussion boards, chat tools, and internal messaging, an approach supported by prior research on asynchronous collaborative learning strategies (Brindley et al., 2009). The LMS and course structure remained consistent across all

conditions, and the instructor remained the same for all students regardless of modality, ensuring internal validity through instructional consistency in line with guidance from quasi-experimental design literature (Shadish et al., 2002). This consistency ensured that variations in group experiences were due to lab collaboration modality and collaborative tool type, not instructional differences with course content delivery. The instructor provided detailed guidance and recommended strategies to support effective collaboration across all types of collaborative learning environments to all students in the course.

Participants

Participants in this dissertation study were enrolled in a required undergraduate business course, *Introductory Principles of Information Management*, during the Spring 2025 semester at a large public university in the Southeastern United States. Eligibility for inclusion required enrollment in the course and being at least 18 years of age at the time of participation. A total of 297 students participated in at least one component of the dissertation study. Eight students were removed due to incomplete survey responses, and an additional 47 were excluded because they changed either instructional modality or collaboration tool type use between the two collaborative assignments. Since the dissertation employed a 2×2 factorial design requiring consistent exposure to modality and technology conditions, these participants were excluded to preserve internal validity and ensure consistent exposure to the experimental conditions, as required by factorial design standards (Field, 2024; Shadish et al., 2002). Further details can be found in the Survey Response and Completion Rates section.

The final analytic sample included 242 students who completed both assignments and remained in the same instructional condition throughout the dissertation study period.

Demographic information was collected through a separate demographic survey administered at the beginning of the semester (see Appendix G). This survey captured details such as age, gender identity, race/ethnicity, prior experience with online learning, and frequency of group work. These variables were gathered to provide descriptive context for the analytic sample and to examine participant diversity, consistent with best practices in online learning research (Arbaugh, 2014; Allen & Seaman, 2017). No demographic variables were used to assign participants to groups or conditions.

Participants were categorized into one of four experimental quadrants based on their consistent modality (asynchronous or synchronous) and tool use (standard or concurrent update technology) as reported on the Small Group Collaboration Surveys I and II. This approach was used instead of relying on course registration data, to ensure that classification accurately reflected students' actual participation conditions, rather than administrative assignment. The final distribution across these quadrants was as follows:

- AS – Asynchronous with standard tools: 53 participants
- AC – Asynchronous with concurrent update tools: 43 participants
- SS – Synchronous with standard tools: 71 participants
- SC – Synchronous with concurrent update tools: 75 participants

This distribution provided sufficient power for between-group comparisons and reflected real-world participation conditions rather than imposed assignment. As detailed in the Power Analysis section below, the final sample size of 242 participants was sufficient to meet the assumptions for inferential testing and supported full implementation of the planned 2×2

factorial design. All procedures were approved by the Institutional Review Board (IRB) (IRB Protocol #UTK IRB-25-08690-XP), and informed consent was obtained from all participants prior to data collection.

Recruitment

Students were invited to participate in the dissertation after selecting their instructional modality for the lab portion of the *Introductory Principles of Information Management* course. Recruitment occurred in Week 5 of the semester, following final enrollment stabilization and IRB approval (UTK IRB-25-08690-XP). The recruitment process was conducted through a single channel: a Canvas course announcement posted by the course instructor (see Appendix A). Depending on each student's notification preferences, the message may have also been delivered via email. The announcement outlined the purpose of the dissertation and provided clear instructions for participation, including expectations for time commitment and the types of data that would be collected.

Follow-up reminders were also posted in Weeks 6 and 7 to encourage participation in the small-group collaboration surveys. All recruitment messages can be found in Appendix A.

Students were informed that participation would involve completing three online surveys and consenting to allow the researcher access to assignment scores for two collaborative lab activities and the course midterm exam. Although students enrolled in the in-person lab modality were eligible to participate and receive extra credit, their data were excluded from the final analyses due to differences in collaboration modality.

Participants who completed all three surveys and remained in the same collaboration modality for both assignments were eligible to receive up to 40 points of extra credit, as outlined

in the course syllabus. This incentive was applied equitably and aligned with university policies regarding optional assignments and voluntary research participation (Resnik, 2018; McMillian & Schumacher, 2010).

To participate, students accessed a secure Qualtrics link provided in the Canvas announcement. This link directed students to the demographic survey, which began with an electronic informed consent form (see Appendix B). Students were required to review and affirm their consent before proceeding. All participation was voluntary, and no students were penalized for choosing not to participate. All procedures were approved by the university's IRB and adhered to ethical guidelines for educational research with human participants.

Research Design

This dissertation used a quantitative, quasi-experimental design with partial randomization at the group level to examine collaborative learning in online higher education contexts. A quantitative approach was selected because it enabled statistical analysis of group-level and individual outcomes across controlled conditions. Specifically, this design supported: (a) statistical testing with increased analytical precision and efficiency (Eyisi, 2016); (b) generalizability to broader populations (Cohen & Morrison, 2017); (c) replicability of methods in future research (Shank & Brown, 2013); (d) group comparisons to enhance internal validity (Johnson & Christensen, 2024); and (e) reduced researcher influence through participant anonymity and procedural detachment (Lichtman, 2011; Creswell & Creswell, 2023). This approach aligned with the deductive logic of the dissertation, which tested theoretical predictions drawn from the Theory of Transactional Distance (Moore, 2013), the Community of Inquiry (CoI) framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976; Kreijns

et al., 2022).

To explore the effects of instructional modality and collaborative technology, the dissertation implemented a 2×2 factorial design. This structure supported comparison across four conditions defined by two independent variables: collaboration modality (asynchronous or synchronous) and tool type (standard tools or concurrent update technology). These two independent variables were selected based on their theoretical relevance to online collaboration and their potential to influence group dynamics, engagement, and learning outcomes. Participants were assigned to one of four conditions: Asynchronous with standard tools (AS) Synchronous with standard tools (SS) Asynchronous with concurrent update tools (AC) Synchronous with concurrent update tools (SC)

This design enabled the analysis of both main effects (e.g., differences due to modality or tool use) and interaction effects (e.g., whether the impact of tool type differed by modality). Multiple data sources, including structured surveys, assignment scores, and rubric evaluations, were used to measure academic performance, social presence, and collaborative processes (Creswell & Creswell, 2023; Teddlie & Tashakkori, 2009). Although students completed group assignments, all data were analyzed at the individual level, a common approach in educational research to ensure consistency in statistical testing (Johnson & Christensen, 2012). Because data were collected during regular instruction in a required course, the design preserved ecological validity while maintaining internal control over conditions (Shadish et al., 2002).

Quadrants and Modality Definitions

During the first week of the course, students selected their preferred lab modality after reviewing the course's objectives, policies, and emphasis on collaborative group assignments.

Once selected, modality assignments remained fixed through the midterm period. Although students were permitted to request a modality change after midterms with instructor approval, this policy did not affect the study, as all data collection occurred prior to that point. Students who did not consistently participate in the same modality across both collaboration assignments were excluded from the final dataset.

Participants were assigned to instructional quadrants based on two factors: (a) their group's collaboration modality (asynchronous or synchronous), and (b) the type of tools used to complete the assignments. Groups either used standard productivity software (Microsoft Word and Excel) or collaborative, concurrent update tools (Google Sheets and LucidChart). These combinations produced four instructional conditions, as shown in **Figure 1**:

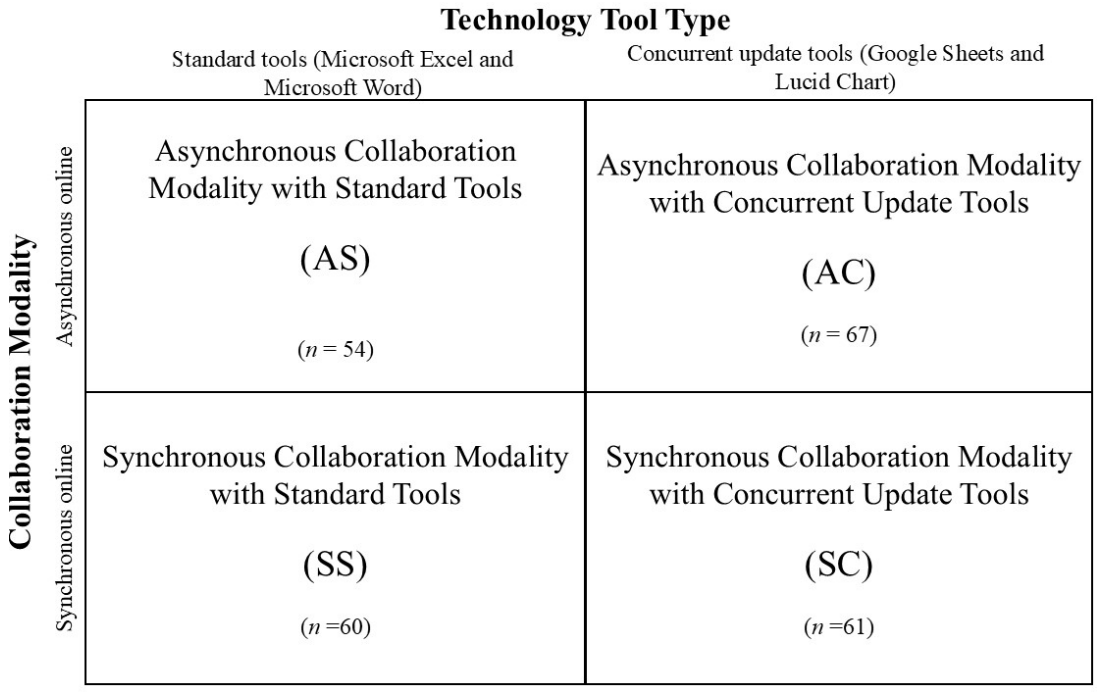


Figure 1

Participant Distribution Across Instructional Quadrants

Note. Each quadrant represents a unique combination of collaboration modality (asynchronous or synchronous) and technology tool type (standard or concurrent update). Standard tools included Microsoft Excel and Microsoft Word. Concurrent update tools included Google Sheets and Lucidchart. Total sample size: N = 242.

- Quadrant 1 – Asynchronous with Standard Tools (AS): Students collaborated asynchronously using standard tools. Group work was coordinated independently via LMS features.

- Quadrant 2 – Synchronous with Standard Tools (SS): Students met in real-time via video conferencing and used standard tools for assignment completion.

- Quadrant 3 – Asynchronous with Concurrent Update Tools (AC): Students collaborated asynchronously using shared documents (e.g., Google Sheets), without live interaction.

- Quadrant 4 – Synchronous with Concurrent Update Tools (SC): Students met synchronously via video conferencing and worked simultaneously in shared documents for real-time collaboration.

This design isolated the effects of both instructional modality and collaborative tool type on group processes and learner outcomes. Instructional consistency (same course content, instructor, and assessments) helped attribute differences to experimental conditions rather than pedagogical variation.

Group Assignment Procedures

Although this dissertation employed a quasi-experimental design without full random assignment to instructional conditions, measures were taken to preserve internal validity within each quadrant, consistent with recommendations for minimizing bias in quasi-experimental

research designs (Shadish et al., 2002). Students self-selected into asynchronous or synchronous formats at the beginning of the term. This type of self-selection is common in educational settings and can be addressed through randomization within conditions to help mitigate confounding variables (Gall et al., 2007).

Within each modality, random assignment procedures were used to form small groups for each collaboration task. Synchronous participants were assigned to breakout rooms using the Zoom platform's random grouping feature during weekly lab sessions. These groupings varied across assignments. Group membership was recorded by teaching staff and imported into the LMS. The use of video conferencing tools such as Zoom for collaborative group formation is supported in the literature as a practical and effective approach for synchronous learning environments (Hrastinski, 2008).

Asynchronous participants were grouped by the instructor using an Excel-based random generator that ensured students were not paired with the same classmates more than once. Assignments were posted weekly, and students were expected to coordinate independently using LMS communication tools. This strategy of varying group membership is supported by online learning literature, which notes that rotating partners can increase engagement and reduce groupthink (Brindley et al., 2009).

These assignment methods helped minimize selection bias and ensured that students consistently collaborated within their assigned modality and tool type. Together, these design decisions aligned with best practices in quasi-experimental educational research and helped preserve the internal consistency of each instructional condition (Shadish et al., 2002; Gall et al., 2007).

Sample Size and Power Analysis

To ensure the dissertation was adequately powered to detect statistically significant differences between instructional conditions, an a priori power analysis was conducted using G*Power 3.1.9.7 software (Faul et al., 2007). The planned analysis involved a two-way ANOVA to examine the interaction of instructional modality (asynchronous vs. synchronous) and technology use (standard vs. concurrent update tools) on measures of collaboration, social presence, and academic performance.

Assuming a medium effect size ($f = 0.25$), alpha = 0.05, and power = 0.80, the required sample was 128 participants (32 per group). The final sample included 242 students, exceeding the minimum threshold. This supported reliable detection of both main and interaction effects and justified the 2×2 factorial design. Participant exclusions, demographics, and quadrant distributions are detailed in the Participants section.

Procedures

This section outlines the procedures used to collect, manage, and protect the data analyzed in this dissertation. It describes the timing of data collection, institutional oversight, survey distribution methods, assignment scoring, participant inclusion criteria, and steps taken to ensure anonymity and data integrity. All procedures were designed to reflect normal course activity while maintaining rigorous research and ethical standards.

Ethical Approval and Semester Timeline

This dissertation followed a structured data collection plan designed to protect participant confidentiality, uphold ethical research standards, and preserve the statistical assumption of

independent observations. All data were collected during the Spring 2025 semester and reflected regular course activity to ensure ecological validity. Each participant completed surveys and assignments individually, with no opportunity for collaboration, discussion, or access to others' responses during the data collection period. This approach ensured that every data point reflected a unique and independent perspective, reducing the potential for common method bias and enhancing the integrity of quantitative analysis (Gall et al., 2007; Field, 2024; Podsakoff et al., 2003).

Institutional Review Board (IRB) approval was granted before the start of data collection (UTK IRB Protocol #25-08690-XP, approved February 19, 2025; see Appendix L). All procedures adhered to university research policy and best practices for human subjects' research (Resnik, 2018; McMillan & Schumacher, 2010). The Demographic Survey opened on February 21, and the final post-assignment survey closed on March 24. The midterm exam occurred on March 14, after both collaborative assignments were completed. Assignment and exam scores were provided to the researcher by the course instructor on April 18.

Data Collection Platforms and Security Measures

To preserve the independence of observations, all instruments were completed individually. Students had no access to other participants' responses, and collaboration on surveys or exams was not possible. This approach ensured that each data point reflected an individual student's experience, aligning with best practices for quantitative analysis.

All survey instruments were administered via Qualtrics using Single Sign-On (SSO) authentication. This process linked each response to a unique university identifier (NetID), allowing the researcher to associate survey responses with assignment and exam performance.

Students were required to review and electronically sign the informed consent form before accessing the first survey.

Assignment and Survey Administration

Following completion of Small Group Collaboration Assignment I, students completed Small Group Collaboration Survey I via Qualtrics. Assignment scores were returned to students through the LMS, and the instructor shared anonymized data with the researcher, including final rubric scores linked to student identifiers. The same process was repeated for Small Group Collaboration Assignment II and Small Group Collaboration Survey II. Although rubrics were identical for both assignments, the researcher only received final scores; disaggregated sub-criteria were not accessible.

The course midterm exam was administered on March 14. The instructor provided total midterm scores as well as a subset of item-level scores associated with topics covered in the collaborative assignments. These scores were integrated with the survey data for later analysis.

Survey Response and Completion Rates

The course had an enrollment of 1,264 students, all of whom were invited to participate. A total of 819 students completed at least one survey, and 726 students completed all three surveys. Of these, 437 were enrolled in face-to-face modality and were excluded from this dissertation. Of the remaining 297 online participants, 8 were removed for submitting incomplete surveys (defined as more than 20% missing data). An additional 47 participants were excluded due to switching modalities (n = 6) or technology types (n = 41) between assignments. This left a final analytic sample of 242 students who: (a) remained in a consistent online collaboration modality, (b) used the same type of tech tool for each of the two measured assignments, (c)

completed all three surveys, and (d) completed both assignments and the midterm exam.

Participation Incentives and Alternative Assignment

To encourage participation, students were offered 40 points of extra credit if they: (a) completed all three surveys, (b) completed both assignments in the same instructional modality, and (c) took the midterm exam. Eligibility was confirmed on April 11. Students who did not qualify were provided with an alternative assignment of equivalent time and effort, involving reflection on four pre-selected TED Talks. Full instructions for the alternative assignment are included in Appendix N. A total of 90 students submitted the alternative assignment; 49 received credit, and 41 were disqualified due to noncompliance with instructions, including use of AI tools despite a clear prohibition in the prompt.

Final Data Processing and Anonymization

At the conclusion of the semester, all identifiable information (NetIDs) was removed from the final dataset. NetIDs were retained only to ensure proper awarding of extra credit and were never associated with names or email addresses. The final analytic dataset used for statistical analysis contained no personally identifiable information and was stored securely in accordance with university policy.

Data Collection Instruments and Measures

This dissertation utilized multiple instruments to gather data related to student collaboration, technology use, and academic performance in online learning environments. These instruments included two collaborative assignments, a midterm exam, and three structured surveys administered through Qualtrics. Each instrument was selected to support quantitative

analysis and reflected best practices in educational measurement design (Creswell & Guetterman, 2024; Field, 2024). While this section provides an overview of instrument design and implementation, theoretical alignment and construct mapping are presented separately in the following section, supported by **Tables 2 through 7.**

Collaborative Assignment Design and Implementation

Students completed two small group collaborative assignments during the first half of the semester. Small Group Collaboration Assignment I required students to collaboratively model operational data for a retail business using spreadsheet software. Small Group Collaboration Assignment II involved creating a conceptual data model to visualize database relationships using the same business scenario. Both assignments were designed to simulate authentic teamwork experiences and promote interdependence among group members, consistent with instructional design practices in collaborative learning (Laal & Ghodsi, 2012).

Assignments were distributed as part of asynchronous lab modules and were accompanied by guided video instructions. Students in the concurrent update conditions received tutorials specific to Google Sheets or LucidChart. Those in the standard conditions used Excel or Word and were provided with foundational instruction only. It was assumed that students had prior knowledge of standard tools based on prerequisite coursework.

Templates were embedded within the assignment instructions to support consistency and guide group interaction. Screenshots of these templates are included in Appendix C (Small Group Collaboration Assignment I) and Appendix E (Small Group Collaboration Assignment II).

Each assignment was assessed using a standardized rubric, which evaluated submissions

on four primary criteria: (a) attainment of learning objectives, (b) content quality and creativity, (c) adherence to instructions, and (d) evidence of collaboration. The rubrics used a four-point performance scale (Needs Improvement, Approaches Expectations, Meets Expectations, Exceeds Expectations) and were identical across conditions. Full rubric details are provided in Appendix D (Small Group Collaboration Assignment I) and Appendix F (Small Group Collaboration Assignment II). Although each submission was evaluated using the full rubric, only final scores were available to the researcher; sub-criteria were not disaggregated.

Mid-Term Exam Description

The midterm exam served as an additional objective performance measure. It consisted of 50 multiple-choice questions and was administered through the course LMS. Ten items were linked to topics covered in the two collaborative assignments, five per assignment, to assess targeted content retention. These items were interspersed among general course questions and were not labeled as assignment-specific during the exam. This design supported internal validity by reducing potential testing bias (Brown, 2001).

Both the total midterm score and the subset of assignment-related questions were retained for analysis. These scores were later integrated with survey responses and assignment scores to evaluate differences across instructional modality and technology condition.

Survey Instruments

Three surveys were used to capture student demographic characteristics, perceptions of collaboration, tool use, and learning experiences. All surveys were hosted on Qualtrics and delivered via the university's secure Single Sign-On (SSO) platform. The instruments were reviewed for clarity and content validity by the dissertation committee and several experienced

educators. Usability testing was conducted with 16 graduate teaching assistants to ensure technical accuracy and ease of completion.

Each survey took approximately 15 to 20 minutes to complete and was designed using primarily Likert-scale items. Several items were reverse coded to reduce acquiescence bias and improve response reliability (Podsakoff et al., 2003; Schwarz, 1999). Full item texts, scale labels, and reverse-coded indicators are documented in the codebook provided in Appendix K.

Demographic Survey

The Demographic Survey included 26 items related to student background characteristics and prior learning experiences. Questions addressed age, gender, ethnicity, academic major, employment status, and prior exposure to online courses and collaboration technologies. The survey also included Likert-scale items on students' self-reported confidence with standard and concurrent tools. These data supported sample description, assumption testing, and contextual interpretation of later findings. The full survey instrument is available in Appendix G.

Small Group Collaboration Survey I

Administered after Small Group Collaboration Assignment I, this 66-item survey captured students' perceptions of their collaboration experience, tool use, and learning outcomes. Students also reported their assigned modality and tool type for that assignment. The survey incorporated a combination of original and adapted items, including:

- Items measuring social and cognitive presence adapted from the CoI framework (Garrison et al., 2000).
- Items from the Theory of Transactional Distance assessing dialogue, structure, and

learner autonomy (Moore & Diehl, 2019).

- Items grounded in Social Presence Theory, including dimensions of immediacy, co-presence, and interpersonal connection (Gunawardena, 1995; Tu & McIssac, 2002).
- Items evaluating tool usability and perceived group effectiveness, developed to reflect practical experiences with collaborative technologies.

Survey items and their theoretical alignment are summarized in Tables 2 through 7 and are discussed in detail in the next section. While open-ended items were included in the instrument, they were excluded from this dissertation's analysis to maintain alignment with the quantitative research design. The full instrument is provided in Appendix H.

Small Group Collaboration Survey II

Small Group Collaboration Survey II replicated the structure of Small Group Collaboration Survey I and was administered after Small Group Collaboration Assignment II. It included the same 66 items, using identical language and response formats to support longitudinal comparison across assignments. As with Small Group Collaboration Survey I, students identified their assigned modality and tool use. The full survey instrument is located in Appendix I.

Construct Development and Theoretical Mapping

Survey items were aligned with theoretical constructs derived from the Theory of Transactional Distance (Moore, 2013), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976). Items were organized into composite variables where appropriate. Each composite contained between three and seven Likert-Scale items, and all

composites were tested for reliability in Chapter 4. Composite development followed established practices for Likert-based scale construction, including internal consistency testing using Cronbach's alpha (Gliem & Gliem, 2003). Variables containing fewer than three items were retained as single-item indicators when justified by strong theoretical rationale or empirical uniqueness.

Some items appeared in more than one construct, reflecting the interwoven nature of structure, dialogue, and presence in collaborative learning environments. For example, Question 53 appears in both surveys and is included in the composite for "Cognitive Presence – Learning Engagement and Transfer" (used for Research Question 3). It is also used as a single-item indicator of perceived academic performance in Research Question 2. This approach is supported by content validity frameworks that recognize the functional overlap between related constructs in educational settings (Haynes, Richard, & Kubany, 1995; Messick, 1995). This dual use is noted in the construct alignment tables below and further discussed in Chapter 4 (see Appendix M for a cross-construct mapping of overlapping survey items).

Instrument Alignment with Research Questions

The three research questions guiding this dissertation were supported by multiple data sources, including collaborative assignment scores, midterm exam results, and survey responses. T**able 2** outlines the alignment between each research question and the relevant data collection instruments. Theoretical mappings for each construct are addressed in subsequent tables.

Table 2.

Research Questions and Data Collection Instrument Alignment

Research Question	**Sub-Part**	**Data Collection Instrumen*t(*s)**
RQ1**:** Do students' academic performance measures change based on:	a) Modality	- Small Group Assignment I Score (Appendix D) - Small Group Assignment II Score (Appendix F) - Mid-Term Exam Score
	b) Use of concurrent update technology	- Same as RQ1a
	c) Interaction of modality and technology	- Same as RQ1a
RQ2: Do learners' perceptions of performance change based on:	a) Modality	- Demographic Survey (Appendix G) - Small Group Collaboration Survey I (Appendix H) - Small Group Collaboration Survey II (Appendix I)
	b) Use of concurrent update technology	- Same as RQ2a
	c) Interaction of modality and technology	- Same as RQ2a
RQ3: Do learners' collaborative experiences change based on:	a) Modality	- Demographic Survey (Appendix G) - Small Group Collaboration Survey I (Appendix H) - Small Group Collaboration Survey II (Appendix I)
	b) Use of concurrent update technology	- Same as RQ3a
	c) Interaction of modality and technology	- Same as RQ3a

Construct Definitions and Summary

Constructs were organized by theoretical framework to support the multidimensional analysis of academic performance, perceived learning, and group experience. Definitions, theoretical justifications, and variable alignments are provided in **Table 3**. Composite variables are marked with an asterisk (*). Full item mappings and reliability statistics are detailed in Appendix K, and survey item labels are listed in the dissertation codebook (Appendix J).

Table 3:
Constructs and Theoretical Mappings

Construct	Definition	Justification	Variables in construct	Aligned Research Questions
Theory of Transactional Distance				
Structure	Perceived organization and clarity of the group work environment	Helps explain differences in support, clarity, and role definition across group assignments	Structure - Concurrent Update Tools & Overall, Structure - Standard Tools & Overall*, Overall_Course_Structure_Managing_Learning	RQ2a–c, RQ3a-c
Dialogue	Perceived quality and frequency of meaningful exchanges that support collaborative learning	Central to understanding how communication (or lack thereof) reduces or increases transactional distance; critical in environments using real- time tools that may not guarantee interaction	No_Interaction	RQ3a-c
Learner Autonomy	Perceived ability of students to direct and regulate their own learning process	Theory of Transactional Distance posits that autonomy becomes more critical when structure and dialogue are low. This construct captures students' perceived control over their learning.	Overall_Course_Empowerment	RQ2a-c

Table 3: Continued

Construct	Definition	Justification	Variables in construct	Aligned Research Questions
Tool Enabled Learning	Perceived value of concurrent update technology (e.g., Google Sheets) in supporting learning and reflection	Highlights the role of tool features in shaping dialogue and enhancing learning, especially when comparing asynchronous vs. real-time collaboration	Enhanced_Learning_Comparison_of_Tools	RQ2a-c
Community of Inquiry Framework				
Cognitive Presence	Degree to which learners engage in meaning-making and reflection	Captures the depth of student engagement and perceived knowledge construction within the group	Cognitive Presence - Group Functioning and Conflict Resolution*, Cognitive Presence - Learning Engagement and Transfer*, Cognitive Presence - Social Cognitive Learning with Peers*, Cognitive Presence - Tool Enabled Collaboration and Learning - Concurrent Update*, Cognitive Presence - Tool Enabled Collaboration and Learning – Standard*	RQ2a–c, RQ3a-c
Social Presence	Perception of interpersonal connection and emotional expression in the group	Directly measured through Likert-scale items focused on group trust, cohesion, and responsiveness	Social Presence - Affective and Relational Connection*	RQ2a–c, RQ3a-c

Table 3: Continued

Construct	Definition	Justification	Variables in construct	Aligned Research Questions
Social Presence Theory				
Immediacy	Perceived ability to communicate in real-time and feel seen/heard	Supports analysis of synchronous vs. asynchronous differences in interaction style	Social Presence - Group Interaction and Participation*	RQ2a–c, RQ3a-c
Interpersonal Connection	Perception that group members recognize, respond to, and support one another during collaboration	Captures emotional and relational engagement among peers, aligning with the affective and cohesive elements of Social Presence in the CoI framework	Social Presence - Group Interaction and Participation*, Social Presence - Affective and Relational Connection*	RQ3a-c
Design and Outcome Variables – Specific to this Dissertation Study Context				
Academic Perceived Performanc e (Self- report)	Students' self assessment of learning outcomes and learning gains	Outcome variable based on perceived academic achievement across group collaborations	Overall_Course_Grou ps_Improved_Grades, Overall_Course_Grou ps_Performance, Overall_Course_Empo werment	RQ2a-c
Real-Time Collaboratio n Tools	Perceptions of tool features that enable or hinder concurrent collaboration	Contextual variable reflecting the implementation of collaborative technology and its perceived impact	Real-Time Collaboration Tools Concurrent Update*, Real-Time Collaboration Tools Standard*	RQ2a–c, RQ3a-c

Note: Asterisk (*) indicates composite variables; all others are single-item indicators.

Construct Operationalization and Theoretical Alignment

To ensure conceptual consistency and methodological rigor, this dissertation mapped each survey item to constructs derived from three foundational theoretical frameworks: the Theory of Transactional Distance (Moore, 2013), the Community of Inquiry (CoI) framework (Garrison, Anderson, & Archer, 2000), and Social Presence Theory (Short, Williams, & Christie,

1976). While the theoretical foundations for each construct were discussed in detail in Chapter 2, this section revisits each framework briefly to explain how specific variables were operationalized for analysis and aligned with the dissertation's research questions. These frameworks served as the foundation for variable development and instrument design, supporting a theory-driven approach to both analysis and interpretation. This multi-framework strategy reflects current practice in distance education research, where hybrid constructs are often necessary to capture complex learning environments (Walker & Fraser, 2005). To address the unique context of technology integration in group collaboration, a fourth construct related to Real-Time Collaboration Tools was also developed, grounded in literature on technology-mediated learning and instructional design (Clark & Mayer, 2023; Hrastinski, 2008).

Each construct was operationalized using Likert-scale items drawn from post-assignment student surveys. When a construct was measured using multiple items with theoretical and empirical cohesion, a composite variable was created by calculating the average of the relevant responses. This operationalization aligns with best practices in educational measurement and theoretical instrument development (DeVellis & Thorpe, 2021; Boone et al., 2014; Gliem & Gliem, 2003). Composite development was guided by established practices in survey-based educational research and verified through internal consistency testing using Cronbach's alpha. Items that met theoretical expectations but could not be reliably aggregated were retained as single-item indicators when justified. A full summary of composite structures and reliability statistics appears in Appendix K, and detailed survey item mappings and variable labels are provided in the dissertation codebook (Appendix J).

Tables 4 through 7 summarize the theoretical alignment of each construct. These tables

identify the specific survey items associated with each variable, indicate whether the item was included in a composite or used as a stand-alone indicator, and clarify how each construct connects to the dissertation's research questions. The inclusion of both composite and overlapping constructs reflects a multidimensional model of collaborative learning aligned with recent applications of the CoI framework (Akyol & Garrison, 2011). Organizing the construct mappings by theoretical framework ensures transparency in measurement strategy and strengthens the link between theory and empirical analysis.

Theory of Transactional Distance

The Theory of Transactional Distance (Moore, 2013) offers a foundational framework for understanding the pedagogical and psychological space that separates learners and instructors in distance education. This distance is shaped by three interrelated elements: dialogue, structure, and learner autonomy. All three constructs were measured as part of this dissertation and tested through student survey responses.

Structure refers to the degree to which course materials, instructional guidance, and expectations are logically organized, explicitly communicated, and consistently delivered. In collaborative group contexts, structure also encompasses clearly defined roles, task division, and the overall scaffolding used to support group processes (Moore & Kearsley, 2012; Chen, 2001). Items capturing this construct addressed students' perceptions of role clarity, group guidelines, and the organizational support provided by collaborative tools. High levels of structure can reduce ambiguity and mitigate the effects of limited instructor involvement, particularly in asynchronous environments where real-time feedback may be unavailable (Falloon, 2011b; Borup et al., 2014).

Learner autonomy is defined as students' perceived capacity to manage, direct, and regulate their own learning behaviors and contributions (Moore, 1993). Autonomy becomes particularly significant when dialogue is limited or when course structure provides minimal external guidance. This construct was operationalized through items measuring students' perceived empowerment, initiative, and ability to manage their learning in group contexts.

Dialogue, the third element of transactional distance, refers to the extent and quality of interaction between learners and instructors or among peers. In this dissertation, dialogue was measured through students' perceptions of interaction frequency and the presence or absence of real-time communication during group work. This construct was treated as a single-item indicator, based on its theoretical alignment with Moore's framework and practical relevance to collaborative tool use.

Survey items aligned with these constructs assessed perceptions of instructional clarity, group expectations, technological scaffolding, peer interaction, and individual initiative. These variables were mapped to multiple components of Research Questions 2 and 3, supporting analysis of how students' perceptions of structure, dialogue, and autonomy varied across instructional modalities and collaborative technology conditions. Reliability of composite variables is reported in Chapter 4, and operationalized constructs are summarized in **Table 4**.

Table 4:

Survey Questions Grounded in the Theory of Transactional Distance

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_09 & S2_09	Google Sheets (LucidChart) was well-suited to supporting asynchronous collaboration, where team members work independently at different times and/or places.	Suited_Asynchronous_Concurrent	Structure	Yes	RQ3a-c
S1_11 & S2_11	Even though Google Sheets (LucidChart) allowed us to contribute at the same time to the assignment, my group still did most of the assignment without direct interaction or communication.	No_Interaction_Concurrent	Dialogue	No	RQ3a-c
S1_14 & S2_14	Using Google Sheets (LucidChart) helped me to learn more from this assignment than if I had used another software that did not have live updating.	Enhanced_Learning_Comparison_of_Tools_Concurrent	Tool Enabled Learning	No	RQ2a-c

Table 4: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_17& S2_17 S1_29 & S2_29	The communication tools we chose are well-suited to supporting our collaboration, even when team members work independently at different times and/or places.	Other_Communication_Supports_Asynchronous	Structure	Yes	RQ3a-c
S1_21 & S2_21	Excel (Word) was well-suited to supporting asynchronous collaboration, where team members work independently at different times and/or places.	Suited_Asynchronous_Standard	Structure	Yes	RQ3a0c
S1_23& S2_23	Even though the assignment focused on collaboration, my group still did most of the assignment without direct interaction or communication.	No_Interaction_Standard	Dialogue	No	RQ3a-c
S1_26& S2_26	Using Google Sheets (LucidChart) would have helped me to learn more from this assignment than using Excel (Word) that did not have live updating.	Enhanced_Learning_Comparison_of_Tools_Standard	Tool Enabled Learning	Yes	RQ2a-c
S1_30 & S2_30	Finding my role within group assignments has been easy.	Overall_Course_Groups_Role	Structure	Yes	RQ3a-c

Table 4: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_32 & S2_32	The course encourages group members to take responsibility for their work within the team.	Overall_Course_Groups_Responsibility	Structure	Yes	RQ3a-c
S1_37 & S2_37	The design of the course and the group activity guidelines have allowed us to work as a team more effectively.	Overall_Course_Guidelines_Team_Effectiveness	Structure	Yes	RQ3a-c
S1_38 & S2_38	The use of technology in our group work ensures that communication is clear and reduces the chance of miscommunication.	Overall_Course_Groups_Tech_Communicati on	Structure	Yes	RQ3a-c
S1_48 & S2_48	The online tools (e.g., group homepages, shared documents, breakout rooms) help us clearly assign roles and responsibilities	Overall_Course_Groups_Tools_Roles	Structure	Yes	RQ3a-c
S1_53 & S2_53	I feel empowered to direct my own learning process in this online course due to the technology and course structure.	Overall_Course_Empowerment	Learner Autonomy	No	RQ2a-c, RQ3a-c
S1_58 & S2_58	The course structure makes it easy for me to stay on track and manage my learning.	Overall_Course_Structure_Managing_Learni ng	Structure	No	RQ3a-c

Community of Inquiry Framework

The CoI framework (Garrison et al., 2000) provides a well-established model for understanding how meaningful learning occurs in online environments. It consists of three core elements: cognitive presence, social presence, and teaching presence. This dissertation focused on cognitive presence and social presence, as both are directly related to collaborative learning and student interaction within the small group assignments.

Teaching presence, the third component of the CoI framework, was not included in this dissertation because the instructional materials, guidance, and assessments were held constant across all study conditions. As such, variation in perceived teaching presence was not a focus of this analysis. Because instructor involvement and course structure were held consistent across all conditions, this dissertation was able to focus specifically on how collaboration modality and technology use shaped cognitive and social dimensions of student experience. This design choice is consistent with prior studies that analyzed selected elements of the CoI framework when instructional variation was minimal (Akyol & Garrison, 2011; Shea & Bidjerano, 2009).

Cognitive presence refers to the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse (Garrison et al., 2001). In this dissertation, cognitive presence was operationalized using Likert-scale items that captured students' perceived engagement, transfer of learning, peer interaction, and the role of collaborative tools in supporting group thinking. Composite variables were created where item clusters demonstrated theoretical and empirical cohesion. This construct was critical for evaluating whether students viewed their group work as intellectually meaningful and whether the tools used contributed to deeper learning processes. This approach aligns with prior CoI-based studies that have

emphasized reflection, resolution, and knowledge construction in small group contexts (Akyol & Garrison, 2011; Shea & Bidjerano, 2009).

Social presence, by contrast, involves the extent to which learners feel socially and emotionally connected to others in the learning environment. It includes dimensions such as interpersonal trust, communication climate, emotional expression, and overall group cohesion (Richardson & Swan, 2003; Garrison, 2008). In the context of online group work, especially when mediated through asynchronous platforms or collaborative tools, the presence or absence of social presence can significantly influence collaboration quality, learner satisfaction, and group outcomes (Lowenthal & Dunlap, 2020; Ke, 2013).

Social presence, by contrast, involves the extent to which learners feel socially and emotionally connected to others in the learning environment. It includes dimensions such as interpersonal trust, communication climate, emotional expression, and overall group cohesion (Richardson & Swan, 2003; Garrison, 2008). In the context of online group work, especially when mediated through asynchronous platforms or collaborative tools, the presence or absence of social presence can significantly influence collaboration quality, learner satisfaction, and group outcomes (Lowenthal & Dunlap, 2020; Ke, 2013). For this dissertation, social presence was operationalized through survey items measuring affective connection, peer responsiveness, perceived support, and relational cohesion. Where appropriate, these items were combined into composite variables, tested for internal reliability, and used as key indicators in Research Questions 2 and 3.

Together, these constructs support a multidimensional analysis of learners' collaborative experiences and perceptions of learning outcomes. A full mapping of survey items to the

cognitive and social presence constructs is provided in **Table 5.**

Table 5:

Survey Questions Grounded in the Community of Inquiry Framework

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_06 & S2_06	Using Google Sheets (LucidChart) improved my ability to collaborate with peers for this assignment.	Improved_ Collaborati on_Concur rent	Cognitive Presence	Yes	RQ3a-c
S1_08 & S2_08	Using Google Sheets (LucidChart) for this group assignment would have allowed me to collaborate effectively with my group even in a different modality from mine (asynchronous, synchronous or in person).	Effective_ Collab_All _Modalitie s_Concurr ent	Cognitive Presence	Yes	RQ3a-c
S1_12 & S2_12	Using Google Sheets (LucidChart) improved our overall performance on the assignment.	Improved_ Performan ce_Concur rent	Cognitive Presence	Yes	RQ3a-c

Table 5: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_18 & S2_18	Using Excel (Word) to complete the assignment improved my ability to collaborate with peers.	Improved_ Collaborati on_Standar d	Cognitive Presence	Yes	RQ3a-c
S1_20 & S2_20	Using Excel (Word) for this group assignment would have allowed me to collaborate effectively with my group even in a different modality from mine (asynchronous, synchronous or in person).	Effective_ Collab_All _Modalitie s_Standard	Cognitive Presence	Yes	RQ3a-c
S1_24 & S2_24	The features of Excel (Word) improved our overall performance on the assignment.	Improved_ Performan ce_Standar d	Cognitive Presence	Yes	RQ3a-c
S1_31 & S2_31	Overall, group leaders struggle to coordinate our using online tools and communication platforms (Group Chat, email, Canvas, etc.).	Overall_C ourse_Gro ups_Leade r_Struggle _Reverse_ Coded	Cognitive Presence	Yes	RQ3a-c

Table 5: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_33 & S2_33	The technologies we use for group work contributed to misunderstandings or conflicts within the group.	Overall_Course_Groups_Tech_Conflict_Reverse_coded	Cognitive Presence - Group Functioning and Conflict Resolution	Yes	RQ3a-c
S1_35 & S2_35	My group members have given me support, help, and encouragement at times when it was necessary.	Overall_Course_Groups_Support	Social Presence	Yes	RQ3a-c
S1_36 & S2_36	I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.	Overall_Course_Groups_Trust	Social Presence	Yes	RQ3a-c
S1_39 & S2_39	Technology helps our group reach consensus more effectively during decision- making processes.	Overall_Course_Groups_Consensus	Cognitive Presence	Yes	RQ3a-c
S1_41 & S2_41	The technology we use in group work makes it harder to resolve conflicts or disagreements.	Overall_Course_Groups_Tech_Resolve_Conflict_Reverse_Coded	Cognitive Presence	Yes	RQ3a-c

Table 5: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_42 & S2_42	The online tools we use hinder the group's ability to reach consensus during decision-making.	Overall_Course_Groups_Consensus_Reverse_Coded	Cognitive Presence	Yes	RQ3a-c
S1_44 & S2_44	Participating in the group assignments was valuable in helping me appreciate different perspectives.	Overall_Course_Groups_Perspective	Cognitive Presence	Yes	RQ3a-c
S1_45 & S2_45	Teamwork has contributed to making me feel more involved in studying the subject.	Overall_Course_Groups_Involvement	Social Presence	Yes	RQ3a-c
S1_46 & S2_46	I have learned more interacting with my teammates than when I work alone.	Overall_Course_Groups_Interaction	Cognitive Presence	Yes	RQ3a-c
S1_49 & S2_49	The time I have spent forming groups and meeting group members has been time well spent as I have learned from the group interactions.	Overall_Course_Forming_Groups	Social Presence	Yes	RQ3a-c

Table 5: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_50 & S2_50	Working in teams has benefited my learning because I am able to see various viewpoints and add my knowledge to others.	Overall_Course_Viewpoints	Cognitive Presence	Yes	RQ3a-c
S1_51 & S2_51	The Learning Management System (Canvas) setup used in this course provides clear structure and guidelines, which help reduce barriers between me and the course content.	Overall_Course_LMS_Structure	Cognitive Presence	Yes	RQ3a-c
S1_52 & S2_52	The ability to communicate directly with my instructor and GTAs through the online tools (like Canvas or Zoom) makes me feel more connected to the course.	Overall_Course_Connection_to_Instructor	Cognitive Presence	Yes	RQ3a-c

Table 5: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_53 & S2_53	I feel empowered to direct my own learning process in this online course due to the technology and course structure.	Overall_Course_Empowerment	Cognitive Presence	Yes	RQ2a-c, RQ3a-c
S1_54 & S2_54	Getting to know other course participants through collaborative assignments gave me a sense of belonging in the course.	Overall_Course_SOB	Social Presence	Yes	RQ3a-c
S1_55 & S2_55	I felt comfortable interacting with other course participants during group activities.	Overall_Course_Group_Comfort	Social Presence	Yes	RQ3a-c
S1_56 & S2_56	I felt motivated to explore content-related questions.	Overall_Course_Motivation	Cognitive Presence	Yes	RQ3a-c
S1_57 & S2_57	Engaging with the course content and the group assignments helped me understand fundamental concepts in this class and increase my performance on assignments.	Overall_Course_Groups_Performance	Academic Performance (Self- report)	No	RQ2a-c

Table 5: Continued

Question Number	Full Survey Text	Variable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_59 & S2_59	Course activities piqued my curiosity.	Overall_Course_Curiosity	Cognitive Presence	Yes	RQ3a-c
S1_60 & S2_60	I can apply the knowledge created in this course to my work or other non-class-related activities.	Overall_Course_Knowledge_Transfer	Cognitive Presence	Yes	RQ3a-c

Social Presence Theory

Social Presence Theory (Short et al., 1976) provides an important theoretical foundation for understanding how emotional and interpersonal dynamics influence communication in mediated environments. This theory defines social presence as the degree to which a person is perceived as a real individual within a communication exchange. It emphasizes the importance of immediacy, intimacy, and affective expression in shaping learners' sense of connection and comfort with others during interaction (Gunawardena, 1995; Tu & McIsaac, 2002). Unlike the broader conceptualization of social presence in the CoI framework, Social Presence Theory focuses more narrowly on the psychological and affective experience of mediated communication.

In this dissertation, Social Presence Theory informed the development of two constructs: immediacy and interpersonal connection. These constructs reflect affective and relational dimensions closely tied to real-time responsiveness and perceived presence in group settings (Tu & McIsaac, 2002). Immediacy was operationalized through items assessing responsiveness, ease of interaction, and the feeling of being acknowledged in group exchanges. Interpersonal

connection was measured through indicators of emotional engagement, peer attentiveness, and supportive group dynamics. Each construct was represented through multi-item composites, where justified, and tested for internal reliability as reported in Chapter 4.

These variables provided insight into how students experienced the collaborative process, particularly in relation to technology-mediated conditions. They were especially useful for interpreting whether different tool types and instructional modalities influenced students' affective engagement and sense of belonging. Both constructs were informed by theoretical definitions and applied in alignment with best practices in survey research (DeVellis & Thorpe, 2021; Boone et al., 2014). These constructs were applied in analyses addressing Research Questions 2 and 3, which examined perceived performance and collaborative experience across modality and technology conditions. Because immediacy and emotional connection are often influenced by tool affordances and temporal constraints, especially in asynchronous environments, these constructs helped explain potential differences in social dynamics across conditions (Richardson & Swan, 2003; Biocca et al., 2003).

Table 6 provides a detailed mapping of each construct and its corresponding survey items. The table indicates which items were included in composite variables, identifies their alignment with research questions, and categorizes them as representing immediacy, interpersonal connection, or related self-perceptions.

Table 6:

Survey Questions Grounded in the Social Presence Theory

Question Number	l Survey Text	'ariable Name	Construct	Included in Composite Variable	Aligned Research Questions
S1_34 & S2_34	The technologies for group work used allowed me to establish personal connections with the members of my team.	Overall_Course_Groups_Tech_Connection	Interperson al Connection	Yes	RQ3a-c
S1_40 & S2_40	Technology helps ensure that everyone's voice is heard in group discussions and activities.	Overall_Course_Groups_Tech_Discussion	Immediacy	Yes	RQ3a-c
S1_43 & S2_43	I felt that my point of view was acknowledged by other members of my groups.	Overall_Course_Groups_POV	Interperson al Connection	Yes	RQ3a-c
S1_47 & S2_47	Interacting with my teammates, I have improved the grades I would have obtained working individually on the task.	Overall_Course_Groups_Improved_Grades	Academic Performan ce (Self- report)	No	RQ2a-c

Note: Additional survey items (e.g., D_22 and select demographic measures) were grounded in Social Presence Theory but were excluded from the statistical analyses. Immediacy and interpersonal connection were each measured using items from both post- assignment surveys. Full definitions of composite variables and reliability statistics are provided in Appendix K.

Real-Time Collaboration Tools Mapping

Given the central role of collaborative tools in this dissertation's intervention, a distinct

construct was developed to assess students' experiences with real-time platforms such as Google Sheets and LucidChart. Although this construct is not grounded in a formal theoretical model, it is supported by instructional design and computer-supported collaborative learning (CSCL) literature. Prior research emphasizes that real-time tools, particularly those offering concurrent update functionality, can improve task coordination, reduce transactional friction, and enhance learners' sense of shared presence in digital environments (Hrastinski, 2008; Clark & Mayer, 2023; Suthers, 2012). CSCL scholars have emphasized the importance of shared digital workspaces in supporting joint problem solving and group cognition, highlighting how visibility into peer contributions facilitates mutual understanding and co-construction of knowledge (Roschelle & Teasley, 1995; Dillenbourg, 1999b). Additionally, Jeong and Hmelo-Silver (2016) identified seven affordances of technology-supported collaboration, including visibility of others' work, immediacy of feedback, and shared focus, which are directly relevant to concurrent update tools and how learners interact within them. These ideas are foundational to this dissertation's focus on collaboration mediated by concurrent update tools.

To capture this construct empirically, survey items were developed to reflect how students experienced tool-enabled collaboration in terms of performance, learning, and communication efficiency. Specific items targeted features such as simultaneous editing, real-time visibility of peer contributions, and the ease of establishing interpersonal connections through shared platforms. This practical approach reflects findings from Chapter 2, which show that tools like Google Docs and Lucidchart can enhance group participation and immediacy. However, their effectiveness depends on thoughtful instructional design to ensure that collaboration is both equitable and meaningful (Lee & Hassell, 2021; Demissie et al., 2025).

Kreijns et al. (2003) further emphasize that social interaction does not emerge automatically in online learning environments; rather, it is shaped by how collaborative tools are implemented and supported. The affordance-based framework proposed by Jeong and Hmelo-Silver (2016) reinforces this view by arguing that technology must be purposefully integrated to support productive interaction, rather than assumed to improve collaboration by default.

Two separate sets of items were included: one for concurrent update tools (Google Sheets and LucidChart) and one for standard tools (Microsoft Excel and Microsoft Word). This distinction was essential to the dissertation's 2×2 factorial design, allowing for comparative analysis of students' experiences across both tool types. As explained in Chapter 2, concurrent update tools offer distinct affordances that are not present in standard applications, particularly in asynchronous environments where immediacy and mutual awareness are otherwise difficult to achieve (Zheng et al., 2016; Reguera & Lopez, 2021). Several items overlapped conceptually with constructs grounded in the CoI framework and Social Presence Theory, especially in the domains of immediacy, co-presence, and group performance. These overlaps were deliberate, as tool usage both shapes and reflects learners' cognitive and interpersonal engagement.

Each construct was measured using multi-item scales, and composite variables were developed for both concurrent and standard tool use. These composites were tested for reliability using Cronbach's alpha and applied in analyses addressing Research Question 3, which examined students' collaborative experiences and perceived learning gains across different instructional conditions. This practical construct complements the theory-based measures by focusing explicitly on technology-mediated collaboration, which is central to the dissertation's intervention. In doing so, it directly responds to the research gaps identified in Chapter 2,

namely, the need to measure tool-specific affordances and their influence on collaborative learning within varied online modalities. It also reflects the broader CSCL recommendation that instructional design and tool selection be aligned with affordances that promote joint attention, real-time feedback, and shared understanding (Jeong & Hmelo-Silver, 2016).

Table 7 presents the full set of survey items used to measure real-time collaboration tool perceptions. The table indicates which questions were grouped into composite variables, identifies their alignment with the research questions, and distinguishes between concurrent and standard tool conditions. These items were intentionally designed to reflect the specific affordances of collaborative technologies as described in the CSCL literature, particularly in relation to visibility, synchronicity, and shared focus (Jeong & Hmelo-Silver, 2016; Dillenbourg, 1999b). By including separate composites for concurrent and standard tools, the table supports comparative analysis of how different platforms influence students' experiences with collaborative learning.

Table 7:

Survey Questions Created to Address Real-Time Collaboration Tools

Question Number	Survey Question	Variable Name	Construct	Included in Composite	Aligned Research Questions
S1_06 & S2_06	Using Google Sheets (LucidChart) improved my ability to collaborate with peers for this assignment.	Improved_Collaboration_Concurrent	Real-Time Collaboration Tools	Yes	RQ3a-c

Question Number	Survey Question	Variable Name	Construct	Included in Composite	Aligned Research Questions
S1_07 & S2_07	Using Google Sheets (LucidChart) for this assignment allowed me to establish personal connections with the members of my team.	Personal_Connection_Concurrent	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_10 & S2_10	Using Google Sheets (LucidChart) made an impact on my learning because I was able to see others contributions in real time and respond with my thoughts and contributions efficiently.	Concurrent_Update_Learning_Impact_Concurrent	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_12 & S2_12	Using Google Sheets (LucidChart) improved our overall performance on the assignment.	Improved_Performance_Concurrent	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_13 & S2_13	Using Google Sheets (LucidChart) made a difference in the group participation and interactivity.	Group_Participation_Concurrent	Real-Time Collaboration Tools	Yes	RQ3a-c

Table 7: Continued

Question Number	Survey Question	Variable Name	Construct	Included in Composite	Aligned Research Questions
S1_16 & S2_16 S1_28 & S2_28	The communication tools we used help build trust and cohesion within our group.	Other_Communication_Tools_Trust	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_18 & S2_18	Using Excel (Word) to complete the assignment improved my ability to collaborate with peers.	Improved_Collaboration_Standard	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_19 & S2_19	Using Excel (Word) for this assignment allowed me to establish personal connections with the members of my team.	Concurrent_Update_Learning_Impact_Standard	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_22 & S2_22	Using Excel (Word) made an impact on my learning because I was able to see others contributions of others and respond with my thoughts and contributions efficiently.	Concurrent_Update_Learning_Impact_Standard	Real-Time Collaboration Tools	Yes	RQ3a-c

Table 7: Continued

Question Number	Survey Question	Variable Name	Construct	Included in Composite	Aligned Research Questions
S1_24 & S2_24	The features of Excel (Word) improved our overall performance on the assignment.	Improved_Performance_Standard	Real-Time Collaboration Tools	Yes	RQ3a-c
S1_25 & S2_25	The features of Excel (Word) made a difference in the group participation and interactivity.	Group_Participation_Standard	Real-Time Collaboration Tools	Yes	RQ3a-c

Note. Composite variables were calculated by averaging corresponding items from Small Group Collaboration Surveys I and II. Items were grouped by tool type: concurrent update tools (Google Sheets, LucidChart) or standard tools (Microsoft Excel, Microsoft Word). All items used a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). Items S1_16/S2_16 and S1_28/S2_28 represent identical questions administered based on tool condition and were combined into a single construct.

Integration of Construct Measures

All survey items were systematically reviewed during the reliability testing process, and only those that demonstrated strong theoretical alignment and acceptable internal consistency were retained as part of composite variables. The development of these composites followed best practices in educational measurement, including the use of Cronbach's alpha to assess internal consistency (DeVellis & Thorpe, 2021; Boone & Boone, 2012; Gliem & Gliem, 2003). Survey items that did not meet criteria for composite formation but remained theoretically significant were retained as single-item indicators and included in the analysis based on their relevance to specific research questions.

The construct mappings provided in **Tables 4 through 7** ensure that each conceptual and contextual element of the dissertation is represented through validated measurement strategies. These mappings also clarify the relationships among theoretical constructs, survey items, and the three research questions guiding the dissertation. By organizing the variables according to the Theory of Transactional Distance, the Community of Inquiry framework, and Social Presence Theory, this approach supports a transparent, theory-driven interpretation of student experiences.

Together, these mappings provide the structural foundation for the data analysis procedures described in the next section. While this section has outlined how constructs were defined and operationalized, the following section details how these variables were prepared and analyzed to address the dissertation's research questions using quantitative methods.

Data Analysis Procedures

Data analysis for this dissertation was conducted using a structured, multi-step approach designed to evaluate the effects of instructional modality (synchronous vs. asynchronous) and collaboration tool type (standard vs. concurrent update) on academic performance and learner perceptions. This plan reflects the dissertation's 2×2 factorial design and aligns with the three guiding theoretical frameworks, the Theory of Transactional Distance, the CoI framework, and Social Presence Theory, as well as the three research questions. Four instructional conditions were compared: AS (Asynchronous Standard), AC (Asynchronous Concurrent), SS (Synchronous Standard), and SC (Synchronous Concurrent). After primary ANOVA and post-hoc analyses were completed, follow-up ANCOVAs were conducted to account for relevant demographic covariates, providing a secondary validity check on significant findings.

All statistical analyses were conducted using SPSS Version 31, with syntax files and log outputs saved to maintain reproducibility and procedural transparency (Field, 2024; Leech et al., 2014). The final dataset included cleaned survey responses, reverse-coded items, validated composite variables, and academic performance scores from the midterm exam and two collaborative assignments. Variable definitions, item-to-construct mappings, and documentation of inclusion criteria are provided in the codebook (Appendix J). Additional reliability summaries and composite variable outcomes are shown in Appendix K.

Data Preparation

Data preparation followed a systematic, multi-phase process to ensure theoretical alignment and analytical validity. This process involved coding, cleaning, and verifying data from the two Small Group Collaboration Surveys and corresponding academic performance scores.

A comprehensive codebook (Appendix J) guided the organization of variables and documentation of decisions throughout the data preparation process. Each survey item was mapped to one or more theoretical frameworks, assigned to a construct, flagged for inclusion in composite variables, and coded for scale direction. Items were also linked to the research questions they addressed. This documentation was iteratively refined during instrument development, reliability testing, and composite construction (Fink, 2024).

Reverse Coding and Composite Variables

All survey items were reviewed for directional consistency, and reverse-coded transformations were applied as needed to maintain coherent Likert-scale interpretation. These coding decisions were documented in SPSS and noted in the codebook. Composite variables

were created by averaging responses to conceptually related items within each construct. This practice follows established guidelines in scale development and survey-based research (Boone & Boone, 2012; Gliem & Gliem, 2003; DeVellis & Thorpe, 2021). Internal consistency for each composite was assessed using Cronbach's alpha (α).Variables with $\alpha \geq 0.70$ were retained for inferential analysis. Constructs that did not meet this threshold were excluded from hypothesis testing and instead discussed descriptively.

To ensure reliability across data points, internal consistency was first assessed separately for corresponding items in Small Group Collaboration Survey I and Small Group Collaboration Survey II. Once both administrations demonstrated sufficient reliability, item responses were averaged to produce unified composite variables. This strategy was justified given the short time interval between surveys and the absence of a longitudinal design (Pallant, 2020; Tabachnick & Fidell, 2019).

Construct Alignment and Theoretical Mapping

As described in the Construct Operationalization and Theoretical Alignment section earlier in Chapter 3, each survey item and composite variable were aligned with one or more guiding frameworks: the Theory of Transactional Distance (Moore, 1993), the CoI framework (Garrison et al, 2000), or Social Presence Theory (Short et al., 1976). Several context-specific constructs, such as Real-Time Collaboration Tools, were also included to reflect this dissertation's applied focus. All mappings were reviewed for conceptual and empirical alignment. Full details are provided in **Tables 4 through 7** and in Appendices J and K. These mappings ensured that all variables used in inferential testing were theoretically grounded and aligned with the dissertation's research questions.

Some survey items were intentionally included in multiple constructs due to their theoretical relevance across domains. For example, Question 53 was used in both a composite variable reflecting cognitive engagement and as a stand-alone item addressing perceived academic performance. These instances of item overlap are clearly documented in Appendix M and are further addressed in Chapter 4 when interpreting results.

Integration of Survey and Performance Data

Survey data were exported from Qualtrics, cleaned in Microsoft Excel, and merged in SPSS using anonymous identifiers. Each participant's survey data were matched to performance scores from Small Group Collaboration Assignments I and II and the midterm exam. Instructional condition was determined based on responses from Small Group Collaboration Survey I and II, which captured students' self-reported group experiences. This approach ensured that participants were categorized based on their actual exposure to instructional modality and collaboration tools, rather than their original course section assignments (Fraenkel et al., 2019).

To maintain confidentiality, all identifiers were removed from the final dataset prior to analysis. Only aggregated data were used in statistical procedures.

Missing Data and Data Inclusion Criteria

Open-ended survey responses were excluded from the analysis, as they were not part of the quantitative research design. For Likert-scale items, listwise deletion was applied at the level of each statistical test to preserve the validity of the analyses (Allison, 2002). Participants were excluded from the final dataset if they met any of the following criteria: having more than 20 percent missing data across the two survey instruments (n = 8), changing instructional modality between Small Group Assignments I and II (n = 6), or switching between standard and

concurrent collaboration tools across those same assignments (n = 41). These exclusion criteria were applied to ensure consistency in participants' instructional experiences and to support the internal validity of the analysis. After applying these criteria, the final analytic sample included 242 participants who completed all required survey items and remained in the same instructional condition for both collaborative assignments.

Final Dataset and Readiness for Analysis

The finalized dataset included cleaned and labeled variables, reversed-coded items, reliable composite scores, and performance data. All variable names and labels were standardized to ensure interpretability in SPSS. The dataset was carefully reviewed to confirm:

- Consistent variable naming and coding conventions
- Correct directional alignment for Likert items
- Accurate mappings to constructs and research questions
- Exclusion of unreliable composite variables
- Completeness of participant records

All decisions were cross-checked against the codebook (Appendix J), and composite reliability outcomes were verified in Appendix K. This structured process ensured that the dataset was fully prepared for the hypothesis testing procedures described in the sections that follow.

Reliability Testing

Internal consistency reliability was assessed using Cronbach's alpha (α), which is widely used to evaluate the extent to which items within a scale measure the same underlying construct (DeVellis & Thorpe, 2021; Taber, 2018; Field, 2024). Composite variables with alpha

coefficients equal to or exceeding .70 were considered sufficiently reliable and were retained for hypothesis testing. This threshold reflects common standards in educational and social science research (Pallant, 2020; Fraenkel et al., 2019; Tabachnick & Fidell, 2019). Composite variables that did not meet this criterion were excluded from inferential analysis to preserve statistical rigor but may be discussed descriptively if theoretically relevant to constructs outlined in the theoretical mapping **(Tables 4–7**) or supported by item-level trends observed during analysis. All reliability analyses were conducted on items drawn from Small Group Collaboration Survey I and II, as introduced in the Instruments and Measures section. Composite reliability results are summarized in Appendix K and were used to determine final variable inclusion for statistical analysis. Composite variables that did not meet the reliability threshold were excluded from all inferential testing and were not further analyzed in Chapter 4. This exclusion was consistent with the dissertation's analytic strategy and supported by guidance in measurement literature cautioning against the interpretation of unreliable scales (Allison, 2002; Fraenkel et al., 2019).

Descriptive Statistics

Descriptive statistics, including means, standard deviations, and frequency distributions, were used to summarize key participant characteristics such as demographic information, prior experience with online learning, familiarity with collaboration tools, and assignment performance across the four instructional conditions. These descriptive analyses provided essential context for interpreting group differences and ensured that the assumptions of inferential tests were evaluated on a solid empirical foundation. Summary statistics for demographic and composite variables are presented in Chapter 4, **Table 11**, while condition-level means and distributions are reported in **Tables 12 through 15.** Data were visually

inspected using boxplots, histograms, and bar charts to detect potential outliers, skewness, and inconsistencies in group distributions. The use of descriptive statistics and data visualization aligns with best practices in quantitative educational research and supports both preliminary interpretation and assumption checking (Field, 2024; Gravetter et al., 2021; Leech et al., 2014).

Assumption Testing

Before conducting inferential analyses, all relevant statistical assumptions were systematically assessed to ensure the validity of the findings. Normality of distribution was evaluated using the Shapiro-Wilk test, which is considered appropriate for small to medium sample sizes and offers greater power in detecting departures from normality (Ghasemi & Zahediasl, 2012; Razali & Wah, 2001). Homogeneity of variance was assessed using Levene's test (Levene, 1960), which is widely used to evaluate whether the variability of a variable is equal across groups. Independence of observations was ensured through the quasi-experimental design of the dissertation, in which each participant completed the surveys and assignments individually and was grouped only once per assignment. Visual inspection of scatterplots was used to assess linearity between continuous predictor and outcome variables, consistent with recommendations for evaluating assumption violations in ANOVA and regression contexts (Field, 2024; Tabachnick & Fidell, 2019).

When violations of assumptions were detected, appropriate corrections were applied to preserve analytic rigor. Welch's ANOVA was used when homogeneity of variance was not met, and Games–Howell post hoc tests were used in cases of unequal group sizes and variances, following best practices for robust testing in educational research (Field, 2024; Ruxton & Beauchamp, 2008). Independent samples *t*-tests were used in cases where a variable was specific

to only two groups, consistent with the design choices explained in Chapter 4. In situations where parametric analysis was not viable due to persistent assumption violations, certain constructs were excluded from hypothesis testing and are instead discussed descriptively in Chapter 4.

Inferential Analysis

Inferential statistical tests were conducted to evaluate the effects of instructional modality (synchronous vs. asynchronous) and collaboration tool type (standard vs. concurrent update) on student outcomes, in alignment with the 2×2 factorial design and the three research questions.

To address Research Question 1, which focused on academic performance, a series of two-way ANOVAs were conducted with instructional modality and collaboration tools as between-subjects factors. Dependent variables included performance scores from Small Group Collaboration Assignment I, Small Group Collaboration Assignment II, and the midterm exam. Interaction effects were tested, and when significant, simple effects analyses were conducted to examine the nature of those differences. Tukey's HSD was not used due to violations of homogeneity assumptions. Instead, Welch's ANOVA was applied when appropriate, and Games-Howell post hoc tests were used for group comparisons with unequal variances or sample sizes, as recommended for educational research with unequal group distributions (Field, 2024; Ruxton & Beauchamp, 2008; Tabachnick & Fidell, 2019).

Research Question 2 focused on learner perceptions of academic performance, including perceived improvement, confidence, and group contribution. Two-way ANOVAs were used to test the effects of modality and tool type on composite variables derived from the survey, including self-reported academic performance items. Variables used in multiple constructs (e.g.,

Question 53) were analyzed independently where applicable. Regression analyses were not conducted due to the study's sample size, factorial design, and the primary focus on mean group differences rather than prediction or mediation (Allison, 2002; Fraenkel et al., 2019). Because the research questions did not focus on identifying the strength or direction of linear relationships between variables, correlational analyses were also not appropriate (Cohen et al., 2018).

To address Research Question 3, which examined students' collaborative experiences and perceived learning gains, two-way ANOVAs were again employed using composite variables aligned with the Theory of Transactional Distance, the CoI framework, and Social Presence Theory. When interaction effects were significant, simple effects tests and Welch's ANOVAs with Games-Howell post hoc comparisons were conducted to identify specific differences among instructional conditions.

For constructs that applied only to students using a single collaboration tool (either standard or concurrent update), independent samples *t*-tests were conducted. These variables included measures specific to tool functionality, usage, and structure, and were not appropriate for inclusion in the factorial ANOVAs. This analytic approach preserved validity by avoiding inappropriate cross-group comparisons for tool-specific items.

Effect sizes were reported for all statistical tests to support interpretation of practical significance. Partial eta squared (η^2) was used for ANOVAs and Welch's tests, and Cohen's *d* was used for independent samples *t*-tests (Lakens, 2013; Field, 2024). Statistical significance was evaluated at the $p < .05$ level, and Games-Howell or Bonferroni corrections were applied as appropriate to control for Type I error in post hoc comparisons.

To further evaluate whether the observed group differences remained significant when accounting for demographic variation, additional analyses of covariance (ANCOVA) were conducted. These follow-up tests examined the robustness of significant results for Research Questions 1 through 3 after accounting for relevant covariates collected through the Demographic Survey (**Appendix G**), including age, gender, prior experience with online courses, and self-reported confidence using collaborative tools (Allen & Seaman, 2017; Arbaugh, 2014).

Each ANCOVA model included instructional modality and collaboration tool type as fixed factors and one demographic variable as a covariate. The homogeneity-of-regression-slopes assumption was verified for each model, and adjusted means were computed. These analyses were performed in SPSS v31 using the General Linear Model → Univariate procedure.

ANCOVA testing was limited to variables that showed significant differences in the primary ANOVA, Welch's ANOVA, or t-test results. Findings provided evidence regarding whether demographic factors contributed to or explained variance in the observed group effects. Results of these analyses are presented in **Appendix O**, which summarizes the adjusted group means, F values, significance levels, and effect sizes for each relevant outcome.

To further assess the stability of significant findings and evaluate susceptibility to omitted variable bias, a sensitivity analysis was conducted using KonFound-it! (Frank et al., 2023). This procedure estimates the percentage of the observed effect, and the corresponding number of cases (Robustness of Inference to Replacement; RIR), that would need to be replaced with null-effect observations to render a finding non-significant at $\alpha = .05$. Higher percentages and RIR values indicate stronger stability. Summary results appear in **Table 28**; full ANCOVA outputs

referenced in this section are provided in **Appendix O**.

Ethical Considerations and IRB Approval

All research activities in this dissertation were conducted in accordance with the ethical standards of the University of Tennessee, Knoxville (*University of Tennessee, Knoxville*, n.d.) and followed federal regulations governing the protection of human subjects (U.S. Department of Health and Human Services, 2018). Before initiating data collection, the study received formal approval from the University of Tennessee, Knoxville, IRB. The approved protocol (UTK IRB-25-08690-XP) ensured that participants were treated with respect, dignity, and autonomy throughout the research process. A copy of the IRB approval letter is included in Appendix L.

Participation in the research was entirely voluntary. Prior to completing any instruments, students reviewed an electronic informed consent form that described the purpose of the dissertation, the scope of their participation, potential risks and benefits, and their right to withdraw at any point without penalty (American Psychological Association, 2020). Only students who provided explicit consent were included in the final dataset. An alternative extra credit assignment of comparable length and difficulty was provided to students who opted not to participate.

Survey instruments used for analysis did not collect personally identifiable information. University-issued identifiers were temporarily used to link survey responses with academic performance data but were removed immediately after integration. All data files were stored in password-protected, cloud-based environments with access restricted to the primary researcher. Temporary access to identifying information was limited to instructional and grading processes

and was not used during data analysis.

All data will be retained for the minimum duration required by IRB policy and securely deleted at the end of that period. This dissertation followed the ethical principles outlined in the Ethical Principles of Psychologists and Code of Conduct (American Psychological Association, 2017) and adhered to all relevant institutional and federal guidelines for conducting research involving human participants.

Delimitations of the Study

This dissertation study was guided by specific methodological and theoretical choices that shaped its scope and focus. First, the study was limited to undergraduate students enrolled in a single course at a large public university, which narrowed the generalizability of the findings to similar instructional contexts. Such intentional sampling decisions reflect the bounded nature of classroom-based educational research (Creswell & Creswell, 2023; Fraenkel et al., 2019). The instructional context is described previously in detail earlier in Chapter 3, and results are interpreted accordingly in Chapter 5.

Group assignment conditions were determined based on students' self-reported experiences across two collaborative assignments, rather than through random assignment. This decision prioritized ecological validity by capturing authentic learning contexts rather than artificial experimental conditions (Maxwell, 2013; Gorard, 2013). While this approach enhanced relevance to real-world settings, it may limit causal inference. The quasi-experimental design structure is described in detail earlier in Chapter 3.

Only students who completed all required instruments and remained in the same

instructional condition across both assignments were included in the final analysis. While this improved internal consistency and comparability, it also reduced the sample size and excluded participants with partial data, a common trade-off in survey-based field research (Fink, 2024; Tabachnick & Fidell, 2019). As noted in Chapter 4, exclusion decisions followed the criteria set during the data preparation stage.

The study focused exclusively on cognitive and social presence (from the CoI framework), structure, dialogue, and learner autonomy (from the Theory of Transactional Distance), and affective immediacy and interpersonal connection (from Social Presence Theory). Teaching presence was not directly measured, as it was held constant through the course design and instructional delivery. These choices were guided by the study's specific research questions and supported by prior literature suggesting that isolating constructs in quasi-experimental designs can strengthen interpretability (Tisdell et al., 2025; Garrison et al., 2001). Chapter 2 provides a rationale for this theoretical focus, and the measurement approach was described previously in Chapter 3.

Finally, the technological dimension was operationalized through constructs related to real-time collaboration tools rather than a broader examination of digital learning platforms. This decision reflected the practical aim of exploring concurrent update features and their impact on group collaboration within the constraints of the instructional setting (Clark & Mayer, 2023; Hrastinski, 2008; Martin et al., 2020). This focus aligned with the gap in literature described in Chapter 2 and directly informed the instrumentation and analysis decisions described earlier in Chapter 3.

These delimitations were established to maintain a focused analytic framework, ensure

alignment with the research questions, and make the dissertation feasible within the instructional and temporal boundaries of a single academic term.

Summary

This chapter presented the methodological design used to examine how instructional modality and collaboration technology influenced academic outcomes and student experiences in online group work. The dissertation employed a quasi-experimental 2×2 factorial design to compare asynchronous and synchronous learning environments with or without the use of concurrent update tools.

To establish a strong contextual foundation, the chapter described the instructional setting, including the course structure, assignment sequence, and overall participant demographics. The survey instruments used in the dissertation were closely aligned with constructs drawn from three foundational frameworks: the Theory of Transactional Distance (Moore, 2013), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976). A fourth construct, Real-Time Collaboration Tools, was developed from instructional design literature to capture students' experiences with synchronous editing platforms (Clark & Mayer, 2023; Hrastinski, 2008).

Constructs were operationalized using theoretically aligned survey items, and composite variables were created when appropriate based on internal consistency testing (DeVellis & Thorpe, 2021; Boone & Boone, 2021). These measures were mapped directly to the dissertation's research questions, ensuring conceptual consistency between theoretical models and analytic procedures. Details of the composite structures are provided in Appendix K, with

full item mappings included in Appendix J. Table-based summaries of constructs are provided in earlier Chapter 3, with composite details in Appendix K and full item mappings in Appendix J.

Subsequent sections described the data collection procedures, including survey distribution, midterm performance integration, and data preparation. The analysis plan was designed to test group differences and interaction effects using two-way ANOVA, Welch's ANOVA, and independent t-tests, with appropriate corrections for assumption violations. Descriptive statistics and assumption testing procedures supported the validity of inferential results, as detailed in Chapter 4.

Finally, this chapter presented the ethical safeguards guiding the dissertation, including IRB approval (UTK IRB-25-08690-XP), informed consent protocols, and data privacy measures. Limitations and delimitations were acknowledged to help contextualize the findings presented in Chapter 4. Together, these methodological elements provide a clear and rigorous framework for analyzing how students experienced collaboration and learning across the study conditions.

CHAPTER 4

RESULTS

This chapter presents the results of this quasi-experimental dissertation investigating how instructional modality (asynchronous versus. synchronous) and collaborative tool design (standard versus concurrent update tools) affect student outcomes in online higher education. Grounded in the Theory of Transactional Distance (Moore, 2013), the Community of Inquiry (CoI) framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976), the dissertation analyzes both objective academic performance and subjective learner perceptions during small-group collaboration.

A 2×2 factorial design was used to compare four distinct instructional conditions: Asynchronous Standard (AS), Asynchronous Concurrent (AC), Synchronous Standard (SS), and Synchronous Concurrent (SC). The results are organized by the following research questions:

RQ1**:** Do students' academic performance measures change based on:

a) group collaboration modality,

b) use of concurrent update technology,

c) the interaction of these two factors?

RQ2**:** Do learners' perceptions of performance change based on:

a) group collaboration modality,

b) use of concurrent update technology,

c) the interaction of these two factors?

RQ3**:** Do learners' collaborative experiences change based on

a) group collaboration modality,

b) use of concurrent update technology,

c) the interaction of these two factors?

The chapter begins with descriptive statistics and demographic summaries to characterize the participant population and evaluate comparability across instructional conditions. Reliability testing of survey-based constructs follows, confirming that the composite variables aligned with the study's theoretical frameworks met internal consistency thresholds using Cronbach's alpha analysis (Tavakol & Dennick, 2011). Assumption testing results are then reported to support the validity of subsequent inferential procedures. Inferential analyses are presented in three sections, aligned with the research questions.

The first section addresses RQ1, comparing academic performance across instructional conditions using two-way analyses of variance (ANOVAs) and post hoc procedures. The second section addresses RQ2, focusing on learners' self-reported perceptions of academic performance, including perceived improvement, contribution, and performance confidence. The final section explores RQ3, analyzing differences in collaborative experiences using two-way ANOVAs for composite variables and individual survey items.

For constructs that were not appropriate for factorial analysis or were tool-specific rather than condition-based, independent samples t-tests were used to compare standard and concurrent update tool use directly. These t-tests were conducted using SPSS version 31, with equal variances tested through Levene's test prior to analysis.

When assumptions of homogeneity of variance were violated for ANOVAs, Welch's ANOVAs and Games-Howell post hoc tests were used as recommended for conditions with unequal variances or non-equivalent group sizes (Field, 2024; Ruxton, 2006).

Statistically significant findings are interpreted in relation to the study's theoretical frameworks, and non-significant results are reported transparently. Overall, the results contribute to a deeper understanding of how instructional design elements, particularly collaboration timing and tool functionality, may influence online learning outcomes and students' experiences with small-group collaboration.

Participant Characteristics and Descriptive Statistics

This section describes the demographic characteristics of the 242 participants included in the final dataset. All participants were enrolled in an undergraduate business course focused on information management and completed the required components of the dissertation research, including the demographic survey and assigned collaborative activities. Demographic data were collected using the Demographic Survey (Dillman et al., 2014; Creswell & Creswell, 2014; see Appendix G). Descriptive data are presented to contextualize the academic background, demographic composition, and prior online learning experiences of the sample.

Categorical Demographics

Table 8 summarizes the categorical characteristics of the final sample. The group was 58.3% female (n = 141) and 41.7% male (n = 101). The majority of participants identified as White (88.0%, n = 213), with smaller proportions identifying as multiple races (7.4%, n = 18), Asian (2.9%, n = 7), Black or African American (0.8%, n = 2), another race (0.4%, n = 1), or declining to answer (0.4%, n = 1). By academic classification, most students were juniors

(76.9%, *n* = 186), followed by seniors (12.0%, *n* = 29) and sophomores (11.2%, *n* = 27). A total of 11.2% (*n* = 27) of participants identified as first-generation college students based on self-report. In terms of ethnicity, 6.2% (*n* = 15) identified as Hispanic or Latino.

Regarding employment status, 57.0% (*n* = 138) worked part-time, 4.1% (*n* = 10) worked full-time, 2.1% (*n* = 5) were self-employed, 2.1% (*n* = 5) were currently seeking employment, and 1.7% (*n* = 4) selected "Other." One-third of the sample (33.1%, *n* = 80) reported not being employed at the time of the dissertation.

Most students reported having taken at least one online college class (96.3%, *n* = 233), and a majority (69.0%, *n* = 167) reported experience with online learning during high school.

Table 8:

Categorical Participant Characteristics (N = 242)

Variable	Category	*n*	%
Gender	Female	141	58.3%
	Male	101	41.7%
Race	White	213	88.0%
	Multiple	18	7.4%
	Asian	7	2.9%
	Black or African American	2	0.8%
	Other	1	0.4%
	Chose not to answer	1	0.4%
Year in School	Junior	186	76.9%
	Senior	29	12.0%
	Sophomore	27	11.2%
First-Generation Status	Yes	27	11.2%
	No	215	88.8%
Ethnicity	Hispanic or Latino	15	6.2%
	Not Hispanic or Latino	227	93.8%
Employment Status	Part-time	138	57.0%
	Not employed	80	33.1%
	Full-time	10	4.1%

Table 8: Continued

Variable	Category	*n*	%
	Self-employed	5	2.1%
	Currently seeking employment	5	2.1%
	Other	4	1.7%
Online College Experience	Yes	233	96.3%
	No	9	3.7%
Online HS Experience	Yes	167	69.0%
	No	75	31.0%

Continuous Demographics

In addition to categorical indicators, several continuous variables were used to describe the sample. **Table 9** provides descriptive statistics for participant age and self-reported prior online course experience. The average age of participants was 21.52 years (*SD* = 2.30), with a range from 19 to 44 years. On average, students reported completing approximately 5.28 online college courses (*SD* = 1.69, *n* = 233) and 4.13 online high school courses (*SD* = 2.18, *n* = 167). These variables were measured on a capped Likert scale, with 7 representing "7 or more" courses. The reduced sample sizes for course data reflect conditional branching logic embedded within the survey.

Table 9:

Continuous Participant Characteristics (N = 242)

Variable	Minimum	Maximum	Mean	*SD*	*n*
Age (years)	19	44	21.53	2.19	242
# Online College Courses[1]	1	7	5.28	1.69	233
# Online HS Courses[1]	1	7	4.13	2.18	167

Note: [1] Responses were capped at 7, indicating "7 or more" courses.

Ordinal Demographics

Two additional variables assessed students' self-rated technology proficiency and the

frequency with which they had engaged in online group work prior to participation in the dissertation study. Most participants identified their technology proficiency as intermediate (77.3%), while 14.9% rated themselves as beginners and 7.9% as advanced users.

Students also reported how frequently they had worked in online groups during prior courses. The most common response was sometimes (47.5%), followed by rarely (30.2%) and often (19.4%). A small number of participants indicated they had never participated in online group work (2.9%). No participants selected the always option in the revised sample.

Table 10:

Ordinal Participant Characteristics (N = 242)

Variable	Category	*n*	Percent
Technology Proficiency	Beginner	36	14.9%
	Intermediate	187	77.3%
	Advanced	19	7.9%
Group Work Frequency	Never	7	2.9%
	Rarely	73	30.2%
	Sometimes	115	47.5%
	Often	47	19.4%

Summary of Participants

The final analytic sample included 242 undergraduate students enrolled in an introductory business course at a large public university in the Southeastern United States. The sample was predominantly female and White, with most students classified as juniors. Nearly all participants had prior experience with online college courses, and more than two-thirds had completed at least one online course in high school.

Most students described themselves as intermediate technology users and reported having worked in online groups at least occasionally. This combination of prior online learning

exposure, moderate technology confidence, and varied group work experience provides essential context for interpreting how instructional modality and collaborative tool design may influence student outcomes in the results that follow.

Reliability Testing of Composite Variables

Before conducting inferential analyses, reliability testing was performed on all composite variables constructed from survey items. Cronbach's alpha was used to assess internal consistency, with a standard threshold of .70 adopted for acceptability (Nunnally & Bernstein, 1994; Tavakol & Dennick, 2011). **Table 11** summarizes the reliability coefficients for both the original and final versions of each composite based on Small Group Collaboration Survey 1 (S1) and Small Group Collaboration Survey 2 (S2).

Several composites were revised to improve internal consistency. For instance, the Group Functioning and Conflict Resolution composite improved from $\alpha = .716$ (S1) and $\alpha = .670$ (S2) to $\alpha = .755$ and $\alpha = .696$, respectively, following the removal of one item and the addition of a better-aligned item. Similarly, the Learning Engagement and Transfer composite saw alpha values rise from .700 and .691 to .766 and .758 after refinement.

Only one composite, Academic Performance (Self-report), failed to meet reliability standards (S1 $\alpha = .573$; S2 $\alpha = .587$) and was removed from composite analysis. However, the original items remain in the dataset for potential descriptive or exploratory use.

All remaining constructs demonstrated acceptable internal consistency and were retained for further analysis. In cases where reliability analysis suggested a need for refinement, individual items were added or removed to improve the internal consistency of the composite

measure. A complete summary of original and final Cronbach's alpha values, along with specific item-level changes, is included in Appendix K.

Several survey items were intentionally used in more than one composite variable or theoretical construct. These overlaps were theoretically justified and tested for internal consistency within each composite independently (Podsakoff et al., 2003). For example, Item Q53 ("I believe this collaboration activity helped improve my grade") was used both in the Learning Engagement and Transfer composite (Cognitive Presence) and as a stand-alone outcome variable in the analysis of perceived academic performance. This approach aligns with research supporting the use of cross-loading items when constructs represent distinct yet overlapping conceptual domains (MacKenzie et al., 2011). Overlapping items were retained only when their contribution improved the reliability of both constructs and aligned with distinct theoretical dimensions. A complete mapping of these overlapping items, their assigned constructs, and variable uses is provided in Appendix M.

One construct, Structure, drawn from the Theory of Transactional Distance, contained several items that also appeared in tool-related composites, such as Real-Time Collaboration Tools and Tool-Enabled Learning (Moore, 2013; Borup et al., 2020). These items reflected the dual role of collaborative technologies as both functional tools and structural components of the instructional design. For instance, Item Q32 ("The collaboration tool supported our group's interaction") captured participants' perceptions of both technological facilitation and course structure. To maintain construct clarity, each overlapping item was tested separately within its assigned composite. Allowing these overlaps supported a more nuanced understanding of how instructional structure was experienced in relation to collaborative tool use, which was a central

aim of the dissertation.

Table 11:

Cronbach's Alpha for Composite Variables – Original and Final Results

Construct	S1 Original α	S1 Final α	S2 Original α	S2 Final α	Composite Retained	Notes
Academic Performance (Self-report)	.573	—	.587	—	No	Dropped due to low reliability
Group Functioning and Conflict Resolution	.716	.755	.670	.696	Yes	Item refined; improved reliability
Learning Engagement and Transfer	.700	.766	.691	.758	Yes	One item added; final version shows strong alpha
Social Cognitive Learning with Peers	.868	.868	.817	.817	Yes	All items retained; already high reliability
Tool-Enabled Learning (Concurrent Update)	.742	.788	.807	.798	Yes	Dropped one construct due to need to examine separately to compare.
Tool-Enabled Learning (Standard Tools)	.844	.844	.801	.801	Yes	No changes needed
Real-Time Collaboration Tools – Concurrent	.703	.703	.749	.749	Yes	Acceptable internal consistency
Real-Time Collaboration Tools – Standard	.712	.712	.752	.752	Yes	Acceptable internal consistency
Social Presence – Affective and Relational Connection	.736	.736	.733	.733	Yes	No changes needed
Social Presence – Group Interaction and Participation	.782	.782	.775	.775	Yes	All items retained

Table 11: Continued

Construct	S1 Original α	S1 Final α	S2 Original α	S2 Final α	Composite Retained	Notes
Social Presence – Trust, Support, and Communication	.745	.745	.726	.726	Yes	Acceptable reliability for exploratory use
Structure – Concurrent Tools & Overall	.708	.708	.700	.700	Yes	Just meets threshold; included in analysis
Structure – Standard Tools & Overall	.725	.725	.731	.731	Yes	Acceptable internal consistency

Survey Composite Scores

Descriptive statistics were computed for 11 composite variables aligned with constructs from the CoI framework (Garrison et al., 2000), the Theory of Transactional Distance (Moore, 2013), Social Presence Theory (Short et al., 19760, and Real-Time Collaboration Tools. As shown in **Table 12**, all composite means exceeded the neutral midpoint of 3.0, indicating generally positive perceptions among participants regarding their online learning experiences (Boone & Boone, 2012).

The highest mean scores were observed for Cognitive Presence – Tool-Enabled Learning with Concurrent Update (M = 3.88, SD = 0.58), Structure – Concurrent Tools and Overall (M = 3.87, SD = 0.54), and Cognitive Presence – Learning Engagement and Transfer (M = 3.86, SD = 0.56), suggesting strong endorsement of cognitive support and technology-enhanced learning experiences. Relatively lower means were observed for Social Presence – Affective and Relational Connection (M = 3.38, SD = 0.71), Real-Time Collaboration Tools – Standard (M = 3.30, SD = 0.69), and Cognitive Presence – Social Cognitive Learning with Peers (M = 3.44, SD

= 0.78), suggesting less perceived emotional or peer-related engagement in those areas.

Importantly, these patterns provide early insights into how participants experienced the instructional design and collaboration tools differently across collaboration modality and technology type. These trends are examined further in the inferential results sections that follow.

Overall, these findings suggest that participants perceived collaborative learning, cognitive engagement, and structural supports favorable, while affective connection and interaction quality, particularly when using standard collaboration tools, received slightly lower ratings. These results justify the continued inclusion of all composite variables in subsequent inferential analyses.

Table 12:

Descriptive Statistics for Composite Variables (All Participants)

Composite Variable	*N*	Minimum	Maximum	Mean	Std. Deviation
g_Group_Functioning_Composite	2	0	0	3.4632	845
g_Learning_Engagement_Composite	2	0	0	3.8550	666
g_Social_CogLearning_Composite	2	0	0	3.4432	282
g_Tool_CollabLearn_ ncurrent_Comp osite	3	0	0	3.9421	648
g_Tool_CollabLearn_Standard_Compos	4	3	0	3.3858	633
_Collab_Tools_Concurrent_Update_Co posite	3	7	0	3.7553	662
_Collab_Tools_Standard_Composite	4	5	0	3.2982	337
cial_Presence_Affective_Composite	2	0	0	3.3771	994
cial_Presence_Interaction_Composite	2	0	0	3.6417	177
ucture_Concurrent_Composite	2	0	0	3.8662	299
Structure_Standard_Composite	242	2.14	5.00	3.8404	.55215
Valid *N* (listwise)	0				

Descriptive Statistics by Experimental Condition

To explore differences in participant perceptions across instructional conditions,

descriptive statistics were calculated for each composite variable by group type: Asynchronous Standard (AS), Asynchronous Concurrent (AC), Synchronous Standard (SS), and Synchronous Concurrent (SC). Results are displayed in **Table 13.**

Participants in the Synchronous Concurrent (SC) group reported the highest levels across most constructs, including Cognitive Presence – Group Functioning (M = 3.67, SD = 0.64), Cognitive Presence – Learning Engagement (M = 3.95, SD = 0.47), and Structure – Concurrent Tools and Overall (M = 4.01, SD = 0.43). These ratings suggest strong perceptions of group dynamics, learning, and structured support when concurrent tools were paired with synchronous collaboration. This trend aligns with evidence suggesting that synchronous collaboration combined with interactive tools can enhance immediacy, feedback, and group cohesion (Hrastinski, 2008; Garrison et al., 2000; Martin et al., 2020).

Conversely, Asynchronous Standard (AS) participants reported lower averages on tool-related and social constructs, including Real-Time Collaboration Tools – Standard (M = 3.35, SD = 0.69) and Social Presence – Affective and Relational Connection (M = 3.32, SD = 0.73). Notably, Asynchronous Concurrent (AC) learners rated concurrent tool integration positively (M = 3.87, SD = 0.62) but slightly lower in areas of social presence compared to synchronous groups. This pattern reflects theoretical expectations from the CoI framework, which emphasizes the role of synchronous interaction in supporting immediacy, co-presence, and relationship-building (Short et al., 1976; Richardson et al., 2017)

Tool-specific constructs were only calculated for participants who used the relevant tool type, as indicated by missing entries in **Table 13**. Taken together, these results provide descriptive support for Research Question 3 and lay the groundwork for the inferential analyses

presented later in this chapter.

Table 13:

Composite Variable Means by Group Condition

Construct	AS	AC	SS	SC
Cognitive Presence – Group Functioning	3.29 (.53)	3.47 (.66)	3.36 (.62)	3.67 (.64)
Cognitive Presence – Learning Engagement	3.66 (.60)	3.81 (.68)	3.93 (.49)	3.95 (.47)
Cognitive Presence – Social Cognitive Learning with Peers	3.29 (.81)	3.31 (.92)	3.49 (.77)	3.59 (.67)
Cognitive Presence – Tool-Enabled Learning (Concurrent)	N/A	3.91 (.63)	N/A	3.95 (.56)
Cognitive Presence – Tool-Enabled Learning (Standard)	3.40 (.74)	N/A	3.38 (.80)	N/A
Real-Time Collaboration Tools (Concurrent)	N/A	3.66 (.64)	N/A	3.81 (.48)
Real-Time Collaboration Tools (Standard)	3.35 (.69)	N/A	3.26 (.70)	N/A
Social Presence – Affective and Relational Connection	3.32 (.73)	3.37 (.84)	3.35 (.71)	3.45 (.64)
Social Presence – Group Interaction and Participation	3.51 (.59)	3.58 (.73)	3.62 (.59)	3.79 (.43)
Structure – Concurrent Tools & Overall	3.65 (.59)	3.95 (.56)	3.83 (.56)	4.01 (.43)
Structure – Standard Tools & Overall	3.68 (.55)	3.85 (.62)	3.80 (.56)	3.99 (.47)

Note: Standard deviations are reported in parenthesis. "N/A" indicates that the construct was not used in that instructional condition.

Descriptive Statistics of Single-Item Variables

Descriptive statistics were calculated for all non-composite variables aligned with the study's theoretical constructs, including device satisfaction, team success, online group effectiveness, perceptions of technology impact, and overall course outcomes. **Table 14** presents the means and standard deviations for these single-item variables.

Most variables showed generally positive perceptions, with means above the neutral

midpoint of 3.0. High scores were reported for Satisfaction with Device Used (M = 4.17, SD = 0.65), Reliable Internet Access (M = 4.24, SD = 0.77), and Comfort Using Online Tools (M = 3.99, SD = 0.85), reflecting strong access and individual preparedness for online learning (Borup et al., 2014).

Lower ratings were observed for Perceptions of Team Success (M = 3.20, SD = 1.03), group work effectiveness online (M = 3.22, SD = 1.09), and the Perceived Impact of Collaborative Groups on Course Grades (M = 2.99, SD = 1.00). These results reflect a contrast between individual-level learning supports and group-level outcomes, which has been noted in prior online collaboration studies (Zydney et al., 2012; Kreijns et al., 2003).

These findings indicate a generally favorable view of technological access and individual learning gains, but more mixed perceptions regarding group-related outcomes such as collaboration success and perceived academic impact. Although these items were not part of multi-item constructs, they were retained as single-item variables due to their conceptual clarity, practical relevance, and strong face validity.

Descriptive statistics for each of the non-composite variables are presented in **Table 14.** These items represent important constructs not captured through composite scales but are conceptually linked to the study's theoretical framework. For example, variables such as Tech Helped with Group Work and Structure Helped Manage Learning reflect the structural and dialogic components of the Theory of Transactional Distance (Moore, 1993), while Felt Empowered in Course reflects aspects of Social Presence Theory (constructs related to interpersonal connection and learner agency (Gunawardena, 1995). See Appendix L for item-level descriptions and mappings.

Table 14:

Descriptive Statistics for Non-Composite (Single-Item) Variables

Variable	N	Min	Max	Mean	SD
Satisfaction with Device Used	242	1	5	4.17	0.65
Success Working in a Team	241	1	5	3.20	1.03
Group Work Was Effective Online	241	1	5	3.22	1.09
Tech Helped with Group Work	241	1	5	3.85	0.81
Online vs. In-Person – Modality Comparison	241	1	5	4.10	0.94
Comfort Working in Online Groups	241	1	5	3.56	1.03
Comfort Using Online Tools	241	1	5	3.99	0.85
Reliable Internet Access	241	1	5	4.24	0.77
Ability to Balance Work and Academic Life	241	1	5	4.16	0.81
No Group Interaction – Group Size Condition	118	1	5	3.19	1.00
No Group Interaction – Experience Level Condition	124	1	5	3.42	0.92
Tools Enhanced Learning – Experience Level Condition	124	1	5	2.94	0.76
Group Work Improved Course Grades	242	1	5	2.99	1.00
Felt Empowered in Course	242	1.5	5	3.94	0.72
Group Work Improved Performance	242	1	5	3.77	0.77
Course Structure Helped Manage Learning	242	1.5	5	4.10	0.71
Enhanced Learning Comparison (Standard)	124	1	5	2.9435	.76299
Enhanced Learning Comparison (Concurrent)	118	1.5	5	3.7034	.80923

To examine differences in individual variable responses across instructional conditions, descriptive statistics were calculated for all non-composite items by group type. These variables represent constructs not fully captured in the composite measures, such as device satisfaction, internet access, comfort with technology, and perceived academic impact.

As shown in **Table 15,** participants across all conditions reported High Satisfaction with Devices ($M > 4.0$), Reliable Internet Access, and a General Sense of Balance in Managing Responsibilities. Ratings of Team Success, Effective Online Group Work, and Learning Gains were more mixed, particularly in the asynchronous and standard conditions. For example, the Asynchronous Concurrent (AC) group reported lower averages on teamwork and group work effectiveness ($M = 2.86$ and 2.84, respectively) compared to the Synchronous Concurrent (SC) and Synchronous Standard (SS) groups. These differences may reflect limitations in building immediacy and cohesion in asynchronous group settings, consistent with prior research on temporal presence and social connectedness (Lowenthal & Dunlap, 2020).

Overall, the results suggest more favorable perceptions of individual learning and course structure than of collaborative group success, with some variability by condition. These findings offer preliminary support for the patterns explored in Research Questions 2 and 3 and establish a context for the inferential analyses presented in subsequent sections. Full descriptive statistics by group type are presented in **Table 15.**

Table 15:

Non-Composite Variable Means by Group Condition

Construct	AS	AC	SS	SC
Satisfied with Device	4.09 (.60)	4.09 (.68)	4.21 (.65)	4.24 (.68)
Success of Team Experience	3.44 (1.07)	2.86 (1.01)	3.37 (.93)	3.08 (1.04)
Group Work Effective Online	3.31 (1.15)	2.84 (1.29)	3.32 (1.03)	3.29 (.96)
Tech Impact on Group Work	3.69 (.94)	3.95 (.72)	3.85 (.86)	3.89 (.71)
Modality Comparison	4.10 (.93)	4.02 (.99)	4.15 (.89)	4.08 (.97)
Comfort in Online Groups	3.67 (.96)	3.23 (1.19)	3.68 (.94)	3.56 (1.03)
Comfort with Online Tools	4.08 (.81)	3.60 (1.12)	4.13 (.76)	4.03 (.74)
Reliable Internet Access	4.25 (.79)	4.19 (.76)	4.15 (.84)	4.36 (.67)
Balance of Online Learning	4.06 (.70)	4.26 (.85)	4.00 (.81)	4.32 (.84)

Table 15: Continued

Construct	AS	AC	SS	SC
No Interaction Hindered Learning (Concurrent)	N/A	3.64 (.86)	N/A	2.93 (.99)
No Interaction Hindered Learning (Standard)	3.46 (.98)	N/A	3.38 (.88)	N/A
Enhanced Learning (Tool Comparison) Standard	2.99 (.76)	N/A	2.91 (.77)	N/A
Enhanced Learning (Tool Comparison) Concurrent	N/A	3.73 (.83)	N/A	3.68 (.80)
Groups Improved Grades	2.98 (.97)	2.88 (1.08)	3.06 (.96)	2.98 (1.03)
Student Empowerment	3.76 (.75)	3.95 (.90)	4.01 (.64)	3.99 (.65)
Group Performance	3.53 (.84)	3.65 (.90)	3.91 (.66)	3.89 (.69)
Structure Managing Learning	3.77 (.77)	4.16 (.76)	4.09 (.59)	4.29 (.67)

Note: Standard deviations are reported in parenthesis. "N/A" indicates that the construct was not used in that instructional condition.

Assumption Testing

Prior to conducting inferential analyses, the core assumptions of two-way ANOVA were systematically evaluated: normality of residuals, homogeneity of variances, and independence of observations. The assumption of independence was ensured by the design of this dissertation, in which each participant completed all measures individually and responses were not shared or influenced by others. This process followed the analytic procedures outlined in Chapter 3. Checks for normality and homogeneity of variance were completed for each dependent variable in the dissertation and are summarized in **Tables 16–19.**

Normality

Normality was assessed by running Shapiro-Wilk tests on the residuals from the two-way ANOVA models for each dependent variable, consistent with best practices recommended by Field (2024) and Tabachnick and Fidell (2019). This aligns with the statistical assumption that model residuals (rather than raw scores) should be normally distributed. In several cases, the

Shapiro-Wilk test yielded statistically significant results ($p < .05$). However, visual inspection of Q-Q plots and boxplots revealed that most distributions were approximately symmetric, lacking severe skew or problematic outliers. Given the large sample size ($n = 242$) and the robustness of ANOVA to minor normality violations, the decision to retain variables without transformation aligns with prior guidance in applied statistics (Blanca et al., 2017; Field, 2024; Lumley et al., 2002).

In this dissertation, variables were classified as "Yes (approx.)" for normality when visual evidence (Q-Q plots, histograms, and boxplots) indicated an approximately normal distribution, even if the Shapiro-Wilk test was significant. Only in cases of both statistical and visual evidence of non-normality would variables be flagged as "No" for normality (which did not occur in this sample). All variables were therefore retained for analysis without transformation.

Homogeneity of Variance

Levene's test was used to assess the assumption of equal variances across the four instructional conditions (AS, AC, SS, SC). This assumption was met for the majority of dependent variables, including both performance scores (percent correct and overall exam) and most RQ2 and RQ3 composites and non-composites. When Levene's test was significant ($p < .05$), indicating unequal group variances, the analytic plan specified in Chapter 3 was followed. In these cases, Welch's ANOVA was used as a robust alternative to the standard two-way ANOVA (Ruxton, 2006; Tomarken & Serlin, 1986). Games-Howell post hoc comparisons were employed as needed, given their appropriateness under conditions of unequal variances and differing group sizes (Field, 2024).

Detailed notes are provided in **Tables 16–19** to clarify which assumptions were violated and how these cases were addressed analytically.

Summary of Assumption Testing

Overall, assumption testing confirmed that ANOVA procedures were suitable for all variables analyzed. Most residual distributions supported approximate normality, and homogeneity of variance was upheld for most comparisons. For all instances in which statistical assumptions were not fully satisfied, the use of robust analytic alternatives ensured validity of results. This comprehensive approach to assumption testing strengthens the credibility of subsequent inferential analyses.

Tables 16 through 19 summarize these results across all research questions:

- **Table 16** covers instructor-assigned performance scores (RQ1),
- **Table 17** presents perceived performance measures (RQ2),
- **Table 18** summarizes composite variables related to collaborative group experiences (RQ3), and
- **Table 19** provides assumption testing results for individual, non-composite items associated with RQ3.

Table 16:

Assumption Testing Summary for RQ1 Variables (Performance Scores)

Dependent Variable	Shapiro-Wilk (*p*)	Levene' s Test (*p*)	Normality Met?	Homoge neity Met?	Statistical Test	Notes on Assumptions
Assignment 1 – Raw Score	<.001	.005	Yes (approx.)	No	Welch's ANOVA	Shapiro-Wilk $p < .001$; histogram showed approximate symmetry and Q-Q plot supported near-normal distribution. Variance assumption violated; Welch's ANOVA used.
Assignment 1 – Percent Correct on Exam	<.001	.573	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk $p < .001$; histogram showed clear symmetry and Q-Q plot confirmed approximate normality. All assumptions met.
Assignment 2 – Raw Score	<.001	< .001	Yes (approx.)	No	Welch's ANOVA	Shapiro-Wilk $p < .001$; histogram showed general symmetry and Q- Q plot showed only minor tail deviations. Variance assumption violated; used Welch's ANOVA.
Assignment 2 – Percent Correct on Exam	<.001	.250	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk $p < .001$; histogram showed bell-shaped curve and Q-Q plot demonstrated strong alignment with normal distribution. All assumptions met.
Overall Exam Score	<.001	.530	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk $p < .001$; histogram and Q-Q plot showed approximate symmetry and minimal deviation. All assumptions met.

Table 17:

Assumption Testing Summary for RQ2 Variables (Perceived Performance)

Dependent Variable	Shapiro-Wilk (p)	Levene's Test (*p*)	Normality Met?	Homogeneity Met?	Statistical Test	Notes on Assumptions
Perceived Improved Grades	<.001	.722	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk $p < .001$; histogram showed symmetric curve and Q- Q plot supported approximate normality. All assumptions met.
Empowerment	<.001	.026	Yes (approx.)	No	Welch's ANOVA	Shapiro-Wilk $p < .001$; histogram showed mild left skew but Q-Q plot supported overall symmetry. Variance not equal; Welch's ANOVA used.
Group Performance	<.001	.048	Yes (approx.)	No	Welch's ANOVA	Shapiro-Wilk $p < .001$; histogram and Q-Q plot both indicated approximately normal distribution. Variance not equal; Welch's ANOVA used.

Table 17: Continued

Dependent Variable	**Shapiro-Wilk (p)**	**Levene's Test (*p*)**	**Normality Met?**	**Homoge-neity Met?**	**Statistical Test**	**Notes on Assumptions**
Enhanced Learning (Tool Comparison - Standard)	.001	.700	Yes (approx.)	Yes	Independe nt Samples t- Test	Shapiro-Wilk p = .001; Q-Q plot and boxplot showed approximate symmetry with minor outliers. Assumptions acceptable. Construct measured for a single technology condition. Comparison conducted via independent samples t-test by modality.
Enhanced Learning (Tool Comparison - Concurrent)	<.001	.854	Yes (approx..)	Yes	Independe nt Samples t- Test	Shapiro-Wilk p < .001; histogram and Q-Q plot showed approximate symmetry with mild tail deviations. Normality approximated based on visual inspection. Construct measured for a single technology condition. Comparison conducted via independent samples t- test by modality.

Table 18:

Assumption Testing Summary for RQ3 Composite Variables

Variable	Shapiro-Wilk (*p*)	evene' Test (*p*)	rmality Met?	Homoge -neity Met?	tistical Test	Notes on Assumptions
Cognitive Presence – Group Functioning & Conflict Resolution	.005	.188	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk p = .005; Q-Q plot showed mild tail deviation but overall symmetry; Levene's $p >$ .05.
Cognitive Presence – Learning Engagement and Transfer	.243	.021	Yes	No	Welch's ANOVA	Normality confirmed by high *p*-value (.243) and strong symmetry in plots. Levene's <.05. Used Welch's ANOVA.
Cognitive Presence – Social Cognitive Learning with Peers	.002	.116	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk p = .002; visual inspection confirmed general symmetry despite slight skew.
Cognitive Presence – Tool Collaboration (Standard)	.558	.333	Yes	Yes	Independe nt Samples t-Test	Normality confirmed by high *p*-value (.558) and strong symmetry in plots. Construct measured for a single technology condition. Comparison conducted via independent samples t- test by modality.

Table 18: Continued

Variable	Shapiro-Wilk (*p*)	Levene' s Test (*p*)	rmality Met?	Homoge -neity Met?	tistical Test	Notes on Assumptions
Cognitive Presence – Tool Collaboration (Concurrent Update)	.020	.427	Yes (approx.)	Yes	Independe nt Samples t- Test	Shapiro-Wilk *p* = .020; histogram showed mild skew and Q-Q plot slight tail deviation, but no critical issues. Construct measured for a single technology condition. Comparison conducted via independent samples t-test by modality.
Real-Time Tools – Standard Use	.665	.813	Yes	Yes	Independe nt Samples t- Test	Shapiro-Wilk *p* = .665; histogram showed symmetric bell-shaped curve and Q-Q plot confirmed normality. Construct measured for a single technology condition. Comparison conducted via independent samples t-test by modality.
Real-Time Tools – Concurrent Update Use	.457	.119	Yes	Yes	Independ e nt Samples t- Test	Shapiro-Wilk *p* = .457; histogram and Q-Q plot confirmed normality with no visible skew. Construct measured for a single technology condition. Comparison conducted via independent samples t-test by modality.
Social Presence – Affective and Relational Connection	.081	.228	Yes	Yes	Standard ANOVA	Shapiro-Wilk *p* = .081; visual inspection showed normality.

Table 18: Continued

Variable	Shapiro-Wilk (*p*)	Levene's Test (*p*)	Normality Met?	Homoge-neity Met?	Statistical Test	Notes on Assumptions
Social Presence – Group Interaction and Participation	.035	.004	Yes (approx.)	No	Welch ANOVA	Shapiro-Wilk $p < .05$; histogram and Q-Q plot suggested symmetric distribution with no severe skew. Levene's <.05. Used Welch's ANOVA.
Structure – Standard Tools	.007	.387	Yes (approx.)	Yes	Independent Samples t- Test	Shapiro-Wilk $p = .007$; histogram and Q-Q plot showed symmetric distribution despite minor tail deviations. Construct measured for a single technology condition. Comparison conducted via independent samples t-test by modality.
Structure – Concurrent Update Tools	.001	.124	Yes (approx.)	Yes	Independent Samples t- Test	Shapiro-Wilk $p = .001$; visual inspection showed symmetric distribution with minor tail deviation. Construct measured for a single technology condition. Comparison conducted via independent samples t- test by modality.

Table 19:

Assumption Testing Summary for RQ3 Non-Composite Variables

Variable	Shapiro-Wilk (*p*)	Levene's Test (*p*)	rmality Met?	omoge-neity Met?	tistical Test	Notes on Assumptions
No Interaction Hindered Learning (Concurrent)	.016	.267	Yes (approx.)	Yes	Independent Samples t-Test	Shapiro-Wilk p = .016; Q-Q plot and boxplot confirmed approximate symmetry. All assumptions met. Construct measured for a single technology condition. Comparison conducted via independent samples t- test by modality.
No Interaction Hindered Learning (Standard)	.004	.191	Yes (approx.)	Yes	Independent Samples t-Test	Shapiro-Wilk p = .004; Q-Q plot and boxplot indicated approximate symmetry with one mild outlier. Assumptions acceptable. Construct measured for a single technology condition. Comparison conducted via independent samples t-test by modality.
Structure Managing Learning	<.001	.241	Yes (approx.)	Yes	Standard ANOVA	Shapiro-Wilk p < .001; Q-Q plot and boxplot indicated approximate symmetry with mild left skew and several low- value outliers. Assumptions acceptable.

Welch's ANOVA and Post Hoc Procedures

To address violations of the homogeneity of variance assumption, Welch's ANOVA, a robust alternative that does not assume equal variances, was conducted for affected variables (Ruxton, 2006; Tomarken & Serlin, 1986). This analytic decision followed the procedures outlined in Chapter 3 and ensured that group mean comparisons remained valid despite unequal variances. This approach was applied across both performance-based scores and perception-based outcomes in the dissertation, as indicated by the results of Levene's tests in **Tables 16–19.**

For example, Welch's ANOVA was used for Small Group Collaboration Assignment 1 (raw score) and the Empowerment composite due to unequal variances across instructional conditions. Additional variables analyzed using this approach included Cognitive Presence – Social Cognitive Learning with Peers and Real-Time Collaboration Tools – Standard, based on the Levene's test results reported in **Tables 17 and 18.**

Games-Howell post hoc comparisons were also conducted for all such variables, following best practices for analyses with unequal variances and differing sample sizes (Field, 2024). This procedure is widely recommended for its robustness and accuracy in identifying group-level differences under heterogeneous conditions (Field, 2024; Zimmerman, 2012). Complete results are presented in the results sections for each research question.

Findings for Research Questions

The following sections present findings aligned with the dissertation's three guiding research questions. Each research question was analyzed using appropriate inferential procedures based on the study's 2x2 factorial design (instructional modality × tool type). These analyses

build upon the descriptive patterns and assumption testing detailed earlier in Chapter 4 and are grounded in the theoretical frameworks introduced in Chapter 2 and operationalized in Chapter 3. Where significant effects or interactions emerged, results are interpreted through the lens of the Theory of Transactional Distance (Moore, 1993; Moore & Kearsley, 2012), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976; Biocca et al., 2003). Supplemental tables provide detailed statistical outputs to support interpretation and transparency.

Research Question 1: Academic Performance

To address RQ1, two-way factorial ANOVAs were conducted to examine the effects of instructional modality (synchronous vs. asynchronous) and collaborative tool type (concurrent update vs. standard tools) on students' academic performance. The dependent variables included Small Group Collaboration Assignment 1 and Small Group Collaboraiton Assignment 2 raw scores, the percent correct on assessment questions related to each assignment, and the overall exam score. These variables were chosen based on their direct linkage to course-level outcomes and were scored using identical rubrics across all participants, as described in Chapter 3.

Assumption testing confirmed that all variables demonstrated approximate normality of residuals based on Shapiro-Wilk tests and visual inspection, as described in the Assumption Testing section. While homogeneity of variance was satisfied for most outcomes, Levene's test indicated violations for Small Group Collaboration Assignment 1 and Small Group Collaboration Assignment 2 raw scores. In these cases, Welch's ANOVA and Games-Howell post hoc comparisons were used as appropriate.

For Small Group Collaboration Assignment 2 raw scores, a significant main effect of tool type was found, $F(1, 237) = 11.36$, $p < .001$, $\eta^2 = .046$, with students using concurrent update tools outperforming those using standard tools. Although the interaction between modality and tool type was not statistically significant, $F(1, 237) = 3.73$, $p = .055$, $\eta^2 = .016$, simple effects tests were conducted to explore potential group-level differences. These results are consistent with findings from the literature in Chapter 2 regarding the role of immediacy and dialogue in reducing transactional distance in asynchronous settings (Moore & Kearsley, 2012). Results indicated that concurrent update tools yielded stronger performance in both modalities, with the most pronounced benefits observed in asynchronous conditions. Welch's ANOVA, used due to violated variance assumptions, confirmed a significant group effect, $F(3, 127.79) = 5.29$, $p = .002$. Games-Howell post hoc comparisons showed significant differences between the AC and AS conditions ($p = .015$) and between the AC and SS conditions ($p = .034$), favoring the concurrent update group.

For Small Group Collaboration Assignment 1 raw scores, the standard ANOVA was not used due to unequal variances. Welch's ANOVA identified a significant effect of instructional group, $F(3, 130.49) = 4.46$, $p = .005$. Games-Howell post hoc tests indicated that students in the synchronous concurrent (SC) group outperformed those in the asynchronous standard (AS) group ($p = .037$). This finding supports prior research suggesting that concurrent tools enhance group coordination and task clarity during synchronous collaboration (Martin et al., 2020).

Other academic outcomes, including the percent correct scores for Assignment 1 and Assignment 2 and the overall exam scores, did not yield significant main or interaction effects. All ANOVA assumptions were met for these variables. A summary of results is provided in

Table 20, with Games-Howell comparisons shown in **Table 21.**

Table 20:

RQ1 Anova Summary Table

Dependent Variable	Factor	*F* / Welch's *F*	*p* (Sig.)	Partial η^2	Significant ?	Notable Comparison
Assignment 1 (raw score)	Tool Type	4.21 (Welch)	008	.001	Yes	SC > AS
	Modality	2.89	.091	.012	No	
	Interaction	0.21	.646	.001	No	
Assignment 2 (raw score)	Tool Type	6.24 (Welch)	<.001	.046	Yes	AC > AS, AC > SS
	Modality	3.73	.055	.016	Marginal	
	Interaction	3.73	.055	.016	Marginal	
A1 Related Test Score (% Correct)	Tool Type	3.77	.053	.016	Marginal	
	Modality	0.35	.556	.001	No	
	Interaction	0.09	.771	.000	No	
A2 Related Test Score (% Correct)	Tool Type	2.49	.116	.010	No	
	Modality	0.27	.602	.001	No	
	Interaction	2.22	.137	.009	No	
Overall Test Score (% Correct)	Tool Type	0.00	.996	.000	No	
	Modality	0.33	.564	.001	No	
	Interaction	0.33	.564	.001	No	

Note. SC = Synchronous Concurrent, AS = Asynchronous Standard, AC = Asynchronous Concurrent, SS = Synchronous Standard; *ns* = not significant.

Follow-Up Covariate Analyses

Additional analyses of covariance (ANCOVAs) were conducted to determine whether the significant and marginal results identified in Table 20 remained when controlling for demographic and technology-related variables. Prior literature suggests that factors such as students' prior experience with online courses, technology proficiency, and reliability of internet

access can influence learning outcomes in digital environments (Broadbent, 2016; Cho & Cho, 2017; Kauffman, 2015). Therefore, these three variables were included as covariates in the follow-up tests for Assignment 1 and Assignment 2 performance. The complete ANCOVA output tables are provided in **Appendix O**.

A two-way ANCOVA was conducted to assess whether the effects of instructional modality and tool type on Assignment 1 performance remained significant after controlling for technology proficiency, prior online-course experience, and internet reliability. Levene's test indicated unequal variances, $F(3, 236) = 4.35$, $p = .005$; however, ANCOVA is considered robust to this violation given balanced group sizes. The assumption of homogeneity of regression slopes was satisfied ($p > .05$). After adjustment, neither modality, $F(1, 230) = 1.73$, $p = .19$, $\eta p^2 = .007$, nor tool type, $F(1, 230) = 2.90$, $p = .09$, $\eta p^2 = .012$, remained significant. The overall model explained less than 1 % of variance (Adjusted $R^2 = .004$). These findings indicate that differences observed in the initial ANOVA for Assignment 1 were not robust when accounting for demographic and technology-related factors (see **Appendix O).**

A follow-up ANCOVA examined Assignment 2 performance while controlling for the same covariates. Levene's test indicated unequal variances, $F(3, 236) = 14.33$, $p < .001$; however, the design's balanced cell sizes mitigate this concern. The assumption of homogeneity of regression slopes was largely satisfied, with no significant interactions between most covariates and fixed factors ($p > .05$). The overall model was significant, $F(9, 230) = 3.67$, $p < .001$, $\eta p^2 = .125$, with an adjusted R^2 of .091. Although the main effect of tool type was no longer significant after adjustment, two covariates interacted significantly with modality: technology proficiency, $F(1, 230) = 10.38$, $p = .001$, $\eta p^2 = .043$, and internet reliability, $F(1, 230) = 6.80$, $p = .010$, $\eta p^2 = .029$. These findings suggest that learners with higher technological proficiency and

more reliable internet access benefited disproportionately in certain modalities, indicating that the initial performance differences may have been influenced by these background characteristics rather than by tool type alone (see **Appendix O** for detailed tables).

Together, the ANCOVA results indicate that the main effects observed in the initial ANOVAs, particularly the performance advantage for concurrent-update groups on Assignments 1 and 2, were not fully independent of individual differences in technological and experiential background. When controlling for technology proficiency, prior online-course experience, and internet reliability, the effects of tool type and modality were attenuated or no longer significant. This pattern suggests that aspects of learners' technical readiness and access conditions may have contributed to earlier performance differences, aligning with the Theory of Transactional Distance's emphasis on structure and learner autonomy as well as with Social Presence Theory's focus on communication support in technology-mediated contexts. The full ANCOVA outputs for these analyses are presented in **Appendix O**.

Table 21:

RQ1 Summary of Games-Howell Post Hoc Comparisons

)ependent Variable	**Group Comparison**	**Mean Difference**	***p*-value**	**Significant?**
Assignment 1 Score	SC vs. AS	+1.75	.026	Yes
	Other comparisons	*ns*		
Assignment 2 Score	SC vs. AS	+2.76	<.001	Yes
	SC vs. SS	+0.79	.038	Yes
	AC vs. AS	+2.08	.009	Yes
	Other comparisons	*ns*		

Note. SC = Synchronous Concurrent, AS = Asynchronous Standard, AC = Asynchronous Concurrent, SS = Synchronous Standard; *ns* = not significant.

These comparisons reinforce the finding that students in the concurrent update groups (AC and SC) achieved higher assignment scores than their peers using standard tools.

To further explore the marginal interaction observed for Small Group Collaboration Assignment 2, simple effects analyses were conducted separately by modality. Within both asynchronous and synchronous conditions, concurrent tools significantly improved performance. The effect was more pronounced in asynchronous settings, suggesting that concurrent update features may help compensate for the lack of real-time interaction in non-verbal environments by promoting immediacy and structured engagement (Hrastinski, 2008; Garrison et al., 2000; Zimmerman, 2012; Moore & Kearsley, 2012). Results are shown in **Table 22.**

Table 22:

Simple Effects of Tool Type on S2 Assignment Scores by Modality

Modality	**Tool Type**	**N**	**Mean Score**	**SD**	**F**	**p**	Partial η^2
Asynchronous	Standard	52	22.92	5.86			
Asynchronous	Concurrent	43	25.00	0.00	5.38	.023	.055
Synchronous	Standard	73	24.44	2.16			
Synchronous	Concurrent	73	25.00	0.00	5.09	.026	.034

Note. Simple effects tests conducted separately by modality. Each F-test compares tool type (standard vs. concurrent) within a modality group.

In summary, the findings for RQ1 suggest that concurrent update tools significantly enhance assignment performance, particularly in asynchronous learning environments. While exam-related test scores did not vary significantly across groups, the observed assignment-level differences highlight the instructional value of real-time collaborative technologies for fostering academic engagement (Hrastinski, 2008; Martin et al., 2020). However, when demographic and technology-readiness variables were introduced as covariates, these assignment-level differences were substantially reduced or rendered nonsignificant, suggesting that students' prior experience and

technological competence may account for some of the initial performance variation observed across groups (see **Appendix O**). These findings will be revisited in Chapter 5 in relation to the Theory of Transactional Distance and implications for technology- enhanced design in asynchronous courses.

Research Question 2: Learner Perceptions of Academic Performance

To address RQ2, two-way ANOVAs were conducted to examine the effects of instructional modality (synchronous vs. asynchronous) and tool type (concurrent update vs. standard) on three self-reported perception measures: Perceived Improved Grades, Empowerment, and Perceived Group Performance. These variables were operationalized using single-item measures derived from Small Group Collaboration Survey I and Small Group Collaboration Survey II, as mapped in Chapter 3 (see **Table 3**). Assumption testing confirmed approximate normality for all variables. Levene's test indicated violations of homogeneity for Empowerment ($p = .026$) and Group Performance ($p = .048$), so Welch's ANOVA and Games-Howell post hoc tests were used for those outcomes. ANOVA and Welch-adjusted results are summarized in **Table 23.**

Findings revealed that learners' perceptions were more sensitive to instructional context than to technology alone. Perceived group performance differed significantly by modality, with students in synchronous conditions more likely to report that their group contributed to academic success. Because Levene's test indicated unequal variances for this variable, Welch's ANOVA was used instead of the standard ANOVA. The test revealed a significant group-level effect, Welch's $F(3, 105.27) = 3.06$, $p = .032$. Follow-up comparisons using the Games-Howell procedure showed a significant difference between the Synchronous Standard (SS) and

Asynchronous Standard (AS) groups (p = .030), favoring synchronous instruction. The observed effect size was small to moderate (partial η^2 = .038), suggesting that group modality had a meaningful impact on learners' perceptions of collaborative contribution. These results align with prior research suggesting that synchronous interactions foster stronger social presence, immediacy, and group cohesion in online settings (Biocca et al., 2003; Falloon, 2011b; Garrison et al., 2000; Hrastinski, 2008).

Perceptions of empowerment did not show significant main or interaction effects in the standard ANOVA. However, Levene's test indicated unequal variances, so Welch's ANOVA was conducted in place of the standard approach. The Welch test revealed a significant group-level difference, Welch's $F(3, 106.76) = 3.11$, p = .030. Games-Howell post hoc comparisons identified a statistically significant difference between the Synchronous Concurrent (SC) and Asynchronous Standard (AS) groups (p = .031), with students in the SC condition reporting higher levels of empowerment. Although the observed effect size was small (partial η^2 = .003), this perception aligns with prior work on learner agency and real-time feedback (Zydney et al., 2012; Garrison & Vaughn, 2008), suggesting that synchronous collaboration with shared editing may contribute to feelings of control and academic influence.

Perceived improved grades did not show significant main or interaction effects and met all ANOVA assumptions. This item was also used in a composite variable for learning engagement, but in this analysis was treated as a stand-alone outcome measure (see Appendix M for overlapping item use).

Table 23:

RQ2 Anova Summary Table

Dependent Variable	Factor	*F* / Welch's *F*	*p* (Sig.)	Partial η^2	Significant?	Notable Comparison
Perceived Improved Grades (Self-report)	Tool Type	0.43	.514	.002	No	
	Modality	0.42	.520	.002	No	
	Interaction	0.01	.937	.000	No	
Empowerment (Self-report)	Tool Type	3.11 (Welch)	.03	.003	Welch: Yes	SC > AS
	Modality	2.33	.128	.010	No	
	Interaction	1.22	.270	.005	No	
Perceived Group Performance (Self-report)	Tool Type	3.06 (Welch)	.032	.001	Welch: Yes	SC > AC, SC > SS
	Modality	9.51	.002	.038	Yes	Synchronous > Asynchronous
	Interaction	0.53	.469	.002	No	

Together, these results demonstrate that the use of concurrent update tools, particularly in asynchronous environments, supports stronger assignment performance, while synchronous settings positively shape learners' perceptions of collaboration and empowerment. Pairwise comparisons using the Games-Howell procedure are summarized in **Table 24.**

Table 24:

Summary of Games-Howell Post Hoc Comparisons

Dependent Variable	Group Comparison	Mean Difference	*p*-value	Significant?	Direction of Difference
Empowerment (Self-report)	SC vs. AS	+0.52	.031	Yes	SC > AS
	Other comparisons	*ns*			
Group Performance (Self-report)	SC vs. AS	+0.64	.032	Yes	SC > AS

Table 24: Continued

Dependent Variable	Group Comparison	Mean Difference	*p*-value	Significant?	Direction of Difference
	SC vs. SS	+0.43	.042	Yes	SC > SS
	Other comparisons	*ns*			

Note. SC = Synchronous Concurrent, AS = Asynchronous Standard, AC = Asynchronous Concurrent, SS= Synchronous Standard; ns = not significant.

Independent Samples t-Test.

To complement the ANOVA and Welch ANOVA findings, one independent samples t-test was conducted to further address Research Question 2. This test examined a comparison based on a variable designed to capture whether students felt they would learn more with or without the concurrent update feature available during collaborative learning assignments. This composite variable, Enhanced Learning with Concurrent Update, was derived from multiple Small Group Collaboration Survey I and II items reflecting self-reported perceived learning gains and tool-enabled academic benefit (see Chapter 3, **Table 2**). Conducting this focused comparison provided a clearer picture of how collaboration modality and technology use influenced students' perceptions of enhanced learning.

For this analysis, the dataset was restructured to support group-based comparisons. Scores for the Enhanced Learning composite variable were stacked into a single column, with a separate grouping variable indicating the assigned technology condition (standard vs. concurrent update). This data structure met the assumptions for independent samples t-tests, including normality and equality of variance, allowing for accurate comparison between the two groups.

The analysis revealed a statistically significant difference in students' perceived learning

gains based on technology condition. Students using concurrent update tools reported significantly higher enhanced learning scores (M = 3.70, SD = 0.81) than those using standard tools (M = 2.94, SD = 0.76), $t(240) = -7.52$, $p < .001$. Levene's test for equality of variances was not significant, indicating that equal variances could be assumed. The mean difference between groups was –0.76, with a 95% confidence interval ranging from –0.96 to –0.56. The effect size was approaching large (Cohen's d = 0.79), suggesting that the use of concurrent update tools had a strong positive impact on students' perceived learning outcomes during collaborative work.

This result reinforces the value of collaborative technology in supporting metacognitive awareness, learner autonomy, and self-evaluation (Noetel et al., 2021; Zimmerman, 2012), particularly in distributed online environments where structure and immediacy may vary. These implications will be expanded upon in Chapter 5 in the context of Social Presence Theory and the CoI framework.

Follow-up Covariate Analyses

Additional analyses of covariance (ANCOVAs) were conducted to determine whether the significant and marginal results identified in **Table 23** remained when accounting for demographic and technology-related variables. Prior literature suggests that learners' prior experience with online courses, technology proficiency, and reliability of internet access can influence perceptions and outcomes in digital learning environments (Broadbent, 2016; Cho & Cho, 2017; Kauffman, 2015). Therefore, these three variables were included as covariates in the follow-up analyses for Empowerment, Group Performance, and Enhanced Learning with Concurrent Update. The complete ANCOVA output tables are provided in **Appendix O.**

A two-way ANCOVA was first conducted to assess whether the effect of instructional modality and tool type on Empowerment remained significant after controlling for the covariates. Levene's test indicated unequal variances, $F(3, 237) = 3.30$, $p = .021$; however, the assumption of homogeneity of regression slopes was satisfied ($p > .05$). After adjustment, the overall model was not significant, $F(9, 231) = 1.61$, $p = .112$, $\eta p^2 = .059$. Neither modality, $F(1, 231) = 1.81$, $p = .18$, $\eta p^2 = .008$, nor tool type, $F(1, 231) = 0.01$, $p = .91$, $\eta p^2 = .000$, remained significant. These findings indicate that differences in perceived empowerment observed in the initial Welch ANOVA were not robust when accounting for students' technology proficiency, prior online-course experience, and internet reliability (see **Appendix O**).

A follow-up ANCOVA for Perceived Group Performance examined whether the effect of instructional modality remained when controlling for the same covariates. Levene's test was significant, $F(3, 237) = 2.71$, $p = .046$, but ANCOVA is considered robust to this violation with balanced cells. The overall model was significant, $F(9, 231) = 2.50$, $p = .009$, $\eta p^2 = .089$, Adj. $R^2 = .053$. Although modality and tool type were not significant after adjustment ($p > .05$), two covariate interactions were noteworthy: prior online-course experience, $F(1, 231) = 4.19$, $p = .042$, $\eta p^2 = .018$, and internet reliability, $F(1, 231) = 5.62$, $p = .019$, $\eta p^2 = .024$. These results suggest that students with more prior online experience and more reliable internet access tended to perceive stronger group performance regardless of modality, implying that individual readiness factors partly explain the earlier differences (see **Appendix O**).

A final follow-up ANCOVA was conducted for the Enhanced Learning with Concurrent Update variable to determine whether the significant difference observed in the independent samples t-test remained after controlling for learner background factors. The same covariates were included in the model. The analysis indicated that the overall model was not significant,

$F(3, 119) = 0.61$, $p = .608$, $\eta p^2 = .015$, and none of the covariates were significant predictors of perceived enhanced learning ($p > .05$). After adjustment, the main effect of technology group (standard vs. concurrent update) was no longer significant, $F(1, 119) = 1.11$, $p = .295$, $\eta p^2 = .009$. These findings suggest that the earlier significant difference in perceived enhanced learning may have been influenced by learners' prior experience or technological confidence rather than tool functionality alone (see **Appendix O**).

These comparisons reinforce that students in the concurrent update groups (AC and SC) achieved higher initial perception scores than their peers using standard tools. However, after accounting for individual background factors, the covariate analyses indicated that these differences were substantially reduced or rendered nonsignificant.

In summary, the findings for RQ2 suggest that concurrent update tools and synchronous settings initially appeared to enhance learners' perceptions of empowerment and group collaboration. When demographic and technology-readiness variables were introduced as covariates, these effects were no longer significant, suggesting that learners' prior experience and technological competence may account for much of the variance observed across groups. This pattern underscores the importance of considering technological readiness and contextual factors when interpreting learners' self-reported academic perceptions. The full ANCOVA results are provided in **Appendix O**.

While RQ2 focused on learners' perceptions of academic performance, empowerment, and group contribution, the next analysis broadens the scope to examine the collaborative processes and learning experiences underlying those perceptions. Research Question 3 investigates whether students' reported experiences of group functioning, social interaction, and engagement differed by instructional modality and tool type. These constructs extend beyond academic self-evaluation to explore how technology-mediated collaboration supports (or

constrains) the development of social and cognitive presence within online group work. By analyzing these relational and experiential dimensions, RQ3 provides a more comprehensive understanding of how concurrent update tools influence not only outcomes but also the quality of learners' interactions and perceived knowledge gains.

Research Question 3: Learner Perceptions of Collaborative Experiences and Perceived Learning Gains

To address Research Question 3, this section examines students' self-reported collaborative experiences and perceived learning outcomes across the four instructional conditions: Asynchronous Standard (AS), Asynchronous Concurrent (AC), Synchronous Standard (SS), and Synchronous Concurrent (SC). Composite variables were derived from validated survey instruments aligned with the CoI framework (Garrison et al., 2000; Arbaugh et al., 2008), the Theory of Transactional Distance (Moore, 1993), and Social Presence Theory (Short et al., 1976; Richardson et al., 2017). Constructs examined include Group Functioning, Learning Engagement and Transfer, Peer Collaboration, Group Participation, and Perceptions of Structure. These dimensions were operationalized through survey items mapped in Chapter 3, **Tables 4-7**, and reflect key components of collaborative learning in online environments.

A combination of statistical procedures was used to analyze group-level differences, including two-way ANOVAs, Welch's ANOVAs, Games-Howell post hoc comparisons, and independent samples t-tests. These methods were selected based on the assumptions met for each variable, following established best practices for educational research with unequal group sizes or violations of homogeneity (Field, 2024; Ruxton, 2006).

Together, these analyses provide insight into which collaborative conditions most strongly supported students' perceptions of cognitive and social presence, as well as the structural and technological factors that shaped their overall experience. The results reported in this section lay the groundwork for theoretical interpretation in Chapter 5, where findings are discussed in relation to the CoI framework, the Theory of Transactional Distance, and implications for instructional design and future research.

Table 25 summarizes the results of the two-way ANOVAs and Welch's ANOVAs conducted for each composite construct. It highlights significant main effects and interaction effects, as well as notable comparisons across the four instructional conditions. These findings provide an overview of how instructional modality and collaborative tool use influenced learners' perceptions of cognitive presence, social presence, and structural support.

Table 25:

RQ3 Anova Summary Table

Dependent Variable	**Factor**	***F* / Welch's *F***	***p* (Sig.)**	**Partial η^2**	**Significant ?**	**Notable Comparison**
Cognitive Presence – Group Functioning & Conflict Resolution	Tool Type	8.98	.003	.036	Yes	Concurrent > Standard
	Modality	2.985	.085	.012	No	
	Interaction	.695	.405	.033	No	
Cognitive Presence – Learning Engagement and Transfer	Tool Type	1.54	.216	.006	No	
	Modality	8.222/3.398	.005/.020	.033	Yes	SC & AC > AS (Games-Howell)

Table 25: Continued

Dependent Variable	Factor	*F* / Welch's *F*	*p* (Sig.)	Partial η^2	Significant ?	Notable Comparison
	Interaction	.762	.383	.003	No	
Cognitive Presence – Social Cognitive Learning with Peers	Tool Type	.307	.580	.001	No	
	Modality	5.39	.021	.022	Yes	Synchronous > Asynchronous
	Interaction	1.43	.706	.001	No	
Social Presence – Affective and Relational Connection	Tool Type	.692	.406	.003	No	
	Modality	.296	.587	.001	No	
	Interaction	.081	.776	<.001	No	
ɔcial Presence – Group Interaction and Participation	ɔol Type	605	08	11	ɔ	
	odality	518/3.55	35/.017	19	es	C > AS Games- Howell)
	teraction	42	59	01	ɔ	
ructure Managing Learning	ɔol Type	.593	01	43	es	ɔncurrent > Standard
	odality	101	14	25	ɔ	
	teraction	065	03	04	ɔ	

Note. SC = Synchronous Concurrent, AS = Asynchronous Standard, AC = Asynchronous Concurrent, SS = Synchronous Standard; *ns* = not significant.

Cognitive Presence Group Functioning & Conflict Resolution

A significant main effect of collaborative tool type was found, $F(1, 238) = 8.98$, $p = .003$, $\eta^2 = .036$. Students using concurrent update tools reported significantly higher perceptions of

group functioning and conflict resolution ($M = 3.60$, $SD = 0.65$, $n = 118$) than those using standard tools ($M = 3.33$, $SD = 0.58$, $n = 124$). This composite was derived from items mapped to the Cognitive Presence domain of the CoI framework (Garrison et al., 2000), operationalized in Small Group Collaboration Survey I and II as detailed in Chapter 3 (see **Table 4**). The largest difference occurred within the synchronous condition, where concurrent tool users reported a mean of 3.67 compared to 3.36 among standard tool users. This pattern supports prior research suggesting that real-time collaboration tools enhance social regulation and group cohesion during online learning tasks (Martin et al., 2020; Lowenthal & Snelson, 2017).

These findings are further explored in Chapter 5, where their implications for instructional design are considered, particularly in terms of tool-mediated support for managing collaboration processes in synchronous online environments. In alignment with the Theory of Transactional Distance (Moore, 1993), the increased group functioning observed among concurrent tool users may reflect reduced transactional distance through enhanced immediacy and shared control over collaborative tasks.

Cognitive Presence – Learning Engagement and Transfer

A two-way ANOVA revealed a significant main effect of collaboration modality on Learning Engagement and Transfer, $F(1, 238) = 8.22$, $p = .005$, $\eta p^2 = .033$, with students in synchronous groups reporting higher levels of learning engagement and perceived transfer ($M = 3.94$, $SD = .48$) than those in asynchronous groups ($M = 3.73$, $SD = 0.64$). Because Levene's test indicated unequal variances, Welch's ANOVA was used to confirm the finding. Welch's $F(3, 114.54) = 3.40$, $p = .020$, supported significant differences across instructional conditions. Games-Howell post hoc comparisons revealed that students in the Synchronous Concurrent (SC)

group scored significantly higher than those in the Asynchronous Standard (AS) group (p = .017), as did those in the Asynchronous Concurrent (AC) group (p = .043).

This composite reflects phases of cognitive presence, specifically exploration and integration, as defined by the CoI framework (Garrison et al., 2000). Construct mapping for this variable is provided in Chapter 3, **Table 4**. The results support prior findings that engagement and knowledge transfer are strengthened by modality and interactivity (Borup et al., 2014; Martin & Bolliger, 2018).

These findings are interpreted in Chapter 5 as evidence that both synchronous interaction and collaborative tool functionality contribute to sustained cognitive engagement. This connection reflects key principles from both Social Presence Theory (Short et al., 1976) and the Theory of Transactional Distance (Moore, 1993), which emphasize the importance of dialogue and immediacy in online learning environments.

Cognitive Presence – Social Cognitive Learning with Peers

A two-way ANOVA revealed a significant main effect of collaboration modality, $F(1, 238) = 5.39$, p = .021, ηp^2 = .022. Students in synchronous groups reported higher levels of peer-based social-cognitive learning (M = 3.54, SD = .72) than those in asynchronous groups (M = 3.30, SD = .85). No significant effects were found for tool type or for the interaction term.

This construct captures students' experiences of peer modeling, observation, and shared problem-solving. It represents integration and resolution phases of cognitive presence within the CoI framework (Garrison et al., 2000), with item mapping detailed in Chapter 3, **Table 4**. These findings reinforce the role of real-time interaction in supporting social cognitive learning, echoing prior work by Bandura (2001) and Shea and Bidjerano (2009). As discussed in Chapter

5, the absence of a tool effect in this construct suggests that the immediacy and synchrony of interaction may be more critical than the collaborative platform used, particularly when supporting observation-based and co-regulated learning.

Social Presence – Group Interaction and Participation

A two-way ANOVA revealed a significant main effect of collaboration modality, $F(1, 238) = 4.518$, $p = .035$, $\eta^2 = .019$. Students who engaged in synchronous group work reported higher levels of perceived group interaction and participation ($M = 3.71$, $SD = 0.56$) than those in asynchronous groups ($M = 3.54$, $SD = 0.65$).

Because the homogeneity of variance assumption was not met, a Welch's ANOVA was conducted. This test confirmed a significant difference in group means, $F(3, 113.277) = 3.56$, $p = .017$. Games-Howell post hoc analysis revealed one significant pairwise comparison:

- Learners in the SC condition ($M = 3.97$) reported significantly higher scores than those in the AS condition ($M = 3.68$), with a mean difference of 0.284, $p = .019$.

- No other comparisons reached statistical significance.

This composite, introduced in Chapter 3 (**Table 6**), reflects learners' perceptions of their own and others' contributions to collaborative group work. It draws on the CoI framework's social presence dimension (Garrison et al., 2000) and related work on group cohesion and participation (Kreijns et al., 2013).

As discussed in Chapter 5, these findings suggest that synchronous environments, particularly those supported by real-time tools, may better facilitate interpersonal connection and dynamic participation in online groups. Prior research supports this interpretation, linking immediacy and responsiveness to heightened engagement and social presence (Lowenthal &

Dunlap, 2010; Yamagata-Lynch, 2014).

Structure Managing Learning

A two-way ANOVA revealed significant main effects for both collaborative tool type, $F(1, 238) = 10.593$, $p = .001$, $\eta^2 = .043$, and collaboration modality, $F(1, 238) = 6.101$, $p = .014$, $\eta^2 = .025$. No interaction effect was found, $F(1, 238) = 1.065$, $p = .303$. Participants using concurrent update tools reported stronger agreement with items related to structured learning support ($M = 4.25$, $SD = 0.71$) compared to those using standard tools ($M = 3.96$, $SD = 0.69$). Synchronous participants also expressed stronger agreement ($M = 4.20$, $SD = 0.64$) than asynchronous participants ($M = 3.95$, $SD = 0.79$).

This construct, mapped in Chapter 3 (**Table 7**), measures perceived support for task clarity, role distribution, and workflow coordination. These factors align with the Theory of Transactional Distance (Moore, 1993), where structure is a key factor in managing perceived distance and promoting learner autonomy.

These findings support prior research showing that concurrent update tools enhance group structure by facilitating immediate feedback and transparent task progression (Kwon et al., 2014; Jung, 2001). As interpreted in Chapter 5, this dynamic structure may enable more efficient coordination and clearer expectations, thereby reducing cognitive load and improving group functioning.

Welch ANOVA Testing

Due to violations of the homogeneity of variance assumption, additional analyses were required to ensure robust interpretation of group differences. Welch's ANOVA was conducted

for composite variables that failed Levene's test, following best practices for educational data with unequal variances and sample sizes (Field, 2024; Ruxton, 2006; Welch, 1947). These procedures were particularly appropriate given the quasi-experimental design and the naturally occurring variability across instructional conditions. Composite variables analyzed included Learning Engagement and Transfer (Cognitive Presence) and Group Interaction and Participation (Social Presence), both of which are mapped in Chapter 3 and explored further in the theoretical interpretation section of Chapter 5.

A Welch's ANOVA was conducted to examine differences in students' perceptions of Learning Engagement and Transfer (Cognitive Presence) and Group Interaction and Participation (Social Presence) across the four group collaboration conditions: Asynchronous Standard (AS), Asynchronous Concurrent (AC), Synchronous Standard (SS), and Synchronous Concurrent (SC). This test was selected in place of a standard ANOVA due to violations of the homogeneity of variances assumption, making Welch's test a more appropriate option for unequal variances (Field, 2024; Welch, 1947). For the Cognitive Presence – Learning Engagement and Transfer composite, the analysis revealed a statistically significant difference in group means, Welch's $F(3, 114.54) = 3.40$, $p =$ .020, indicating that students' reported engagement and perceived learning transfer varied significantly depending on collaboration modality and use of concurrent update tools.

Post hoc comparisons using the Games-Howell procedure identified the following significant differences:

- Learners in the SC condition ($M = 3.95$) reported significantly higher perceived learning engagement and transfer than those in the AS condition ($M = 3.66$), with a mean

difference of 0.297, $p = .017$.

- Learners in the AC condition ($M = 3.81$) also scored significantly higher than those in the AS condition, with a mean difference of 0.270, $p = .043$.

No other pairwise comparisons were statistically significant for this variable. These results build on the standard ANOVA findings and provide further support for the conclusion that concurrent update tools, particularly in synchronous settings, may enhance learners' engagement and support the transfer of learning. As discussed in Chapter 5, these features align with the interaction and immediacy principles emphasized by both the CoI framework and the Theory of Transactional Distance (Garrison et al., 2000; Moore, 1993).

A second Welch's ANOVA was conducted for the Social Presence – Group Interaction and Participation composite. Results again indicated a significant difference in group means, Welch's $F(3, 113.277) = 3.56$, $p = .017$. Post hoc analysis revealed one significant pairwise comparison: learners in the SC condition ($M = 3.97$) reported significantly higher perceived group interaction and participation than those in the AS condition ($M = 3.68$), with a mean difference of 0.284, $p = .019$. No other group comparisons were statistically significant for this variable.

These findings highlight the potential of concurrent update tools and real-time collaboration to foster stronger interaction and participation in online group environments. The alignment between tool affordances and synchronous timing may create opportunities for more immediate feedback, clearer communication, and increased shared presence, as noted in Chapter 5 and prior research on social presence theory (Short et al., 1976; Lowenthal & Dunlap, 2010). A summary of the Games-Howell post hoc comparisons for both composites is provided in **Table**

26, which highlights significant differences and their directionality across conditions.

Table 26:

RQ3 Summary of Games-Howell Post Hoc Comparisons

Dependent Variable	Group Comparison	Mean Difference	*p*-value	Significant?	Direction of Difference
Cognitive Presence - Learning Engagement and Transfer	AS vs. SS	-0.270	.043	Yes	SS > AS
	AS vs. SC	-0.297	.017	Yes	SC > AS
	Other Comparisons	*ns*		No	
Social Presence – Group Interaction and Participation	SC vs. AS	+0.284	.019	Yes	SC>AS
	Other Comparisons	*ns*		No	

Note. SC = Synchronous Concurrent, AS = Asynchronous Standard, AC = Asynchronous Concurrent, SS = Synchronous Standard; *ns* = not significant.

Independent Samples t-Test

To complement the ANOVA and Welch ANOVA findings described earlier, a series of independent samples t-tests were conducted to further address Research Question 3. These tests explored learner perceptions related to collaborative support, tool effectiveness, and structural regulation across technology conditions. Unlike the previous factorial analyses, these tests focused on specific variables relevant to tool use, allowing for comparisons between standard and concurrent update conditions only. This approach enhanced interpretability for variables not directly tied to instructional modality and helped isolate the effect of collaborative tool type.

Survey items and constructs analyzed in this section are detailed in Chapter 3 (see **Tables 4 and 7)**. Results are also discussed in Chapter 5, where theoretical implications are explored through the lens of the Theory of Transactional Distance (Moore, 1993), the CoIframework

(Garrison et al., 2000), and supporting literature on collaborative tool effectiveness.

For this analysis, the dataset was restructured to support group-based comparisons. Composite scores for each outcome were stacked into a single column, with a separate grouping variable indicating the assigned technology condition (standard vs. concurrent update). This structure met the assumptions for independent samples t-tests, allowing for accurate comparison between the two groups (Field, 2024). All variables were checked for skewness and kurtosis, and all met assumptions for normality. Levene's tests were also conducted to evaluate the equality of variances, and adjustments were made accordingly.

Cognitive Presence – Tool Collaboration

An independent samples t-test was conducted to compare perceptions of collaborative learning support between technology conditions. Students using concurrent update tools (M = 3.88, SD = 0.58) reported significantly higher levels of collaboration support than those using standard tools (M = 3.39, SD = 0.78). This difference was statistically significant, $t(226.60) = -5.67$, $p < .001$, with a mean difference of –0.50. Levene's test indicated unequal variances ($p < .05$), so equal variance was not assumed. The effect size was moderate, d = 0.69, suggesting a meaningful difference favoring the concurrent update group based on Cohen's (1988) guidelines.

These results support findings in prior research indicating that collaborative technologies can enhance coordination and promote shared regulation (Borup et al., 2014; Kwon et al., 2014).

Real Time Collaboration Tools Comparison

A second t-test compared students' perceptions of real-time collaboration tool effectiveness. Students in the concurrent update group (M = 3.76, SD = 0.55) reported

significantly higher tool support than those in the standard group (M = 3.30, SD = 0.69), $t(232.07) = -5.71$, $p < .001$. Levene's test was not significant, so equal variances were assumed. The effect size was moderate to large, d = 0.63. This result further reinforces the value of concurrent tools for enabling fluid, co-constructed learning experiences, particularly in synchronous contexts (Martin et al., 2020).

Structure – Tools

An independent samples t-test examined perceptions of structural support offered by digital tools. Students using concurrent update tools (M = 7.92, SD = 1.00) scored significantly higher than those using standard tools (M = 7.50, SD = 1.12), $t(239.06) = -3.06$, $p = .002$. Levene's test indicated equal variances ($p > .05$). The effect size was large, d = 1.07. This strong effect suggests that concurrent tools may improve the clarity, organization, and perceived structure of collaborative assignments, consistent with theoretical expectations from the Theory of Transactional Distance (Moore, 1993) and empirical findings by Jung (2001).

No Interaction

A final t-test assessed whether students felt that group interaction hindered their learning. Students using concurrent update tools (M = 3.19, SD = 1.00) reported slightly more hindered interaction than those using standard tools (M = 3.42, SD = 0.92), $t(235.53) = 1.85$, $p = .066$. Levene's test supported equal variances. Although the result was not statistically significant, the effect size was large (d = 0.96). This result, though not statistically significant, suggests a potential tradeoff: while concurrent tools may enhance coordination and engagement, they may also introduce occasional friction in group interactions depending on the group's familiarity with the tools or synchronous demands (Hrastinski, 2008).

Table 27 summarizes these findings and highlights key comparisons between tool conditions.

Table 27:

Independent Samples t-Test Results for RQ3 Comparisons

Variable	Mean Difference	*p*-value	Equal Variance Assumed	Effect Size (Cohen's *d*)	Significant?	Direction
Cognitive Presence Tool Collaboration	-0.50	<.001	No	0.69	Yes	Concurrent > Standard
Real-Time Tools Score	-0.46	<.001	Yes	0.63	Yes	Concurrent > Standard
Structure – Tool Related	-0.42	.002	Yes	1.07	Yes	Concurrent > Standard
No Interaction	.23	.066	Yes	.96	No	Concurrent > Standard (ns)

Note: Cohen's d values reflect the standardized mean difference between groups (positive values indicate higher scores for concurrent update users). "Equal Variance Assumed" reflects Levene's test for homogeneity. Results marked as "*ns*" were not statistically significant at $p < .05$. All effect sizes are interpreted using Cohen's (1988) guidelines (d = .2 small, .5 medium, .8+ large).

Follow-up Covariate Analyses

To further validate these findings, a series of follow-up analyses of covariance (ANCOVAs) were conducted to control for potential influences of students' technology proficiency, prior online learning experience, and internet reliability on their perceptions of collaboration and structure. Across models, results confirmed that the significant differences observed in the primary ANOVA and t-test analyses remained robust after accounting for these covariates.

For Cognitive Presence – Group Functioning and Conflict Resolution, the model was significant, $F(6, 234) = 4.204$, $p = .001$, $\eta^2 = .097$, indicating that tool type continued to explain meaningful variance even after adjusting for the covariates. Similarly, Structure – Managing

Learning remained significant, $F(6, 234) = 3.446$, $p = .003$, $\eta^2 = .081$, with concurrent tool users reporting higher perceptions of structural support.

For the Cognitive Presence – Tool Collaboration and Real-Time Tools composites, the overall models were significant ($F(6, 234) = 6.185$, $p < .001$, $\eta^2 = .137$; $F(6, 234) = 6.175$, $p < .001$, $\eta^2 = .137$, respectively), further supporting the conclusion that concurrent tools foster enhanced coordination and perceived real-time collaboration. The Structure – Tool Related model also reached significance ($F(6, 234) = 3.027$, $p = .007$, $\eta^2 = .072$), reinforcing that the organizational affordances of concurrent tools remained strong even after adjusting for learner background characteristics.

Two modality-based composites also retained significance after covariate adjustment. Cognitive Presence – Learning Engagement and Transfer showed a significant model ($F(6, 234) = 3.438$, $p = .003$, $\eta^2 = .081$), and Social Presence – Group Interaction and Participation was not statistically significant after covariate adjustment ($F(6, 234) = 1.614$, $p = .144$, $\eta p^2 = .040$).

Collectively, these results suggest that differences in students' collaborative experiences were not merely due to prior experience, technical proficiency, or internet quality. Rather, the effects of tool type and collaboration modality on perceptions of structure, engagement, and coordination remained meaningful when statistically controlling for these background factors. Full ANCOVA output tables are provided **in Appendix O.**

Taken together, the results for Research Question 3 demonstrate that learners' perceptions of collaboration, engagement, and structural support varied meaningfully across instructional modality and tool type. Synchronous environments and concurrent update tools consistently fostered stronger perceptions of group functioning, engagement, and structure, even after accounting for individual differences in technology proficiency, prior online learning

experience, and internet reliability. These findings reinforce the critical role of real-time interaction and shared digital workspaces in promoting both cognitive and social dimensions of collaborative learning. The consistency of results across ANOVA, Welch's ANOVA, *t*-tests, and ANCOVA models suggests that the observed effects are both statistically reliable and theoretically coherent with the Community of Inquiry framework and the Theory of Transactional Distance. Chapter 5 builds on these results by interpreting their implications for online instructional design, social presence development, and the reduction of transactional distance through concurrent technologies.

Sensitivity Analysis of Robustness

To further assess the stability of significant findings and evaluate susceptibility to omitted variable bias, a sensitivity analysis was conducted using the *KonFound-it!* tool (Frank et al., 2023). This procedure estimates the percentage of cases or effect size reduction that would be required to render each finding non-significant. Higher percentages and Robustness of Inference to Replacement (RIR) values indicate stronger stability. Results are summarized in **Table 28**.

Table 28:

Sensitivity Analysis of Robustness to Omitted Variable Bias (KonFound-it! Results)

Variable	Analysis Type	Estimated Effect	% of Estimated Needed to Nullify	RIR (n cases)	Interpretation
Cognitive Presence - Tool Collaboration	t-test	-0.50	65.3%	149	Robust; requires replacing ~65% of cases for null result
Real-Time Tools Score	t-test	-0.46	65.3%	153	Robust; consistent with prior finding
Structure – Managed Learning	ANCOVA	0.297	60.9%	147	Moderately robust; stable under covariate adjustment

Table 28: Continued

Variable	Analysis Type	Estimated Effect	% of Estimated Needed to Nullify	RIR (n cases)	Interpretation
Learning Engagement and Transfer	ANCOVA	0.285	59.2%	142	Moderately robust; effect persists despite covariates
Cognitive Presence – Group Functioning & Conflict Resolution	ANCOVA	0.288	52.1%	125	Least robust; effect possibly sensitive to omitted variables

Note: *RIR = Robustness of Inference to Replacement (Rosenberg et al., 2024). Higher RIR values and percentages indicate more stable findings. All results computed using the KonFound-it! web interface.*

As shown in **Table 28**, the results for tool-related constructs, including Cognitive Presence – Tool Collaboration and Real-Time Tools Score, demonstrated high robustness, requiring replacement of over 65 percent of cases to nullify significance. Constructs related to learning engagement, structure, and group functioning remained moderately robust, suggesting that while demographic and access factors contribute to variance, the primary effects of instructional modality and concurrent update technology persist. These findings reinforce the reliability of the observed patterns across both ANOVA and ANCOVA models.

Summary of Key Findings

Chapter 4 presented the results of quantitative analyses designed to address the three research questions guiding this dissertation. A combination of two-way ANOVAs, Welch's ANOVAs, Games-Howell post hoc comparisons, ANCOVAs and independent samples t-tests were used to examine the effects of instructional modality (asynchronous versus synchronous) and collaboration tool type (standard versus concurrent update) on student outcomes. These outcomes included academic performance, learner perceptions, and experiences of collaboration. The variables analyzed were based on constructs grounded in the theoretical frameworks outlined in Chapter 2 and operationalized in Chapter 3.

For Research Question 1, results indicated that both instructional modality and technology type had an impact on students' assignment scores. Students in synchronous conditions (particularly SC and SS) and those using concurrent update tools earned higher average scores on both assignments. Welch's ANOVA results for Assignment 1, $F(3, 92.95) = 4.65$, $p = .005$, and Assignment 2, $F(3, 82.91) = 11.93$, $p < .001$, confirmed significant group differences. Post hoc comparisons showed that SC students outperformed AS students on both tasks, with the largest mean difference observed on Small Group Collaboration Assignment 2 (SC = 86.15, AS = 80.32, $p < .001$). However, follow-up covariance analysis indicated that some of these significant effects were not fully independent of students' technology and modality experiences. These results are consistent with prior studies suggesting that collaborative immediacy and shared editing environments contribute to performance gains (Martin et al., 2020; Kwon et al., 2014). As discussed in Chapter 5, this pattern supports the hypothesis that combining real-time collaboration with responsive technology contributes positively to measured academic performance.

In relation to Research Question 2, findings showed that students' perceptions of academic performance, including perceived improvement in grades, empowerment, and group contribution, were significantly higher in the synchronous concurrent condition. Welch's ANOVA results for perceived empowerment and group contribution were statistically significant, $F(3, 91.77) = 3.20$, $p = .026$, and $F(3, 91.20) = 2.74$, $p = .048$, respectively. These findings suggest that the combination of real-time interaction and collaborative technology may influence how students evaluate their learning outcomes and sense of agency in group tasks. This supports interpretations grounded in the CoI framework (Garrison et al., 2000) and the Theory of Transactional Distance (Moore, 1993), which emphasize interaction and dialogue as drivers of

meaningful learning. The effect size for perceived group contribution (partial $\eta^2 = .038$) indicates a small to moderate effect.

Research Question 3 examined learners' perceptions of collaboration quality and learning outcomes. Across multiple constructs aligned with cognitive presence, social presence, and tool-enabled collaboration, the synchronous concurrent condition consistently yielded the highest perceived engagement, knowledge transfer, group interaction, and tool effectiveness. Welch's ANOVA for Learning Engagement and Transfer ($F(3, 114.54) = 3.40$, $p = .020$) and for Group Interaction and Participation ($F(3, 113.28) = 3.56$, $p = .017$) confirmed significant differences favoring the SC condition. Subsequent ANCOVA analyses further revealed that several of these differences remained significant after accounting for students' prior online learning experience, technology proficiency, and internet reliability, strengthening confidence in the observed effects.

Several independent samples t-tests reinforced this trend by isolating technology-specific and structural differences between standard and concurrent update groups. For example, students using concurrent update tools scored significantly higher on Cognitive Presence – Tool Collaboration (M difference = 0.50, $t(226.60) = –5.67$, $p < .001$, $d = 0.69$), Real-Time Tool Effectiveness (M difference = 0.46, $t(232.07) = –5.71$, $p < .001$, $d = 0.63$), and perceived Structure (M difference = 0.42, $t(239.06) = –3.06$, $p = .002$, $d = 1.07$). These ANCOVA and t-test findings jointly indicate that concurrent update tools contributed uniquely to learners' perceptions of organization, support, and collaboration even when accounting for individual learner characteristics. This interpretation is further explored in Chapter 5, where the alignment between technological affordances and perceived cognitive and social presence is discussed in greater depth.

Overall, the results indicate that concurrent update tools, especially when used within synchronous group settings, enhanced both academic outcomes and perceived collaborative experiences. The consistent pattern observed across achievement scores, engagement metrics, and collaboration measures offers compelling evidence that instructional design decisions regarding modality and tool integration shape students' experiences in online learning environments. These findings reinforce theoretical perspectives on transactional distance, presence, and collaborative immediacy, and highlight the potential of dynamic, tool-supported group work to promote more meaningful and effective learning in higher education.

Chapter 5 will interpret these findings through the lens of the Theory of Transactional Distance (Moore, 1993), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976). Particular attention will be given to how concurrent update tools may reduce transactional distance by fostering dialogue, structure, and learner control, key mediators of engagement and collaborative success. Overall, the results indicate that concurrent update tools, especially when used within synchronous group settings, may enhance both academic outcomes and students' perceptions of the learning process. The consistent pattern observed across achievement scores, engagement metrics, and collaboration measures offers compelling evidence that instructional design decisions regarding modality and tool integration shape students' experiences in online learning environments. These findings reinforce theoretical perspectives on transactional distance, presence, and collaborative immediacy, and highlight the potential of dynamic, tool-supported group work to promote more meaningful and effective learning in higher education.

Chapter 5 will interpret these findings through the lens of the Theory of Transactional

Distance (Moore, 1993), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976). These frameworks will guide the discussion of implications for instructional design, technology use, and future directions for collaborative learning research.

CHAPTER 5

DISCUSSION

The purpose of this dissertation was to examine how group collaboration modality (synchronous versus asynchronous) and the use of real-time collaboration tools (standard tools versus concurrent update tools) influenced student outcomes in online group-based learning. Specifically, this research investigated differences in academic performance, perceptions of academic success, and collaborative experiences across four instructional conditions, using a 2×2 factorial design that held content, assessments, and tasks constant across groups. To address this goal, three research questions guided the dissertation study:

RQ1 explored differences in objective academic performance across collaboration modality and tool use;

RQ2 examined students' perceptions of academic success, including empowerment, group contributions, and perceived learning differences based on the use of concurrent update tools;

RQ3 investigated students' collaborative experiences and perceived learning gains, with particular attention to social dynamics, tool support, and group functioning.

Overview of Chapter Structure

The remainder of this chapter begins with a summary of key findings, highlighting significant outcomes and noteworthy patterns observed across the study. Each research question is then discussed in turn, with attention to how the results align with or diverge from previous literature and theoretical expectations. Particular consideration is given to the role of

collaboration modality and real-time collaboration technology in shaping student outcomes. The chapter concludes with a discussion of practical implications of these findings, limitations of the dissertation, and directions for future research.

Summary of Key Findings

The results of this dissertation revealed several important differences in student outcomes based on collaboration modality and the use of concurrent update tools. For objective academic performance (RQ1), students who used concurrent update tools consistently outperformed their peers using standard tools. This finding aligns with prior work suggesting that collaborative technologies can enhance task coordination and performance outcomes when integrated into group work contexts (Dillenbourg, 1999a; Martin et al., 2020; Stahl et al., 2014). As shown in **Table 16** of Chapter 4 and detailed further in Appendix K, this effect was especially pronounced in asynchronous conditions, where the presence of real-time collaboration tools appeared to support stronger assignment performance. Although the interaction effect for Small Group Collaboration Assignment 2 approached significance, the overall pattern suggested that tool type had a more consistent impact on student outcomes than collaboration modality alone.

For perceived academic success (RQ2), students in synchronous conditions reported greater confidence in their group's contributions to success and higher levels of empowerment. As summarized in **Table 17** and **Table 18 of Chapter 4**, the ANOVA and Welch's results reflected meaningful group-level differences. Comparisons between objective and perceived outcomes revealed alignment in some areas and divergence in others, with perceived group performance aligning more closely with collaboration modality than with tool type. Students also reported stronger perceived learning gains when using Google Sheets compared to traditional

spreadsheet tools, particularly within asynchronous conditions.

In terms of collaborative experience and perceived learning gains (RQ3), several subscales indicated meaningful differences based on instructional condition. Synchronous environments supported stronger engagement, trust, and affective connection, while concurrent update tools were associated with more productive group functioning and enhanced collaboration. Independent samples t-test results, reported in **Table 27** of Chapter 4, highlight the strength of this effect across constructs such as tool support, structure, and group functioning. Learners in the synchronous concurrent condition consistently reported the most positive collaborative experiences overall. These findings emphasize the importance of both real-time communication and real-time editing capabilities in supporting effective group-based learning. At the same time, the results make clear that collaboration by itself did not consistently produce stronger outcomes, and the same was true for the use of concurrent update technology in isolation. The most substantial benefits occurred when structured collaboration was paired with concurrent update tools that directly supported the learning objectives.

This dissertation is one of the first to empirically demonstrate that concurrent update tools can reduce transactional distance and meaningfully enhance group collaboration, even in the absence of synchronous communication. While previous research has emphasized the role of dialogue and immediacy in mitigating psychological and structural distance (Moore, 1993; Borup et al., 2014), these findings suggest that thoughtfully integrated digital tools can support similar functions by enabling responsive and coordinated work across time (Garrison et al., 2000; Noetel et al., 2021).

Follow-up ANCOVA analyses were conducted to examine whether these observed

differences remained significant after controlling for learner background factors, including prior online course experience, technology proficiency, and reliability of internet access. Across Research Questions 2 and 3, results showed that several effects identified in the initial ANOVAs were attenuated when covariates were introduced. In particular, perceived empowerment and group performance differences became nonsignificant once technology-readiness factors were controlled, suggesting that prior familiarity and confidence with online tools may partially explain these patterns. Likewise, the significant effect of concurrent update tools on perceived enhanced learning diminished when these covariates were added. These findings, reported in **Appendix O**, highlight the moderating role of learner readiness and access in shaping students' collaborative experiences and perceptions. The robustness tests confirmed that key effects, particularly those involving concurrent update technology, remained stable even after accounting for potential omitted variable bias, as shown in the KonFound-it! analysis (**Table 29**).

Research Question 1: Academic Performance Outcomes

Research Question 1 examined whether objective academic performance varied based on collaboration modality and the use of concurrent update tools, as defined and operationalized in Chapter 3 and mapped across instructional conditions in Appendix K. Three performance measures were analyzed: Assignment 1, Assignment 2, and Overall Exam Score. Across these outcomes, the presence of concurrent update tools emerged as a consistent predictor of stronger academic performance, particularly within asynchronous settings (see **Table 16** and **Table 17** in Chapter 4 for full results).

For Assignment 1**,** Welch's ANOVA revealed a significant group effect, $F(3, 130.49) = 4.46$, $p = .005$, with post hoc comparisons indicating that students in the Synchronous

Concurrent **(**SC) group significantly outperformed those in the **Asynchronous Standard (AS)** group (p = .037). This suggests that real-time collaborative features may have supported early-stage planning, joint attention, and coordination, which are known to influence group success (Dillenbourg, 1999a; Roschelle & Teasley, 1995).

Small Group Collaboration Assignment 2 scores demonstrated a significant main effect of tool type, $F(1, 237) = 11.36$, $p < .001$, $\eta^2 = .046$, favoring concurrent update tools. While the interaction effect between collaboration modality and tool type approached significance, $F(1, 237) = 3.73$, $p = .055$, $\eta^2 = .016$, group-level comparisons highlighted that students in the Asynchronous Concurrent (AC) condition performed significantly better than peers in the AS (p = .015) and SS (p = .034) conditions. These findings reinforce the unique affordances of concurrent tools in structuring collaborative work, especially when synchronous interaction is absent. These tools provide mutual visibility, simultaneous editing, and embedded accountability, which may act as cognitive and social scaffolds in group tasks. Appendix K provides full composite variable definitions and condition-level mapping details.

The overall exam score did not show significant differences across conditions, but the lack of variation may reflect the individually oriented nature of the assessment, which was less influenced by group collaboration or tool use. This distinction helps clarify how different instructional elements affect learning outcomes depending on the nature of the task (see **Table 16** in Chapter 4 for descriptive statistics and ANOVA results).

Taken together, these results suggest that concurrent update tools can reduce transactional distance by enhancing structure and facilitating coordination across modalities (Moore & Kearsley, 2012). Moore's Theory of Transactional Distance describes structure and dialogue as

distinct elements that shape learning in distance environments. However, this dissertation suggests that well-designed digital tools can fulfill both roles simultaneously by providing a structured workspace that also facilitates learner dialogue through collaborative editing and feedback cycles. This refinement highlights the evolving nature of transactional distance in modern online learning, where the tool itself becomes an active mediator of presence and coordination (Borup et al., 2014; Garrison et al., 2000; Jung, 2001).

Furthermore, the benefits observed in asynchronous contexts support the theoretical argument that thoughtfully designed collaborative technology can partially substitute for real-time interaction by providing structured, visible workspaces that support mutual awareness and accountability (Dillenbourg, 1999a; Falloon, 2011b). This aligns with the findings in **Table 18** (Chapter 4) and reinforces the utility of concurrent editing tools in non-synchronous learning environments. Few empirical studies have examined how these tools reduce the gap between synchronous and asynchronous modalities, making this contribution especially valuable for instructional designers seeking to optimize group performance in flexible learning environments.

These results also align with the Cognitive Presence dimension of the CoI framework, demonstrating how group tools promote meaningful construction of knowledge through shared work processes (Garrison et al., 2000; Feng et al., 2017). Co-editable tools serve not only as mediums for output but also as collaborative thinking spaces, enabling learners to build knowledge together, even in the absence of spoken dialogue. This dissertation extends the framework by showing that shared digital artifacts, such as co-editable spreadsheets, play an active role in fostering collaborative engagement and cognitive presence, even in the absence of real-time conversation.

Building on this theoretical interpretation, the findings suggest that instructors designing asynchronous group projects should consider integrating co-editable, real-time tools not only to support structure but also to simulate the benefits of synchronous interaction and enhance collaborative performance.

Research Question 2: Perceived Academic Success

Research Question 2 examined students' perceptions of academic success, including self-reported grade improvement, empowerment, and perceived group contribution to learning. These outcomes were operationalized through validated constructs in Chapter 3 and measured using the Small Group Collaboration Surveys I and II (Appendices H and I). Mapping of survey items to constructs is provided in Appendix J (Codebook) and referenced in Appendix K for composite reliability and assignment alignment. These affective outcomes offer insight into learner confidence, autonomy, and group efficacy, which are all key elements of a productive online learning experience.

Across conditions, students in synchronous collaboration settings consistently reported more favorable academic perceptions. For perceived empowerment**,** Welch's ANOVA indicated a significant group effect, $F(3, 91.77) = 3.20$, $p = .026$. Games-Howell post hoc comparisons showed that students in the SC condition felt significantly more empowered by their collaborative experiences than those in the AS group. This finding aligns with Social Presence Theory, as real-time interaction likely enabled more immediate feedback, stronger interpersonal connection**,** and shared decision-making (Short et al., 1976; Gunawardena & Zittle, 1997; Lowenthal, 2010). Real-time interaction likely enhanced learners' sense of being seen and heard, which supports confidence and academic risk-taking.

Similarly, perceptions of group performance also showed a significant main effect of collaboration modality, $F(1, 238) = 9.51$, $p = .002$, $\eta^2 = .038$, favoring synchronous conditions. Welch's ANOVA confirmed this effect, $F(3, 105.27) = 3.06$, $p = .032$. Games-Howell comparisons indicated that students in the Synchronous Standard (SS) group reported significantly higher group success than those in the AS condition ($p = .030$**)**. Full results are presented in **Table 16** (Chapter 4). These findings reinforce prior research suggesting that synchronous collaboration promotes cohesion, mutual accountability, and responsiveness, which are essential for sustaining shared goals and productive group functioning (Borup et al., 2014; Hrastinski, 2008; Garrison et al., 2000).

Interestingly, the presence of concurrent update tools alone did not predict consistently higher perceptions of empowerment or group contribution. While these tools offer logistical benefits and support coordination (as shown in RQ1), learners' subjective perceptions of academic agency and value appeared more strongly influenced by interpersonal connection and real-time communication. These patterns support the theoretical perspective that learner autonomy and academic efficacy are co-constructed through both structural supports and the social negotiation of roles within collaborative environments (Moore, 2013; Anderson & Dron, 2011; Garrison & Akyol, 2013). This interplay mirrors the relationship between structure and dialogue in the Theory of Transactional Distance, suggesting that effective online learning requires both task design and interpersonal immediacy (Moore & Kearsley, 2012).

Overall, these findings emphasize that learners' perceptions of academic success are shaped not only by observable performance outcomes but also by the social and structural characteristics of their collaborative experience. Integrating real-time communication with

thoughtfully designed collaborative tools may provide the strongest support for academic self-efficacy, group motivation, and perceived learning impact in online environments. These insights offer meaningful guidance for instructional designers and educators seeking to foster both competence and motivation in online group work.

To examine whether these perceptual differences remained significant when accounting for individual background factors, additional ANCOVA tests were conducted. When demographic and technology-related covariates were included in follow-up ANCOVA models, the previously significant effects for Empowerment and Group Performance were no longer statistically significant. This outcome indicates that factors such as students' prior online experience and reliability of internet access likely influenced their perceptions of collaboration and agency. In addition, the Enhanced Learning with Concurrent Update variable, which initially showed a strong positive effect in the t-test, also became nonsignificant after adjustment. These findings emphasize that learner readiness and access conditions can moderate the impact of instructional modality and tool use, tempering the strength of initial between-group differences.

Research Question 3: Collaborative Experience and Perceived Learning Gains

Research Question 3: Collaborative Experience and Perceived Learning Gains Research Question 3 explored how students' collaborative experiences and perceived learning gains varied based on collaboration modality and the use of concurrent update tools. Constructs analyzed included Group Functioning and Conflict Resolution, Learning Engagement and Transfer, Social Presence, Tool-Enabled Collaboration, and Structure, as operationalized and mapped in Chapter 3 and detailed in the codebook (Appendix J) and Small Group Collaboration Surveys (Appendices H and I). Composite variable development and internal consistency are

reported in Appendix K. Overall, participants in synchronous environments and those using concurrent update tools reported significantly more positive experiences across multiple domains, suggesting that both instructional design elements contributed meaningfully to the quality of online group collaboration.

Learning Engagement and Transfer scores were significantly higher for synchronous participants, $F(1, 238) = 8.22$, $p = .005$, $\eta^2 = .033$, and post hoc analyses revealed that students in both the Synchronous Concurrent (SC) and Asynchronous Concurrent (AC) groups outperformed their peers in the Asynchronous Standard (AS) condition. (**Table 18** in Chapter 4) These results suggest that concurrent update tools can bolster learning engagement even when real-time communication is absent. This finding aligns with research demonstrating that collaborative digital environments promote active participation, deeper cognitive processing, and greater transfer of learning (deNoyelles et al., 2014; Feng et al., 2017; Kreijns et al., 2013). It also supports the assertion that real-time editing tools may reduce transactional distance by increasing structure and enabling responsive group coordination (Moore & Kearsley, 2012; Falloon, 2011a).

Group Functioning and Conflict Resolution also showed significant differences, with students in synchronous conditions, particularly SC, reporting more effective teamwork ($M = 3.67$, $SD = 0.64$) than their asynchronous peers. Participants described their groups as better at managing conflict, staying organized, and supporting individual learning. (**Table 18** in Chapter 4) These perceptions echo calls in the CSCL literature to examine how technology supports not only communication but also group regulation and co-regulated learning processes (Järvelä et al., 2016; Volet et al., 2009). This pattern aligns with both the social and cognitive presence

dimensions of the CoI framework, which emphasize shared understanding and collaborative learning as central to effective group engagement (Garrison et al., 2000; Akyol & Garrison, 2011). Prior work has also demonstrated that synchronous tools promote accountability, trust, and immediacy (Hrastinski, 2008; Borup et al., 2014).

Findings related to Social Presence, specifically trust and affective connection**,** also favored synchronous groups. Students in synchronous settings described more supportive and responsive group climates. This aligns with early foundational work in Social Presence Theory suggesting that immediacy and emotional expression are more easily communicated through real-time interaction (Short et al., 1976; Gunawardena & Zittle, 1997). Although asynchronous concurrent users rated the tool positively for collaboration, their social presence scores remained lower than those in synchronous conditions. (**Table 18** in Chapter 4) This suggests that while collaborative tools facilitate task coordination, they do not fully replicate the relational richness and emotional immediacy of real-time dialogue.

Tool-Enabled Collaboration was particularly strong in concurrent tool groups. Composite scores for Tool-Enabled Learning with Concurrent Update reached the highest overall means (M = 3.88, SD = 0.58), (**Table 18** in Chapter 4) with both AC and SC groups endorsing these tools as helpful in structuring group work, maintaining awareness of group progress, and supporting shared understanding. These findings underscore the role of collaborative technology not just in performance, but in shaping learners' experience of the group process. This supports foundational work in CSCL, which identifies co-editing tools as mediators of shared knowledge construction and collaborative meaning-making (Stahl et al., 2006; Suthers, 2006). These tools not only support cognitive presence but also extend how we conceptualize group coordination in

digital spaces.

Structural support and perceived clarity were strongest in concurrent tool conditions. Students in SC and AC groups rated Structure – Concurrent Tools and Overall structure significantly higher than those in standard tool groups (Table 18 in Chapter 4). This reinforces the idea that shared visual workspaces, live editing, and persistent access to group materials provide external scaffolds that reduce ambiguity and promote mutual awareness. These findings validate the Theory of Transactional Distance, which posits that structure reduces the psychological and pedagogical distance between learners (Moore, 2013). They also reflect Suthers' (2006) concept of intersubjective meaning-making, where shared digital artifacts enable collaborative learning through visible, editable, and mutually referenced representations.

In summary, students reported stronger collaboration, clearer expectations, increased engagement, and more positive group dynamics when either synchronous interaction or concurrent update tools were present. Importantly, concurrent tools enhanced collaboration even in asynchronous settings, indicating that thoughtfully designed technology can partially substitute for the affordances of real-time conversation. These findings offer compelling evidence that both collaborative modality and technological tool use significantly shape learner perceptions and group outcomes. (See full results in **Table 18** in Chapter 4)

Follow-up ANCOVA analyses were also performed for RQ3 to test the robustness of significant findings while controlling for the same covariates (prior online-course experience, technology proficiency, and internet reliability). When these variables were introduced, several tool-type and modality effects were reduced in magnitude or became nonsignificant. For example, differences in Group Functioning and Structure – Managing Learning no longer

reached significance after adjustment, although the overall models remained statistically reliable. These results suggest that part of the observed advantage for concurrent-tool groups may stem from students' prior comfort with collaborative technologies rather than the tools themselves. The complete ANCOVA tables are presented in **Appendix O**.

Taken together, these results offer not only practical guidance for instructional designers but also refine theoretical models of online collaboration. The findings extend the CoI framework (Garrison et al., 2000) by showing that shared digital artifacts support both social and cognitive presence (Stahl et al., 2006; Suthers, 2006). While the CoI model traditionally emphasizes discourse and interaction, this dissertation suggests that technological tools themselves can serve as vehicles for presence and engagement (Feng et al., 2017; deNoyelles et al., 2014). Similarly, the Theory of Transactional Distance (Moore, 1993; Moore & Kearsley, 2012) is expanded to include the structural and dialogic functions of tools that allow learners to coordinate, reflect, and build meaning asynchronously. These results demonstrate that immediacy and collaboration can be simulated through strategic design and integration of collaborative technologies, although such tools may not fully replicate the depth of real-time interaction (Borup et al., 2014; Hrastinski, 2008).

Implications for Theory

This dissertation contributes to the theoretical understanding of technology-mediated collaboration in online learning environments. Specifically, it expands key constructs from the Theory of Transactional Distance (Moore, 1993; Moore, 2013), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976). Findings from this dissertation demonstrate that concurrent update tools, such as co-editable spreadsheets, function as integrated

structural, cognitive, and social supports that reduce perceived distance and foster presence, even in asynchronous conditions (see **Table 18** in Chapter 4; Appendices J and K for construct alignment and composite scores). This integrative role of technology extends theoretical models that often treat structure, dialogue, and social engagement as discrete variables.

Expanding the Theory of Transactional Distance

These findings extend the Theory of Transactional Distance by demonstrating that structure and dialogue are not always separate or opposing forces. Rather, thoughtfully designed tools can simultaneously support both functions. For instance, in this dissertation, the Asynchronous Concurrent (AC) group outperformed the Asynchronous Standard (AS) group on Small Group Collaboration Assignment 2 ($p = .015$; **see Table 16** in Chapter 4), indicating that shared, co-editing tools improved coordination and structure in the absence of real-time communication. This result supports the notion that transactional distance can be reduced not only through increased instructor dialogue or course design but also through affordances embedded within collaborative tools themselves (Moore & Kearsley, 2012; Falloon, 2011a; Bolliger & Inan, 2012).

In this way, concurrent technologies such as live-updating spreadsheets serve as both organizational scaffolds and implicit communication channels, helping to simulate immediacy and shared decision-making in asynchronous contexts. These findings reinforce the evolving relevance of Moore's framework in contemporary learning environments where learners rely increasingly on tools, rather than instructors, to shape their collaborative experience (Moore, 2013; Yamagata-Lynch, 2014).

Refining the CoI Framework

The results also refine the CoI framework by emphasizing the role of shared digital artifacts in supporting both cognitive and social presence. While the framework traditionally centers discourse as the mechanism for presence development, this dissertation found that concurrent update tools enhanced trust, group functioning, and shared meaning-making. For example, Tool-Enabled Learning with Concurrent Update received the highest composite scores (M = 3.88, SD = 0.58; see **Table 18** in Chapter 4), with both AC and SC groups reporting more positive collaboration experiences.

These findings align with perspectives from the computer-supported collaborative learning (CSCL) literature (Stahl et al., 2006; Suthers, 2006), which emphasize the role of tools in supporting intersubjective understanding and joint knowledge construction. This dissertation confirms that co-editable tools not only support shared task completion but also function as dynamic spaces for constructing meaning together, thus enhancing cognitive presence (Garrison et al., 2000; Feng et al., 2017). This research also extends that work by showing that digital tools, when co-used for content generation and task completion, can actively support the development of cognitive presence even in the absence of synchronous interaction.

Supporting the Role of Regulation and Awareness

These findings also reinforce prior work by Järvelä et al. (2016), who emphasized the need for collaborative learning technologies that support regulation and coordination in distributed environments. Tool affordances, such as live-updating cells, shared visibility, and co-editable templates, enabled learners to coordinate more efficiently, resolve conflict, and maintain shared awareness of group progress. These patterns were most evident in the AC and SC groups,

where higher scores were observed for group functioning, conflict resolution, and tool-enabled collaboration (see **Table 18** in Chapter 4). These results also support recent work on co- and socially shared regulation in collaborative learning, suggesting that tools can serve as boundary objects around which joint attention and regulation are organized (Volet et al., 2009; Järvelä et al., 2015).

Extending Social Presence Theory

In addition, the findings contribute to Social Presence Theory by demonstrating that affective connection, trust, and group rapport, which are typically associated with synchronous interaction, can also be supported through collaborative tools that enable co-editing and visual coordination. As shown in **Table 18** (Chapter 4), students in asynchronous concurrent conditions reported higher social presence scores than those using standard tools. This suggests that immediacy and mutual awareness, as described in Social Presence Theory (Short et al., 1976) and operationalized by Gunawardena and Zittle (1997), can be simulated through shared digital environments that promote visibility and responsiveness.

These results also align with Lowenthal's (2010) expanded interpretation of social presence, which includes perceptions of interaction quality, relationshi*p*-building, and responsiveness, even in asynchronous contexts. Additionally, the co-editing experience may activate perceptions of interpersonal involvement and shared accountability, strengthening affective ties among group members (Richardson & Swan, 2003; Kreijns et al., 2013). By enabling ongoing task alignment and increasing the visibility of group effort, concurrent update tools appear to support these relational dimensions of presence, particularly within structured collaborative tasks.

Conclusion: Toward a Technology-Augmented Theory of Online Collaboration

Taken together, these findings offer strong empirical support for expanding the role of technological affordances in theoretical models of online learning. By integrating collaborative tools into group work design, instructors can enhance multiple dimensions of presence, reduce transactional distance, and support co-regulated learning (Järvelä et al., 2016; Garrison & Akyol, 2013; Moore, 2013). This dissertation adds to a growing body of research that views technology not only as a medium but also as an active agent in shaping the quality of interaction, cognition, and presence in online environments (Dillenbourg, 1999a; Suthers, 2006; Feng et al., 2017).

As digital learning continues to evolve, models like the CoI and the Theory of Transactional Distance must evolve in parallel, accounting for how emerging technologies are reshaping both the boundaries and functions of online collaboration.

Implications for Practice

This dissertation's findings provide practical guidance for improving collaborative learning in online higher education, particularly through the integration of concurrent update technology. As outlined in Chapters 3 and 4, these tools not only enhanced academic outcomes but also improved perceptions of group collaboration, learning, and trust. The following implications are organized by key stakeholder groups to promote actionable change grounded in empirical findings.

For Instructional Designers

Instructional designers should integrate concurrent update tools into collaborative assignment design to provide both structure and interaction support. As demonstrated in Chapter

4, students in the asynchronous concurrent (AC) group significantly outperformed their asynchronous peers (AS) on Assignment 2 (p = .015; see **Table 16** in Chapter 4), suggesting that co-editable tools supported coordination and task management even in the absence of live dialogue. Composite scores for Tool-Enabled Learning with Concurrent Update were alsohighest among AC and SC participants (M = 3.88, SD = 0.58; see **Table 18** in Chapter 4 and Appendix K), indicating strong student endorsement of these tools for both efficiency and collaboration. These findings reinforce the CSCL literature's emphasis on designing environments that support both collaboration and knowledge construction (Stahl et al., 2006; Suthers, 2006; Janssen et al., 2011).

To support these outcomes, instructional designers should consider embedding structured co-editable templates, visible contribution tracking, and scaffolds for collaborative planning. These design features align with the Theory of Transactional Distance by enhancing structure while enabling forms of dialogue and shared awareness (Moore, 2013; Moore & Kearsley, 2012). This recommendation is supported by data from the Small Group Collaboration Surveys (Appendices H and I), which include items specifically targeting learners' perceptions of tool-enabled structure and group coordination. Designers should also align tool use with intended learning outcomes, as discussed in Chapter 3, ensuring that digital affordances reinforce pedagogical goals.

For Faculty and Instructors

Faculty should not assume that synchronous collaboration or technology alone ensures successful group interaction. This dissertation found that the strongest outcomes across assignments and perception measures occurred in the synchronous concurrent (SC) condition,

where real-time communication was supported by collaborative tool use (**Table 16** and **Table 18** in Chapter 4; see also Appendix K for composite variable reliability). These results suggest that instructors should intentionally combine synchronous meetings with shared digital workspaces to support planning, coordination, and reflection. These practices align with the CoI framework's emphasis on the intersection of cognitive and social presence in fostering meaningful collaboration (Garrison et al., 2000; Akyol & Garrison, 2011; Kreijns et al., 2013).

Even in asynchronous settings, faculty can enhance collaboration by embedding clear expectations for concurrent update tool use, modeling co-editing strategies, and fostering a sense of shared ownership over group work. These practices support both cognitive and social presence (Garrison et al., 2000; Lowenthal, 2010) and can simulate immediacy by making student contributions more transparent and responsive (Gunawardena & Zittle, 1997; Richardson et al., 2017). Survey data presented in **Table 25** (Chapter 4) show that students who used concurrent update tools reported significantly stronger engagement and trust in their group processes, further supporting these instructional strategies.

For Higher Education Administrators

Administrators should prioritize access to collaborative tools across all modalities. Findings from this dissertation reinforce the importance of equitable access to digital infrastructure that supports group interaction, particularly for asynchronous learners. Integration of real-time co-editing platforms within institutional LMS environments can reduce barriers, streamline instructor oversight, and promote consistency in student experiences. See Chapter 3 and Appendices C–F for details on the collaborative assignments and how concurrent update tools were embedded into instructional design and course implementation. Providing access to

these tools also addresses institutional equity concerns, particularly for nontraditional or remote learners who may lack informal peer support structures (Martin et al., 2020).

Additionally, professional development opportunities should include training on collaborative technology use, including strategies for monitoring participation, designing co-editable tasks, and aligning tool functions with learning outcomes. This supports scalable implementation across disciplines and maximizes the value of existing ed tech investments (Bolliger & Shepherd, 2010; Martin et al., 2020). Workshops should be informed by both theoretical models (e.g., CoI, Theory of Transactional Distance) and empirical data such as those provided in this dissertation, including mapping of outcomes to constructs in Appendix J and student endorsement patterns in Appendix K (Trust & Horrocks, 2019).

For Educational Technology Developers

Although not the primary focus of this dissertation, the findings also suggest opportunities for educational technology developers. Co-editable tools that allow visual coordination, live updating, and user attribution were perceived as enhancing group functioning, especially in asynchronous settings (see **Table 18** in Chapter 4 and Appendix K. Developers should consider integrating features that support structured collaboration, such as revision histories, progress indicators, and embedded comment threads. These features promote accountability and transparency, aligning with both social presence and transactional distance theories (Moore, 2013; Short et al., 1976). Developers might also consult the construct mappings in Appendix J to identify specific learner needs, such as visibility of contributions or support for co-regulated learning (Järvelä et al., 2016).

Conclusion

When used thoughtfully, concurrent update tools can significantly enhance online group learning by reducing transactional distance, increasing structure, and supporting relational trust. This dissertation provides compelling evidence that both the design and delivery of online collaborative work should intentionally incorporate digital tools that support visibility, responsiveness, and joint meaning-making. These implications are grounded in consistent results across assignments (**Table 16**), perceptions of collaboration and tool use (**Tables 18 and 25**), and theoretical constructs (Appendix J), demonstrating how instructional design, faculty strategy, and technology integration converge to shape student outcomes. Educators and institutions seeking to improve online collaboration can do so by aligning pedagogical strategies with the affordances of modern co-editing platforms.

Limitations

While this dissertation was carefully designed to examine how instructional modality and collaborative tool use affect learner outcomes, several limitations should be noted when interpreting the findings. Participants were assigned to instructional conditions based on their reported modality and tool use, and self-selection bias may have been introduced through students' decisions to complete both collaborative assignments and all survey items, a known threat to external validity in quasi-experimental research (Shadish et al., 2002). Although responses were cross-checked for consistency, reliance on self-report introduces potential subjectivity in condition classification (Podsakoff et al., 2003; Leech et al., 2014). A total of 55 participants were excluded due to inconsistent exposure or missing data (see Appendix K), which reduced the overall sample size and contributed to unequal group sizes that may have affected

statistical power and interpretability (Tabachnick & Fidell, 2019).

Self-selection into asynchronous or synchronous formats, or specific collaboration tools, may have been influenced by prior familiarity, learning preferences, or technology comfort. These factors could influence both performance and perceptions, thereby confounding some of the effects attributed to the experimental conditions (Fraenkel et al., 2019). Pre-existing differences in students' prior knowledge, group experience, and motivation were not directly measured or statistically controlled. Although demographic and baseline data were collected (see Chapter 3 and Appendix G), these variables were not incorporated as covariates. Because learner readiness, confidence, and collaboration history can shape group outcomes, the absence of such controls should be considered when interpreting between-group differences (Creswell & Clark, 2018; Volet et al., 2009).

However, follow-up ANCOVA tests were conducted post hoc to account for several of these potential confounding factors (see **Appendix O**). These analyses incorporated demographic and technology-readiness variables, such as prior online-course experience, technology proficiency, and internet reliability, to evaluate whether significant results remained after controlling for individual background differences. While this step partially mitigates concerns regarding internal validity, the covariates were self-reported and may not capture the full range of learner readiness or contextual influences. Therefore, the findings should still be interpreted with caution regarding causality. Although sensitivity analyses indicated moderate to high robustness for most constructs, unmeasured variables such as students' workload or instructor immediacy could still influence the observed relationships.

Although instructors followed a standardized facilitation guide and assessment rubric (see

Appendices D and F), the potential for subtle variations in instructor communication or responsiveness across groups cannot be entirely ruled out. These variations may have influenced students' collaborative experiences, particularly in synchronous conditions where instructor presence was more visible. Research on teaching presence has shown that even minor instructor behaviors can shape group dynamics and learner perceptions (Garrison et al., 2010; Bolliger & Martin, 2018).

This dissertation examined short-term structured collaboration within two course-based assignments. While this design allowed for consistent implementation and measurement (see Chapter 3), it may not capture the dynamics of more sustained or organic collaborative learning. Prior work suggests that deeper trust, shared knowledge construction, and role negotiation evolve over time and may differ in long-term or informal collaborative settings (Roblyer et al., 2007; Volet & Mansfield, 2006).

The sample was limited to undergraduate business students at a single public institution, which may constrain generalizability. As discussed in Chapter 4, patterns of tool adoption and social interaction may differ across disciplines, institutional cultures, or educational levels. Research has documented significant variability in students' engagement with educational technology across contexts (Bower, 2019; Martin et al., 2020). Additional research in STEM, humanities, and graduate-level settings is needed to confirm the broader applicability of these findings.

Although uniform instructions and templates were provided (see Appendices C and E), this dissertation did not assess students' prior experience with co-editing tools. Familiarity with platforms such as Google Sheets or Excel may have influenced learners' comfort, efficiency, and

perceived value of the tools, particularly in asynchronous environments where live support was not available (Suthers, 2006; Kwon et al., 2014). Future studies may benefit from pre-assessments of tool proficiency or digital literacy.

While the dissertation initially included open-ended survey items to provide qualitative insight, these data were excluded from final analysis due to low response rates and inconsistent detail. As a result, the findings rely solely on quantitative data. Mixed-methods research designs often offer richer interpretive power, especially for capturing emotional, relational, and contextual dynamics in collaborative learning (Creswell & Clark, 2018; Yamagata-Lynch, 2014). See Chapter 3 for a description of the open-ended survey items and rationale for their exclusion.

Finally, although instructional materials, assessments, and rubrics were held constant (see Chapter 3 and Appendices D and F), external variables such as academic calendar timing, workload from other courses, and interpersonal group dynamics may have influenced learner engagement and performance. These uncontrolled variables are common in field-based research and present ongoing challenges for causal inference (Järvelä et al., 2016; Dillenbourg, 1999a; Shadish et al., 2002).

Recommendations for Future Research

Building on the results of this dissertation, several areas merit further investigation to deepen understanding of how instructional modality and real-time collaborative tools shape student learning and group dynamics in online settings. These recommendations emphasize both theoretical advancement and applied innovation, and are grounded in the findings and limitations described in Chapters 3 and 4.

First, future studies should explore longitudinal effects of tool-enabled collaboration, particularly with concurrent update platforms, across extended courses or multi-assignment sequences. While this dissertation examined short-term collaboration within two assignments, longitudinal research could capture how relationships, tool mastery, and group cohesion evolve over time. Such designs may also reveal cumulative impacts on learner autonomy, engagement, and collaborative fluency (Järvelä et al., 2016). Changes in perceptions of trust, tool utility, and cognitive presence could be assessed using repeated measures to complement the cross-sectional data presented in this dissertation (see Chapter 4, **Table 18**).

Second, mixed-methods approaches should be considered to supplement quantitative results with rich qualitative data. While this dissertation initially included open-ended survey items (see Chapter 3), those data were excluded due to low response rates and inconsistent detail. Future research should consider interviews, reflective journals, or focus groups to better capture the affective, interpersonal, and motivational dynamics of learners navigating real-time collaborative tools. These methods may offer insights into trust-building, conflict resolution, or peer accountability that structured surveys may overlook (Creswell & Clark, 2018; Garrison et al., 2010).

Third, research is needed to examine how individual differences such as prior experience with collaboration tools, digital self-efficacy, or cultural background, influence students' perceptions of learning and group engagement. In this dissertation, participants were randomly assigned but not matched on these variables (see Chapter 3), yet prior literature suggests that learner familiarity with technology and collaborative norms can shape engagement and satisfaction (Bower, 2017; Suthers, 2006). Future work might employ stratified sampling or

covariate analysis to assess how these factors influence tool effectiveness.

Fourth, future studies should investigate disciplinary differences in the effectiveness of collaborative tools. While this dissertation focused on undergraduate business students, it remains unclear whether the same affordances would yield comparable benefits in disciplines that emphasize divergent collaboration processes, such as design, health sciences, or STEM laboratories. Comparative studies could clarify whether tool affordances foster different forms of co-regulation, group functioning, and cognitive presence depending on context (Stahl et al., 2014; Roblyer et al., 2007; Volet et al., 2009).

Fifth, the findings related to the Asynchronous Concurrent (AC) group highlight the need to better understand the mechanisms by which real-time tools support learning without real-time communication. AC participants demonstrated strong assignment performance (**Table 16** in Chapter 4), higher collaboration scores (**Table 18** in Chapter 4), and greater composite values for Tool-Enabled Learning. Future research could isolate the specific affordances of concurrent update tools, such as shared visibility, live editing, or version control, that most directly contribute to these gains. These insights could guide the design of tools specifically optimized for asynchronous group work.

Finally, researchers should further examine how collaborative technology affordances intersect with theoretical constructs. For example, studies might test how shared digital artifacts influence dimensions of cognitive presence, such as triggering events, exploration, and integration (Garrison et al., 2001), or how tool-supported structure moderates the perceived distance between learners and content, instructors, or peers (Moore & Kearsley, 2012). This line of research could involve developing and validating new instruments to measure multi-functional

roles of collaborative tools in mediating dialogue, structure, and presence (see Appendix J for construct mappings used in this dissertation).

Taken together, the findings of this dissertation offer a strong foundation for ongoing research into how technology-enhanced collaboration shapes online learning. By extending this work through longer timelines, more diverse learner populations, cross-disciplinary comparisons, and deeper theoretical integration, future researchers can continue to strengthen our understanding of how to design equitable, engaging, and effective collaborative experiences in online education.

Conclusion

This dissertation set out to examine how collaborative modality (asynchronous versus synchronous) and collaborative technology (standard tools versus concurrent update tools) affect academic performance, perceived learning outcomes, and collaborative experiences in online learning environments. Using a quasi-experimental 2x2 factorial design with undergraduate students, the research produced several important findings that contribute to both the refinement of theory and the advancement of online instructional practice.

A central contribution of this dissertation is its demonstration that concurrent update tools, such as co-editable spreadsheets, can simultaneously provide structure, foster social connection, and enhance cognitive engagement. This was especially evident in the asynchronous concurrent (AC) condition, where students significantly outperformed peers in the asynchronous standard (AS) condition on Assignment 2 (see **Table 16** in Chapter 4) and reported more positive collaborative experiences on multiple measures of group functioning and tool-enabled learning

(see **Table 18** in Chapter 4). These results reinforce the notion that technology, when intentionally integrated, can serve as both a structural and social mechanism for reducing perceived distance and improving group functioning, even in the absence of real-time communication (Moore, 2013; Garrison et al., 2000; Short et al., 1976). These findings align with CSCL perspectives that emphasize the role of tools in mediating collaboration and shared meaning-making (Stahl et al., 2006; Suthers, 2006).

The findings also offer important refinements to the Theory of Transactional Distance (Moore, 1993), the CoI framework (Garrison et al., 2000), and Social Presence Theory (Short et al., 1976). Rather than treating structure and dialogue as opposing forces, this dissertation demonstrates that tool-enabled collaboration can blend these dimensions through features such as shared visibility, version control, and mutual accountability. Similarly, the results highlight that co-editing platforms not only support discourse and cognitive presence, but also simulate immediacy and responsiveness traditionally associated with live interaction. Students reported higher affective connection, trust, and participation in tool-rich environments, aligning with foundational elements of Social Presence Theory (Gunawardena & Zittle, 1997; Lowenthal, 2010). These patterns were consistent across both composite and single-item variables, as detailed in **Tables 18 and 25** in Chapter 4.

From a practical standpoint, the dissertation provides clear guidance for improving collaborative learning in online settings. Real-time editing tools can enhance both academic outcomes and learner satisfaction when thoughtfully embedded into course design. Instructors and designers should consider integrating these technologies across both synchronous and asynchronous environments to foster shared meaning-making, coordination, and group cohesion.

The instructional design considerations outlined in Chapter 3 and the recommendations for practice in Chapter 5 highlight how structured tool integration supports pedagogical goals. At the institutional level, investment in platform access, student training, and LMS integration can help scale these benefits across diverse learner populations (Bolliger & Shepherd, 2010; Martin et al., 2020). At the same time, the findings underscore that neither collaboration alone nor the use of concurrent update technology in isolation is sufficient to produce consistent improvements in outcomes. The most notable gains occurred when these elements worked in tandem, when collaborative activities were purposefully structured and supported by concurrent update tools that aligned with the task demands and learning objectives.

Importantly, this dissertation is among the first to empirically demonstrate that concurrent update tools can support presence, coordination, and learning outcomes across instructional modalities. By foregrounding the role of technological affordances in online collaboration, the research opens new pathways for theorizing how interaction, engagement, and trust develop in distributed learning environments (Stahl et al., 2006; Järvelä et al., 2016). It also responds directly to calls for more nuanced, tool-specific research within the fields of instructional design and online learning (Volet et al., 2009; Garrison & Akyol, 2013).

Overall, this dissertation contributes a timely and theoretically grounded investigation into how instructional design and collaborative technology shape online group learning. It affirms and extends existing frameworks by demonstrating how co-editing tools function as bridges between structure, presence, and learner interaction. In doing so, it reinforces that collaboration or technology alone is not enough. The most impactful outcomes arise when both are intentionally integrated to work together. By centering student outcomes and collaboration

processes, the research offers both conceptual insight and actionable guidance, advancing the field's understanding of how to design online learning environments that are equitable, engaging, and effective.

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