5-12-2024

Comparing Equivalent Face-To-Face [F2F] and Online [OL] Delivery Formats: Observations of Learner Interactions to Determine Instructional Quality

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Abstract

Instruction, designed to impact learning, accentuates the quantity and quality of learner interactions. Theoretically, the higher the level or quantity of learner interaction within instruction, the higher the quality of instruction. Learner interactions are fostered through learner-to-learner (L2L), learner-to-instructor (L2I), and learner-to-content (L2C) experiences.

Higher education graduate programs have advanced over the last few decades to enhance learner interactions by providing quality instructional experiences using technologies in multiple delivery options, ranging from traditional face-to-face (F2F) or residency options to various newer formats in a variety of online (OL) versions. Today, learners are often faced with the choice to enroll in a F2F or OL course, expecting to achieve desired learning outcomes regardless of the delivery format. Too often, learners have come to realize that enrolling in one format over the other impacts their involvement in learning and, thus, may affect the quality of their expected learning experiences. The expectations for achieving quality learning experiences in different delivery formats raise the question of 'which format is better?' Scholarship has sought to answer this question by comparing the quality of instruction in these different instructional formats. This effort has been criticized for using learner achievement, satisfaction and persistence data to represent actual instructional and learning experiences. Many studies employing this effort do not capture learner interaction data during instruction – thus limiting the validity of results used to compare quality of instruction between traditional face-to-face (F2F) and online delivery formats.

Therefore, this study explored actual learner interaction behaviors during instruction with the purpose to determine the quality of instruction in the two different formats of the same course taught by the same instructor. Frequency of learner interaction was used to determine the quality

of instruction within and between both formats. A comparative case study research design with a mixed method data collection and analysis approach was used to explore learner interaction behaviors across two equivalent formats of the same course: one format delivered F2F (n=11), and one delivered fully OL (n=15). Data were collected during 5 instructional F2F sections and 5 OL instructional sections. Learner interaction frequency (quantitative) and fieldnotes (qualitative) data were recorded through an unobstructive observational method using a modified Behavioral Observational Checklist (BOC).

Results show that the frequency of learner interactions between both formats had similar pattern for each type of interaction. L2L and L2I interactions were similar within and between both formats; on the other hand, L2C interaction was similar in each format but different between both. Further analysis showed the differences were a result of lower quality of interaction frequency in specific observed sessions. The observed instructional and learning behaviors recorded in the fieldnotes showed that these differences in frequency was a result of most OL learners' consistent demonstration of high-quality engagement and interaction during small groups and open class discussions, while a few F2F learners participated or interacted during small groups and open class discussions. The differences in frequency did not statistically impact the level of learner interaction with other learners, the instructor, or the content.

Comparatively, this dissertation study suggests that the course delivered similar quality of instruction across both F2F and OL formats. It highlights lower quality of L2L interaction in both F2F and OL observed sessions 2, 4 and 5. There was also a lower quality of interaction for L2C in F2F and OL observation sessions 2. These findings point to types of interaction that need to be enhanced to assure similar learning experiences in both F2F and OL delivery formats.

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by

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M.S., Syracuse University, 2019

Dissertation

Submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Instructional Design, Development & Evaluation.

Syracuse University

June 2024

Acknowledgement

My educational journey has been one filled with miracles and divine blessings. Therefore, in acknowledgment and realization of that believed, I am first and foremost thankful to God for his continuous guidance of my steps through life.

This journey has also been a teamwork of my family. I am deeply grateful to them, particularly my wife, Sianneh Belleye Whorway, and my children, Garnneh, Girmena, and Gormah, for their prayers, patience, and unwavering support during this journey. Despite being miles apart, the thought of your sacrifices while I was away gave me the strength to work harder and achieve this win for all of us.

This dissertation owes much to my exceptional advisor, Dr. Tiffany A. Koszalka. Dr. Koszalka research work through the Research in Designing Learning Resources (RIDLR) Laboratory served as the foundation upon which this dissertation was built. Particularly, my deepest appreciation for this entire dissertation goes to you Dr. Koszalka, for allowing me to join your team and benefit from your patience, trust, and dedication. I learned immensely from you, and my development as a researcher has been profoundly influenced by the exceptional knowledge you have kindly shared with me over the years. You were there with me from the formulation of this dissertation to the final defense and publication. I am deeply and wholeheartedly thankful to you, Dr. Koszalka.

A heartfelt appreciation goes to my dissertation committee members. Dr. Rob Pusch provided valuable feedback that prompted me to think more deeply about the organization and understanding of the constructs this study explores. Dr. Xiaoxia Silvie Huang offered insightful feedback that guided me to think critically about key terms and concepts adopted in this study. I

am grateful to you, Dr. Pusch and Dr. Huang, your support was critical for my success with this dissertation.

My appreciation extends to Dr. Joanna Masingila, who joined my committee as the oral chairperson. Although you joined the committee towards the end, you have been a part of my journey since we first met in the spring of 2018. You believed in me, prayed for me, and supported me in ways I can not find the words to fully express. During the dissertation defense, having you as my oral chair ensured that the logistics were adhered to according to the graduate school standards. On that day, seeing you in the room and reflecting on the journey we shared brought me immense joy and gratitude. Thank you for everything.

A special appreciation goes to my dearest friends, whose calls, text messages filled with laugher and encouragement helped me find joy and resilience throughout this terminal study.

Finally, a huge appreciation goes to my parents, Victoria and Andrew Whorway. Thank you for giving me the gift of life, always believing in the promise of education, and supporting me from the very beginning.

Humbly,

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Chapter 1 - Introduction

The quality of instruction can be measured through the frequency of learner interactions (Koszalka & Whorway, 2024). Active behavioral participation (interactions) and behavioral evidence of cognitive processing (engagement in thinking) during learning involve demonstrating and sharing learned content knowledge (Hrastinski, 2009; Wenger, 2000) while completing assigned tasks (Gickling & Armstrong, 1978). Therefore, indicators of interaction and engagement can suggest a level of instructional quality.

This study compared face-to-face (F2F) and online (OL) instruction based on indicators of interaction and engagement. Understandably, this type of investigation has often been discounted because of the great dissimilarity between the two instructional environments. Johnson et al. (2000) referred to such an investigation as "a classic example of comparing apples to oranges" (p. 31). This study attempted not to determine if one fruit is better than the other; instead, it hopes to demonstrate that, if grown properly, these fruits can be equal in terms of nutritional value. Particularly, this study examined whether instructionally designed equivalent courses – in terms of content, instructional, and learning activities – that differ in terms of delivery formats can be equivalent in terms of instructional quality.

Historically, many instructional quality comparative studies across F2F and OL courses were conducted using large data sets with no measure of equivalence for comparison (Bernard et al., 2004). These studies have been criticized as collecting indirect survey data (e.g., grades, satisfaction) that do not represent actual learner behaviors [interactions] during instruction (Bailey, 2022; Tang & Tang, 2020). Thus, questions have been raised as to the accuracy of conclusions about the characteristics of actual learner behaviors in either format. This study examined a course by comparing its established equivalent face-to-face (F2F) and online (OL)

formats in an effort to investigate the quality of instruction based on actual learner behaviors [interactions]. The F2F and OL formats had similar instructional materials and learning activities (i.e., equivalent instruction) and content organization (equivalent structure). Ultimately, using the proposed approach (i.e., observational approach) helped unpack the level of learner interaction and elucidate the benefits of improving instructional design strategies to improve learner interactions to enhance the quality of instruction, regardless of delivery platform. Below is a list of key terminology, with definitions, used in this study.

- *Interaction* – a confluence of observable interaction relationships among learners, instructors, and content resulting in learning outcomes (Grabowski, 2004; Moore 1989, 2006, 2012, 2018).
- *Engagement* – a cognitive learning process occurring during instructional events observed through behavioral indicators (Hiver et al., 2021; Hrastinski, 2009).
- *Behavioral observation* – a systematic approach that focuses on observable engagement indicators during instructional interaction (Creswell, 2013).
- *Instructional Quality* **–** instructional quality as observable instructional characteristics led by the instructor that includes how they teach, how they engage learners that leads to the learning outcomes (Mu et al., 2022, p 2).
- *Equivalent Instruction* – the design characteristics of instructional materials and learning activities for two or more delivery formats of the same course, suggesting the same content, the same learning outcomes, and similar resources and activities (Simonson, 2003b).
- *Equivalent Structure* – a design of instructional procedure for two or more delivery formats of the same course that demonstrates how the learner advances to parts of the

content, then subparts, all in an organized manner until the desired level of detail and complexity is achieved (Reigeluth et al., 1980).

1.1 Nature of the problem

A core determinant of quality instruction is learner interactions, including learner-to-learner (L2L), learner-to-instructor (L2I), and learner-to-content (L2C) exchanges (Moore, 1989). Multiple studies have suggested that the frequency of learner interactions during instruction is a key indicator of the quality of instruction.

Moore (2012) considered learner interaction as a confluence of observable interaction relationships among learners, instructors, and content and the cognitive learning processes (engagement) occurring during instructional events, resulting in learning outcomes. Interaction indicators characterize learner active behavioral participation during the learning process (Grabowski, 2004) while cognitive learning processes (engagement) indicators characterize learner active participation, signaling that there is the occurrence of cognitive involvement (Hiver et al., 2021). Together, active behavioral participation (interactions) and cognitive learning processing (engagement) during learning involve demonstrating and sharing learned content knowledge (Hrastinski, 2009; Wenger, 2000) while completing assigned tasks (Gickling & Armstrong, 1978). Thus, the frequency of learner interaction (i.e., both interaction and engagement) during instruction suggests a level of instructional quality.

For example, Sitzmann et al. (2006) examined the comparative effectiveness of classroom or face-to-face (F2F) instruction and web-based or online (OL) instruction through a meta-analysis of 65 studies published between 1990 and 2004. The frequency of learner interaction in both forms of instruction was one of the factors analyzed. Overall, OL instruction had lower levels of interaction than F2F instruction. Specifically, results showed that OL

instruction tended to have fewer opportunities for synchronous interaction, which was suggested as important for promoting high-quality learning. However, it was also noted that the frequency of interaction varied greatly within each type of instruction. Some OL instructional sessions may have had more opportunities for interaction than others, and some F2F instructional sessions may have had less interaction than others. Therefore, it was recommended that instructional designers pay close attention to the frequency and quality of interaction and incorporate strategies that promote interaction when designing instruction (Mayer, 2004; Sitzmann et al.**,** 2006).

Mayer (2004) also argued that pure discovery learning, which involves allowing learners to explore a concept on their own without any interaction, is not an effective method of instruction. He proposed guided methods of instruction that involved learner-instructor interaction. Mayer (2004) stressed that interaction in instruction helps learners process information more effectively, receive feedback and clarification, and benefit from other learners' expertise and knowledge, ultimately helping learners build a deeper understanding of the material. He recommended increasing the frequency of learner interaction by promoting quality learning through approaches that engage learners with the course materials. Numerous research studies have shown that learner interaction is a critical determinant of quality instruction in and across both F2F and OL delivery platforms (Bernard et al., 2009; Marco-Fondevila et al., 2022; Moore, 1989, 2006, 2012, 2018; Tu & McIsaac, 2002; Vrasidas & McIsaac, 1999; Xiao, 2017; Zimmerman, 2012).

However, much of the literature describing comparison between F2F and OL instruction has been judged as 'poor quality' based on a lack of reliable course data and valid measures showing key descriptives of the comparative nature of courses being evaluated (Bernard et al., 2004, p. 186). These measures generally focus on success (e.g., grades, satisfaction) and

persistence (e.g., completion) data collected mostly through self-report instruments, which are retrospective and subjective and thus do not capture actual learner interactions during instruction, nor have they reflected levels of learner engagement that are predictive of high-quality instruction (Akram et al., 2021; A. Cohen & Baruth, 2017; Zhao & Watterston, 2021*).*

To address the lack of reliable course data and measures from previous studies that failed to show key descriptives of the quality of instruction that learners have experienced, this study used an observational research approach and collected actual learner interaction data during active instruction. Observational research gives researchers direct access to the research setting and first-hand knowledge of learner interactions (Creswell, 2014). This research used a direct observational approach that enabled the first-hand collection of learner interaction data, which was analyzed to determine the quality of instruction within and between both F2F and OL formats of the same course. The data collected and analyzed was not limited to self-report biases or other subjective factors.

A modified version of a validated Behavioral Observation Checklist (Koszalka, & Whorway, 2024) was used during instruction to directly gather learner behavioral interaction data in the two sections of the same course, one F2F and one fully OL. The learner behavioral interaction data included frequency data and descriptive data. Frequencies included the number of times learners interact with peers, instructors, and content during specified observation periods (i.e., quantitative data). Descriptive data outlined specific instructional and learning behaviors observed during instruction; those were collected in the observer fieldnotes (i.e., qualitative data). Thus, both quantitative data (i.e., frequencies of specified interaction behaviors) and qualitative data based on observer fieldnotes (i.e., specific instructional and learning behaviors that influenced the frequency of learner interaction) were collected to develop a profile of learner

interactions for multiple sessions observed in the equivalent F2F and OL delivery formats. These data points helped determine the frequency and quality of learner interactions in both delivery formats, thus the quality of instruction. It also helped the researcher describe and unpack actual learner interaction experiences that will be helpful in informing guidelines to enhance instructional approaches across both F2F and OL delivery formats.

1.1.1 Comparative equivalence of F2F and OL instruction – methodological problems

In the 1980s, comparative research examining F2F and OL instruction focused on "establishing comparative equivalence" (Bernard et al., 2009, p. 1244). According to Barnard et al. (2004), these efforts towards establishing equivalence attempted to determine the value of innovations or interventions to support learning. Thus, their goal was to support continuous improvement efforts in instruction. Other research efforts have provided evidence about whether the design (i.e., instruction) and structure of courses influence the performance of learners (Castro & Tumibay, 2019). Overall, the goal of establishing equivalence across compared courses or delivery platforms has been to support instructional efforts that influence learning.

Instructional efforts to enhance learning and instruction through the design of equivalent delivery formats can be traced to the early 1990s, when educational institutions began to make significant investments and increased efforts to integrate digital technologies into instruction. Even today, as new instructional delivery formats continue to emerge, these formats are reportedly becoming more significant to the continuation of learning, especially in distance formats. Thus, there has been an increase in the number of studies comparing the equivalence of these delivery formats and newer instructional design strategies employed to enhance the effectiveness of technology-enhanced instruction in both F2F and OL learning environments (M. Allen et al., 2002; Johnson et al., 2000).

Johnson et al. (2000) suggested that the fundamental focus for studies investigating instructional design strategies should be to "optimize instructional designs to maximize learning opportunities and achievements in both online and face-to-face environments" (p. 31). Merrill's (2002) five fundamental principles of instruction emphasized the importance of creating meaningful and relevant learning experiences that provide opportunities for learner interactions that lead to application and integration of knowledge into the learner's context.

Further, R. C. Clark and Mayer (2016) emphasized that such meaningful and relevant learning experiences provide learners with interactive learning opportunities and feedback, as well as realistic and relevant scenarios that allow for the transfer of learning to real-world situations. Core to these interactive learning opportunities is the implementation of instructional materials and activities that allow learners to interact with other learners, the instructor, and content, thus promoting the application of knowledge and innovation. However, in addition to a number of studies exploring instructional design strategies and the relevance of instructional materials for effective learning experiences, comparisons of delivery formats grew quickly to assess the result of investing in digital technologies for instruction. These movements (i.e., explorations of instructional design strategies, relevance of instructional materials and innovations of instructional delivery formats) prompted an increased interest in comparing F2F and OL instruction – responding to the question, which format was better? (Johnson et al., 2000; Neuhauser 2002; Nguyen, 2015). A seminal database (Nosignificantdifference.org) established in 2004 has been tracking comparison research attempting to answer what format is better in terms of the effectiveness of F2F and OL instruction. Findings from this repository appear to favor OL instruction as better than F2F instruction due to its heavy reliance on self-reported data. As discussed in the introduction section of this paper, reliance on self-report lacks the ability to

capture actual learner interaction behavior during instruction. Thus, this study used an observational approach—observing learner behavior that demonstrated the impact of the effectiveness of either F2F or OL instruction.

With the recent COVID pandemic that resulted in closing in-person classes and opening alternative OL instruction, this question of 'which is better' continued to echo as higher education institutions reported that economic and digital literacy challenges were major as learners were forced to engage in OL instruction (Cranfield et al., 2021). Conclusions about these challenges were based only on the delivery and not the learning experience, even though learners were the source of data. These challenges resonated with a history of examining institution- or school-wide F2F versus OL course quality based on measures of success and persistence (Abrami et al., 2011; Bernard et al., 2009). These more recent studies skewed away from investigating design strategy comparisons to investigating course delivery comparisons based on success or achievement (e.g., grades), persistence (e.g., course completion), and learner attitude (e.g., course satisfaction), thus forgoing any description of courses beyond F2F or OL delivery platforms. They were criticized by individual researchers and distance education [DE] research groups as lacking the credibility of true comparisons of instruction (Bernard et al., 2004; Heinich et al, 1999). For example, Pei and Wu (2019) in a systematic review of 16 articles published between 2000 and 2017 stressed that none of the comparison studies found a significant difference between F2F and OL instruction due to statistical methods. The consistency in results increased scholarly interest beyond 'which format is better,' to examining the credibility of methods used to determine the effectiveness of F2F and OL learning delivery formats.

1.1.2 Ways to achieve comparative equivalence – learner interaction variable focus.

The synthesis of hundreds of these comparative studies suggested the comparison methods were inadequate (Bernard et al., 2004; R.E. Clark, 2000). Previous metrics of success and achievement, persistence, and attitude unwittingly collapsed instructional design features into overall categories of delivery mode. This collapsing strategy, intentional or not, simply indicated the perceived value of different delivery methods without consideration of learner interactions and engagement measures of quality instruction. OL instruction was found to be either much better or much worse than F2F instruction, while some pedagogical features noted in OL asynchronous learning were found to have led to better achievements than in F2F synchronous instruction. However, the question of how F2F compares to OL instruction actually impedes our understanding of how to make OL instruction better, irrespective of the learning environment (Bernard et al., 2004). Thus, it was recommended that comparison studies be reset to start with a focus on which instructional strategies or learning activities were administered in *equivalent ways* across the studied courses (Bernard et al., 2004).

When environmental variables were clearly identified and controlled – to establish equivalence – different instructional treatments were able to be contrasted, thus leading to research approaches suggesting more precise effect size measures, reduced internal threats to validity, more accurate measures of differences, and indications of which interventions, activities, or treatments had more or less influence on learner success and achievement, persistence, and/or satisfaction (Bernard et al., 2004). These types of data, in turn, were better able to support subsequent efforts to enhance specific aspects of the instruction that may have resulted in poorer outcomes. For example, Soffer and Nachmias (2018) examined learners' perceptions of the effectiveness of three (3) courses with F2F and OL formats. Effectiveness was examined through

these variables: grades and attrition rate, instructional aspects, engagement, and satisfaction. Data were collected from these structural aspects of the courses – overall course structure design, learning content contribution, lessons watched/presence, assignment assessments, and communication. Results suggested that there were significant differences between F2F and OL courses in instructional design features: course structure, reading materials, complementary materials, lessons watched or present, and communication with course staff. They found a lack of significant differences in assignment assessments and communication with other students. Soffer and Nachmias (2018) did not collapse the instructional design features; rather, comparisons were based on specific aspects of instruction, showing which were significant or not significant features related to learning and instruction. Focus on these types of specific structures of instruction may point to activities or treatments that can be enhanced to support stronger learning outcomes and higher quality instruction in F2F and OL formats.

The culmination of the Bernard et al. (2004) meta-analysis suggested that critical distance education constructs supporting adequate and effective comparative contrasts include learner interaction (Moore, 1989), learner autonomy (Moore & Kersley, 2011), and technology functionality (Moore & Kersley, 2011). Using these constructs, accompanied by structural descriptive data, may produce more rigorous, precise, and valuable results that help to unpack and better understand the similarities and differences in compared course research (Bernard et al., 2004). These similarities and differences may reveal important course attributes that ensure learners experience high-quality instruction in F2F and OL formats.

1.1.3 Problematic comparison measures – achievement, persistence, attitude

Recent research focusing on quality of instruction comparing F2F and OL instruction has claimed that learner success and achievement (i.e., grades); persistence (i.e., retention); and

attitude (i.e., satisfaction) were crucial comparison measures (Akram et al., 2021; A. Cohen & Baruth, 2017). Although valuable in responding to questions about F2F and OL instruction in general, there are several problematic issues with these comparative measures (Haverila et al., 2020; Paul & Jefferson, 2019; Simonson, 1999a, 2003b). One issue is that, alone or together, they fail to provide evidence on instructional design features that can inform future design decisions. They have also been deemed measures that do not consider the equivalence of course features or the level of actual learner interaction but rather rely primarily on post-instruction outcomes such as grades, attrition rate, and learner satisfaction (M. Allen et al., 2002; Swan, 2001).

Learner achievement, or success, is commonly used as a measure of persistence to determine instructional quality. The nature of the problem presented by the variable of achievement comes from traditional retrospective assessment approaches (i.e., quizzes, tests, self-reports) suggesting results can be influenced by the operationalization of grades (Paul & Jefferson, 2019). The operationalization of grades usually involves assigning points and conventional A-F grading scales, which are primarily subjective and lack scope and depth (Beale et al., 2014; Lorenzo-Alvarez et al., 2019). Research shows that most grades "received in a class may not necessarily show actual ability, especially if the weights were adjusted to heavily favor group tasks and writing projects" (Paul & Jefferson, 2019, p. 7).

Furthermore, research has consistently shown that the use of achievement or success as a measure of the effectiveness of F2F and OL instruction has no comparative difference. For example, in a study, Paul and Jefferson (2019) examined which instructional format (i.e., F2F or traditional versus OL) proved more effective over an 8-year period in an environmental science class. They found no significant differences in performance between F2F and OL learners. The

assessments employed showed that both F2F and OL learners performed at the same success level. Another study by Beale et al. (2014) comparing F2F learning with hybrid learning in an embryology course also found no difference in grades. Lorenzo-Alvarez et al. (2019) replicated these results in a radiology education course offered both on an F2F and OL learning platforms. The consistency of grades between different formats raises doubts about whether they truly reflect the quality of instruction, especially if the instructor has discretionary control over them. Thus, achievement (success) measures have raised questions about their rigor as measures for comparison studies.

Measures of persistence have also been problematic in comparative research on F2F versus OL courses. Persistence results have been highly inconsistent when determining if F2F or OL instructional formats are better or worse than each other (Haverila et al., 2020). The inconsistency of learners' persistence, as shown through retention frequencies, can be influenced by external factors like social, environmental, and traumatic issues, not related to instructional design factors (Haverila et al., 2020). This suggests that retention is often affected by issues ranging from a learner's sense of belonging to the learning community, early educational experiences, motivation, support or lack of support from peers, family, and the learning community, and the level / types of communication with instructors (Castles, 2004; Hart, 2012). Cases of traumatic issues, ongoing financial problems, sudden conflict with family members, and chronic illness were often reported as reasons for attrition or dropout (Hart, 2012). Gibbs (2010) concluded that learner persistence did not characterize the learners' experiences during instruction; rather, they were often highly related to non-academic issues and thus should not be used to compare the quality of instruction across F2F and OL instruction.

Learner attitude or satisfaction, or how well learners liked or enjoyed instruction, is another of these common measures used in F2F versus OL comparison studies. Satisfaction is often used as a measure affecting persistence when comparing F2F and OL instruction (M. Allen et al., 2002; Delnoij et al., 2020). Like persistence, satisfaction is highly problematic due to its subjective and retrospective nature, which supposedly reflects learners' perceptions of the interaction they experienced during instruction (Purarjomandlangrudi et al., 2016; Simonson, 1999a, 2003b).

At the center of collecting satisfaction data, for example, was the use of self-reports. Such self-reports are not generally designed to effectively capture learner interactions during instruction, nor do they reflect the actual level of engagement data that suggests high-quality learning and instruction (Akram et al., 2021; A. Cohen & Baruth, 2017; Zhao & Watterston, 2021). Rather, self-report instruments are primarily used after instruction and are susceptible to accuracy, bias, and labor intensity issues that impact the interpretation of results (Appleton et al., 2006; Fredricks & McColskey, 2012). For example, in a study investigating the role of social presence in relation to learner interactions and learning outcome beliefs, Bailey (2022) pointed out that self-report data was unable to capture actual experiences of social presence and level of interactions. In addition, Tang and Tang (2020) recently stressed that self-report instruments are time-sensitive and unlikely to be accurate because people usually tend to either underestimate or overestimate their ability or experiences after the fact. Hence, the time of data collection when using self-report instruments and the unlikelihood of collecting accurate objective data challenge the validity of research results from comparison studies.

With the limited capacity of self-reports, however, M. Allen et al. (2002) suggested that self-reports were one possible source of data that may be compared in conjunction with other

data for the effectiveness of instruction. For example, a self-reported source of data examining the design and structure of a course might provide data on satisfaction levels and perceived learning effectiveness of specific aspects of the course (Swan, 2001). Another source of self-report data may be in examining learners' self-efficacy, influenced by race, gender, social status, and educational level, that can provide data on learners' satisfaction levels and approaches to learning based on their own characteristics (Ke & Kwak, 2013; Shen et al., 2013). However, Bailey (2022) strongly recommended using other data to support exploring satisfaction, such as interviews and observations. Together, these evidence-driven methods can provide actual performance data that better unpacks satisfaction and attitude data to infer the quality of learning and instruction.

In summary, achievement and success, persistence, and satisfaction data have provided some insights when examining F2F as compared to OL instruction. However, there have been challenges to the interpretation of these data – mostly arguing that interpretation challenges are due to the subjective nature of these data and the influence of factors outside of the instructional environment. These challenges have resulted in call-to-question results suggesting whether F2F or OL instruction is superior to the other. Bernard et al. (2004) suggested measures that are more helpful in comparison research should focus on interactions that occur within the instruction, those that are core to quality learning experiences. These learning experiences should reflect learner engagements with instructional content, the instructor, and other learners – those learner interactions that lead to quality instruction.

1.2 Study's Significance

1.2.1 Rationale that supports learner interactions as core measures in comparison studies.

Learner interaction has been identified as a key indicator of quality instruction and learning (Moore, 1989). Learner interactions have become more widely used in recent comparative research studies as a core construct of learning experiences, both in F2F and OL learning environments. Learner interactions between learners, instructors, and content have been shown to lead to high-quality learning outcomes (Anderson, 2003; Holmberg, 2020; Moore, 2018; Vygotsky, 1978). Learner interactions during instruction were traced to Moore's (1989) description of Dewey and Bentley's (1948) idea of transaction as the inherent reciprocal relationship between the learners, instructors, and content in a learning environment. Moore's (1989) description is explicit in his suggestions of three types of interaction during instruction. These types of interactions include learner-to-learner [L2L], learner-to-instructor [L2I], and learner-to-content [L2C].

This study argues that these interactions happen during instruction. Therefore, they can only be accurately captured during that time and not after instruction, when it is typical for most self-report instruments to be employed.

1.2.2 Comparative equivalence in this study – focused on observations of learner interactions.

This study concurs with Barnard et al.'s (2004) argument that comparative studies must begin with some type of equivalence between course structure and instruction. Establishing course structures saves instructional designers and subjective matter experts time and money (Reigeluth, 2018). Reigeluth et al. (1980) propose that instructional design should use pervasive content relations and align them with a "structure" which represents a kind of pervasive relation

within a unified order. Courses can be structured using learning, procedural, taxonomical, and theoretical structures. These structures will be discussed in more detail in chapter 2.

In the case of the Soffer and Nachmias (2018) study, they first ensured that the F2F and OL formats of those three courses were procedurally structured. By establishing an equivalence in the courses' structures, this means that both formats had the same order of performing tasks. The order of performing tasks in those courses can be described as procedural structure – wherein learners finish one step of the course and proceed to the next (Reigeluth, 2018). Procedural structure underscores the importance of consistency in performing tasks that facilitate comparable learning experiences and interactions during F2F and OL instruction. For this study, equivalence of structures suggests 97% similarities, which means there are satisfactory similarities in the order of learning and instructional tasks in the context of procedural structure. Thus, this adherence concurs with Simonson (2003b) and Barnard et al.'s (2004) assertion that equivalent instructional and learning activities or tasks suggest equivalent learning experiences.

Regarding equivalence of instruction, comparisons of F2F and OL learning environments are generally considered incomparable due to the geographic-based design factors that separate instructors and learners, thus requiring different types of instructional strategies to support learning (Bernard et al., 2004; Simonson, 1999a). Comparison research, however, is possible when heeding the suggestions to identify equivalent factors that suggest the quality of instruction through different types of activities. These equivalence factors (e.g., learner interactions) can provide data on the effectiveness of design features and offer a better way to examine the effectiveness of various instructional treatments across both F2F and OL learning environments (Barnard et al., 2009: Paul & Jefferson, 2019**).** Comparative equivalence of instruction in this

study uses structured observation and seeks to highlight learners' actual performance (via the frequency of interaction and observation fieldnotes) during instruction (Bailey, 2022),

Research suggests that there are specific approaches to conducting structured observation, which include time sampling, event sampling, focal sampling, participants, and semi-structured observations. *Time sampling observations* is used to study frequently occurring behaviors for a specific amount of time and records whether or not a particular behavior or activity took place; *event sampling* to observed the intensity, duration, and frequency of behaviors within a defined event; scan observations to obtain true frequency of behaviors and the rules that promote efficiency of these behaviors; *focal sampling* recording an individual participant continuously to collect data on multiple types, sequences, and frequencies of behaviors; *participants observation* to study broad and complex constructs that encompass a variety of events or behaviors, generally in applied settings; and *semi-structured observations* where experimental control is provided in the natural setting (Ostrov & Hart, 2013).

Each approach is dictated by the types of questions being asked, the research context, and the types of data being collected, e.g., identification of specific behaviors or performance, frequency (tally) of specified participant behaviors, number of exchanges/ interactions among stakeholders, scale of performance observed, and/or environmental variables (Ostrov & Hart, 2013; Patton, 1987).

This study uses time sampling observations to highlight learners' actual performance during instruction (Bailey, 2022) using a modified version of a validated Behavioral Observation Checklist (BOC) (Koszalka & Whorway, 2024) that supports structural observations over a specific amount of time. Structural observations through behavioral observation instruments – like the BOC – employed in an unobstructed way with direct access to the instructional

environment, – has the ability to collect detailed and honest descriptive accounts of contextual factors (Fredricks & McColskey, 2012). This ability is advantageous in examining engagement indicators across F2F and OL instruction (Fredricks & McColskey, 2012). Thus, it supports equivalence measure – like interactions – in comparative studies by gathering data on learners' active participation and involvement in learning activities during instruction in the same course offered in both a fully F2F and fully OL format.

1.3 Study's Goal

The overall goal of this research was to gather and analyze data that will ultimately be able to support instructional designers, learning scientists, and educators in designing and redesigning online and face-to-face courses (i.e., instructional design features) to enhance the quantity and quality of learning interactions. Such data will help identify specific activity characteristics where strategies may be incorporated to stimulate higher levels of learner interactions. It is also hypothesized that this observational comparative research approach sheds new light on the value and techniques to gather and examine data relevant to actual performance during different types of instructional delivery modes.

It is important to note, however, that research studies involving observations have their own set of limitations, even when structured observation tools are utilized for data collection. These tools provide a systematic approach to data gathering, but there are still challenges associated with accounting for confounding variables and controlling them adequately (Creswell, 2013). This study acknowledges challenges in accounting for human factors such as cultural and gender differences, prior knowledge, and cognitive styles – which have been identified as factors known to influence instruction (Baumgartner et al., 2018; Mayer & Moreno, 2003). These factors were considered possible confounding variables for this study, and although they may not

be directly related to capturing learner behaviors in this observation study, they may suggest why certain patterns were observed.

Cultural and gender differences can play a role in how individuals interact and learn with each other. Research has shown that males and females often exhibit variations in cognitive abilities, learning styles, and social behaviors based on their previous learning experiences (Gurian et al., 2015; Hyde, 2005). Thus, interpreting the 'whys' of behavior data needs to be done cautiously. Prior knowledge is another crucial human confounding variable that may impact the outcomes of a study on learner interactions. Learners enter learning settings with varying levels of prior knowledge and experiences related to the subject matter being studied. Individuals with extensive prior knowledge in a particular area may approach learning and interactions differently than those with limited or no prior knowledge (Mayer, 2002; Vygotsky, 1978). In this study, the course is designed at an introductory level for new graduate students, so it is more likely that learners have a similar, low-level of previous content knowledge. Thus, the data collected will not focus on the 'why' learners behave in observed ways, instead it focused on the 'how and when' (frequency) of behaviors during instruction.

To address some of the limitations, this study relies on fieldnotes, which are detailed descriptions of the observational context and any additional relevant information that may explain frequency counts. Fieldnotes allow researchers to capture and document aspects of the observation that may not be covered by the structured characteristics (H.R. Bernard, 2011). These notes provide a more comprehensive understanding of the context, potential confounding variables, and other relevant factors that may influence the outcomes (interaction behaviors) being studied.

1.4 Study's Purpose

The purpose of this dissertation is to tally frequency, identify frequency patterns, and compare the level of learner interactions that occur in the different sections of the same course where one is offered in F2F format and one is offered fully OL. The chosen course that had been structured with equivalent activity characteristics (e.g., objectives, activities, content resources, etc.) in each of the F2F and OL sections. Each section of this course, F2F and OL were established to have a level of likeness or course structure equivalence across both delivery formats, indicating 97% equivalents in objectives, activities, resources, and other structural components of the course (Koszalka, in development). Differences were identified as types and magnitude of activities that were different primarily due to distance between instructors and learners in F2F versus OL online environment, such as mode of synchronous instruction as in-person-synchronous-local versus in-person-synchronous-video conference. In other words, the primary difference was that F2F sections had weekly classroom sessions whereas the OL sections conducted several video-based sessions.

The second step in the process identified where to gather learner interaction data to seek quality instruction metrics across the compared sections. Overall, these levels of comparison determined the level of learner interactions in equivalent sessions of the F2F and OL sections and established if there were significant differences — better or worse — in level of interactions, thus suggesting a level of instructional and learning quality between the two delivery formats. Data were gathered during synchronous sessions where instructors and learners were both present. The study used a modified version of the BOC to collect quantitative data – counts (tallies) of interactions – based on Moore's (2018) three types of interactions (i.e., learner-to-learner, learners-to-instructor, and learner-to-content), along with observer fieldnotes. The use of

this observation approach and fieldnotes allows direct access to the phenomena to collect actual performance data, as Bailey (2022) suggested.

1.5 Research Questions

The research questions that guided this process was:

Research Question 1: What is the frequency of learner interactions with each other, instructor, and course content during observed sessions of equivalent online and face-to-face instructional delivery formats?

Research Question 2: Are there any variations in the frequency of learner interactions during the observed sessions within and between the two formats of the courses being compared?

Research Question 3: Do variations in the frequency of learner interaction suggest that either delivery format extends a higher or lower level of quality within specific observation sessions of the course?

Research Question 4: What characteristics of instructional and learning behaviors during instruction may have influenced the interpretation of observed frequency data?

1.6 Chapter Summary

In summary, empirical studies have shown that the quality of instruction is heavily influenced by learner interaction, including learner-to-learner, learner-to-instructor, and learner-to-content exchanges. Studies show that the frequency of learner interaction during instruction is a key indicator of the quality of instruction. Comparative studies have been conducted to examine the effectiveness of classroom or face-to-face (F2F) and online (OL) instruction, with the frequency of learner interaction being one of the factors analyzed in these studies. Overall, OL instruction had lower levels of interaction than F2F instruction, although the frequency of interaction varied greatly within each type of instruction.

Much of the literature describing comparison between F2F and OL instruction has been judged as ‘poor quality’ based on a lack of reliable course data and valid measures of course equivalency and data showing key descriptives of the comparative nature of the courses being evaluated. With the development of several innovative instructional delivery formats, such as OL synchronous and asynchronous, blended, hybrid, and hyflex formats, an increased interest in comparing F2F and OL instruction has recently surged.

However, the credibility of the methods used to examine the effectiveness of F2F and OL instruction within these delivery formats has been questioned. The most commonly used self-report methods have not generally been conducted in structurally equivalent courses and self-report data like measures of achievement and success, persistence, and satisfaction have been found to be an ineffective measures of actual learner behaviors. The interpretation of these data has often been argued as being subjective and likely influenced by factors outside of the instructional environment. Researchers have suggested that the use of observation as an evidence-driven method is much more helpful in comparison research as it provides actual performance data on the interactions that occur within the instruction. These interaction data are core to determining the quality of the instruction and can show key descriptives that highlight the comparative features of the courses being examined. It has been recommended that instructional designers pay close attention to the frequency and quality of interaction and incorporate strategies that promote interaction when designing instruction.

Therefore, this study gathered learner interaction data using a behavioral observation approach to compare the quality of instruction across F2F and fully OL sections of the same course. This observation method allows for the collection of actual learner interaction data as learners participate during the instruction. This allows real-time behaviors to be analyzed to

determine if there are similarities and differences in patterns of learner-to-learner, learner-to-instructor, and learners-to-content interactions within and across equivalent sections delivered either F2F and OL. Such data helps in comparisons to determine if one type of format is better (as defined by learner interactions measures) than another and how instruction may be enhanced to ensure quality instruction in either delivery format.

In chapter 2 there is a detailed analysis of relevant literature on learner interaction. This analysis addresses the concept of instructional interaction – a central focus in studies comparing face-to-face (F2F) and online (OL) learning environments. It details how interaction is operationalized through instructional attributes that directly impact instruction in specific delivery formats (i.e., F2F and OL) to facilitate learning. It details the concept of course equivalence in different delivery formats. Further, it factors in how the quantity or frequency of interactions directly impacts instruction, which leads to high-quality learning.

Chapter 2 - Literature Overview

Comparative studies across F2F and OL courses have been criticized for collecting indirect survey data (e.g., grades, satisfaction) that do not represent actual learner behaviors [interactions] (Bailey, 2022; Bernard et al., 2004; Tang & Tang, 2020), lacking the credibility of true comparisons of instruction (Bernard et al., 2004; Tang & Tang, 2020). These comparison studies have also been criticized as failing to show key descriptives of the quality of learning that learners experienced (Heinich et al., 1999). This study aims to examine and compare two sections of the same course with established equivalence across face-to-face (F2F) and online (OL) formats in an effort to investigate the quality of instruction and learning based on actual learner interactions. Ultimately, using an observational approach, this study attempts to unpack and describe the level of learner interaction occurring during each section and elucidate the benefits of improving instructional design strategies to increase learner interactions to enhance the quality of instruction and learning, in both F2F and OL delivery platforms.

This chapter provides a detailed analysis of literature relevant to this study. It details how the concept of interaction is operationalized through instructional attributes that directly impact instruction in different delivery formats (i.e., F2F and OL) to facilitate learning. The literature review addresses the importance of equivalency of courses in comparisons studies. Further, this literature review describes how the quantity or frequency of interactions directly impacts instruction, which leads to high-quality learning. The detailed analysis of these relevant pieces of literature and their contribution to understanding learner interaction and instructional quality provides clarity for this study's contribution to scholarship and innovation.

2.1 Instructional Interaction

Interaction is one of the most used constructs in studies that compare F2F and OL learning environments (Anderson, 2003; Tenenbaum et. al., 2020; Wagner, 1994). Interaction is a confluence of observable interaction relationships among learners, instructors, and content occurring during instructional events, resulting in learning outcomes (Koszalka & Whorway, 2024; Moore, 2018). Interaction indiscriminately operationalizes its application through instructional methodologies in social contexts (Simpson & Galbo, 1986). Specifically, within a learning context, Wagner (1994) has described the application of interaction as having attributes that directly impact instruction while using delivery systems to facilitate learning. This study focuses only on those attributes that Wagner (1994) also terms instructional interaction: “An instructional interaction is an event that takes place between a learner and the learner's environment. Its purpose is to respond to the learner in a way intended to change his or her behavior toward an educational goal” (p. 8) .

It is this instructional interaction that Moore (1989) described as the reciprocal relationship between the learner, the instructor, and the content in the learning environment. Moore's (1989) description of interaction is well explained and referenced (cited) as the three types of learner interactions: learner-to-learner, learner-to-instructor, and learner-to-content interactions.

It is critical to recognize that Moore's (1989) idea of these three types of interaction is rooted in the concept of reciprocal or transactional learning, which is traced to the Socratic method. The Socratic method emphasized that learning happens through interaction manifested by a question-and-answer exchange; as the instructor asks chunks of content-related questions, learners provide content-related answers; thus, learners are led to the desired knowledge

(Dinkins & Cangelosi, 2019). This method was expanded through Piaget and Vygotsky's work; Piaget's theory of cognitive development (1936) and Vygotsky's sociocultural theory (1978), respectively.

Piaget's theory of cognitive development asserted that learning happens through learners' interaction with the environment, wherein knowledge is constructed from personal experience (Pass, 2007). Vygotsky's sociocultural theory argues that learning happens through interpersonal interaction with the environment (Pass, 2007). Comparatively, Piaget argued that learners' knowledge acquisition was a sole exploration, while Vygotsky argued that learners' knowledge acquisition was an interdependent exploration. Many lines have been drawn between Piaget's argument and what appears to be Vygotsky's counterargument. However, and most important to this study, it draws from this debate that both arguments ascertain that learners must interact, whether solely or interdependently, with their environment or a social context in which they acquire or construct knowledge.

As mentioned in Chapter 1, under the nature of the problem, Dewey and Bentley (1948) developed the early concept of 'transaction' from the intersection of Piaget's and Vygotsky's debate. Dewey expanded the ‘transaction’ concept through the transactional theory (Vanderstraeten, 2002) which suggests that the only way to acquire information about human beings is through their actions. This action is primarily observable between individuals and their environments. Moore (1989) argued that within a learning environment such action is the observable reciprocal relationships between the learner, the instructor, and the content, hence the three types of interaction.

2.1.1 Learner-to-Learner interaction [L2L]

Learner-to-learner interaction is observable among individual learners or learners working in organized groups (Moore, 1989). Research suggests that in large F2F classrooms the use of asynchronous techniques like recorded video and virtual media interaction tools can be useful tools to enhance L2L interaction (Du Plessis, 2020; Tawfik et al., 2018). However, these tools are fundamentally delivery systems that facilitate interaction and do not enhance interaction or impact learning (R.E. Clark, 1983; Wagner, 1994).

It is the design and purposeful implementation of meaningful or deep learning activities that enhance interaction (Webb & Moallem, 2016). Purposefully designed learning activities should enable a learner to share information with other learners individually or in a group, ask questions of other learners individually or in a group, demonstrate their knowledge of the content, and receive feedback from other learners.

2.1.2 Learner-to-Instructor interaction [L2I]

According to Moore (1989), when an instructor seeks "to stimulate or at least maintain the student's interest in what is to be taught, to motivate the student to learn, to enhance and maintain the learner's interest, including self-direction and self-motivation" (p. 2), the instruction that precedes such intent describes learners and instructor interaction. Studies show that when instruction is designed to provide motivational and emotional support through communication strategies, such purposefully designed interaction predicts the degree of learners' satisfaction and hence achievement (Fredericksen et al., 2020; Kang & Im, 2013).

Whatever communication strategies are integrated into the design of interaction, it is paramount that the goal of interaction between learner and instructor remains to provide motivational and emotional support to enhance learning (Bernard et al., 2009). The design and

purposeful implementation of interaction between the learners and instructor should allow learners to ask questions, present, share, or demonstrate knowledge learned, and receive constructive feedback from the instructor.

2.1.3 Learner-to-content interaction [L2C]

Moore (1989) described learners and content interaction as "the process of intellectually interacting with the content that results in changes in the learner's understanding, the learner's perspective, or the cognitive structures of the learner's mind" (p. 2). Moore (1989) argued that 'without it [cognitive engagement] there cannot be education" (p. 2). However, the complexity of independently observing the learner and content and fundamentally reviewing its consistent traits with exclusion from learner-to-learner and learner-to-instructor has been challenging (Xiao, 2017; Zimmerman, 2012).

The design of interactive instruction provides an observation opportunity to independently track learner and content interaction (Jonassen, 1985). Interactive instruction allows learners to complete tasks and answer questions that prompt desired outcomes; learners respond to feedback by demonstrating the desired outcomes accordingly (Jonassen, 1985). Interactive instruction originated before computer-based instruction; thus, it should be distinct from refined conceptualizations at the start of the age of instructional technology, which focus on how these technologies facilitate interactivity (Jonassen, 1985).

Fundamentally, interactivity, at its inception, focused on the design of the learning environment as a social context that facilitates learning. Learning environments are spaces wherein learners learn, and they are classified based on their synchronicity and modalities since the evolution of instructional technologies (Ebner & Gegenfurtner, 2019). Synchronicity refers to the timing of interactions between the learner and instructor; modalities refer to the mode of

content delivery in the learning environment (Ebner & Gegenfurtner, 2019). There are two learning environments focused on during this study: face-to-face (F2F) and online learning (OL) environments. Within these learning environments, there is either F2F instruction or OL instruction based on synchronization.

2.2 Definition of Face-to-face (F2F) Instruction

F2F instruction takes place in learning environments where synchronicity occurs, usually a traditional in-person learning environment or an online learning environment where learners and instructors are together at the same time via digital technologies (Ebner & Gegenfurtner, 2019). F2F instruction is direct and happens in real-time through live video streaming or in a traditional F2F classroom.

2.3 Definition of Online Instruction

OL instruction takes place in learning environments where synchronicity does not always occur (Ebner & Gegenfurtner, 2019). Often, online instruction is referred to as virtual instruction, usually delivered when learners and instructors are in different physical places. OL instruction may be implemented in asynchronous (not at the same time), synchronous (same time), hybrid (combination of F2F and OL sessions in one course with synchronous and asynchronous sessions), or blended (combination of synchronous and asynchronous sessions in a course) formats using an online learning environment.

2.4 Instructional Interaction during Face-to-face Instruction

Interactions are at the center of most effective instruction in learning environments (Baker et al., 2010). It entails reciprocal behavioral actions between L2L, L2C, and L2I while implementing instructional and learning activities. During F2F instruction, the degree of

interaction is fundamental to maximizing academic performance and the success of the learning process in a course (Marco-Fondevila et al., 2022).

Marco-Fondevila et al. (2022) examined the impact of learner-F2F interaction on academic performance. The investigation covered several groups of university students over four years as the researchers analyzed the effect of F2F interaction through participation techniques on learners' academic performance. The study results showed a significant improvement in learners' academic performance with enhanced active participation techniques. Further, the study revealed that learners expressed preference for instructional approaches that favored group interaction that included active participation with other learners.

Group interaction through collaborative learning activities is a vital part of F2F instruction and is generally carried out through F2F synchronous communication (Dzemidzic et al., 2019). F2F synchronous communication refers to a traditional way of communication that requires the simultaneous participation of instructors and/or learners (Redmond, 2011). In this mode, there are generally spontaneous exchanges that contain both verbal messages and nonverbal cues, such as tone of voice, gestures, and facial expressions (Borup et al., 2011). Interaction in this mode of instruction is primarily enhanced through participation techniques — voice, gestures, and facial expressions — that drive collaborative activities. Both verbal and nonverbal behaviors, as indicated through participation techniques, can indicate interactions that suggest quality learning and provide measures related to instructional quality. Thus, capturing and describing learner interaction in F2F instruction elucidates the benefits of creating instructional design strategies that improve learner interactions in real-time, enhancing the quality of instruction.

2.5 Instructional Interaction during Online Instruction

Promoting and maintaining interaction during OL instruction is a fundamental learning interest, as it affirms the central role that instructors play in creating and leading a dynamic and academically effective learning environment. One of the biggest advantages of online instruction is that people can interact at their own pace and have the flexibility to take courses without physically walking in the classroom (Vrasidas & McIsaac, 1999).

However, research acknowledges that designing for interaction in an OL environment can be complex (Park, 2014; Vrasidas & McIsaac, 1999). Vrasidas and McIsaac (1999) suggested that the instructional layout of online courses, the class size, feedback medium, and learners prior experience with technology all influenced the design complexity for interaction in an online learning environment. Despite this complexity, OL courses have shown significantly better results on examinations, solving complicated problems, thus have been perceived to be better than F2F courses (Castro & Tumibay, 2019; Soffer & Nachmias, 2018). Social presence today is often considered integral to perceiving online courses as being better, while examinations and other performance indicators have fluctuated between and equally amongst F2F and OL courses. Social presence has been shown to have implications for course design that influence learners' perceptions (Richardson et. al. 2017, 2013; Vrasidas & McIsaac, 1999).

Boston et al. (2009) explored the relationship between indicators of the Community of Inquiry Framework (CoI) (in which – social presence is an indicator) and student persistence. They analyzed over 28,000 student records and 28,877 survey data and found that affective indicators of social presence accounted for more than 20% of the variance in learners' retention. This means that learners did not feel (satisfied) that the design of the course allowed them to have meaningful interactions with other peers that led to quality learning, thus less effective

instructional quality. For learners to have meaningful interactions that lead to quality instruction, Vrasidas and McIsaac (1999) suggest it can be possible when learners interact with their peers, collaborate, discuss their positions, form arguments, re-evaluate their initial positions, and negotiate meaning. These instructional strategies allow learners to interact with their peers (L2L) at the same time, interact with the content (L2C) and the instructor (L2I) simultaneously. – such interaction at an increasing level leads to higher quality learning experiences. Research linking social presence and OL course environments has become popular in part because of the Community of Inquiry (CoI) model, in which social presence is measured along with teaching presence and cognitive presence. The CoI is a framework widely adopted for addressing the design complexity of interaction in online learning (Lapsley et al., 2008; Garrison & Akyol, 2013; Kozan & Richardson, 2014).

Garrison and Anderson (2003) developed the CoI model focused on creating and enriching interaction in online learning environments. The model involves three main elements: social presence, cognitive presence, and teacher presence. These three separate but integrated elements reflect the observable reciprocal relationship dynamic within learning environments. COI involves learner focus on perceptions about teacher, learner, and content interactions, just as Moore's concept of learners interaction seeks to observe interactive relationships among L2I, L2L, and L2C.

The observable reciprocal relationship between learners, L2L, is manifested in social presence through emotional (affective) expressions and open communication where learners build and sustain a sense of group commitment. The reciprocal, observable relationship between the L2I is manifested in the teacher's presence through the instructor providing timely feedback and facilitating learning activities. The reciprocal observable relationship between L2C is

manifested in cognitive presence through the presentation of content and demonstration of lessons learned.

With these manifestations, generally, CoI bears design opportunities for creating interactions among learners and their instructors. According to Shea et al. (2022), this premise highlighted the framework's emphasis on teaching and learning as inherently interactive. They stressed that this premise was considerably emphasized in the terms' 'community' and 'inquiry,' as both are dialogic and active.

The use of CoI to design for interaction in OL environments is due to how it describes organizing instruction, social, and cognitive processes to achieve high-quality instruction for the duration of an online course. Most importantly, CoI highlights that implementing a design for interaction depends on the instructor and learner's actions during instruction. According to Caskurlu et al. (2021), these instructor and learner actions meant accountability, being real, and supporting the learning process during the course duration. Caskurlu et al. (2021) arrived at this conclusion after a thematic synthesis of 35 qualitative studies focused on factors informed by the CoI framework that impacted the quality of learner OL learning experiences. According to the study results, accountability pertained to the course design and facilitation. The course design was presented through weekly course introductions and objectives, informing students about due dates and time frames, providing clear instructions and expectations on participation, and selecting manageable content and learning activities. Course facilitation was provided by the instructor being accessible and responsive to learner questions regarding course expectations and/or content-related questions and actively involved in class discussions by providing subject-matter expert knowledge; the learners being active participators and responsive to their peers' content-related inquiries/questions.

Further, Caskurlu et al. (2021) suggested that being real pertains to learners' abilities to express themselves through many visual cues supported by the course design. They suggested that learners can be themselves or be allowed to disclose their abilities through learning activities that encourage them to engage in content-related interaction.

As per supporting the learning process during the course duration, Caskurlu et al. (2021) reported that learners valued interaction, especially when their autonomy was encouraged. Notably, in that study, learners reported satisfaction when they constructed their knowledge through (a) interaction (content-related and social); (b) comprehension and reflection; and (c) active participation in collaborative and cooperative activities.

Despite the enormous concentration of CoI toward designing for interaction demonstrated through learners and instructor's actions, several empirical studies have challenged the CoI framework's ability to foster its' inherent elements (i.e., social, teaching, and cognitive presence) toward high-quality learning outcomes (Annand, 2011; Maddrell et al., 2017; Rourke & Kanuka, 2009). In particular, Annand (2011) re-emphasized a continuous critique of CoI, which suggested that the framework does not sufficiently inform OL education design, development, and implementation processes that may lead to high-quality instruction. This critique argued that CoI publications do not produce validity evidence that is sufficient to inform the design of instruction because CoI-designed learning processes are investigated through learners' satisfaction and perceptions of learning.

This study does not use CoI as a framework but highlights that it also focuses on interactions and the need to design instruction that prioritizes interactions; however, as Annand (2011) and other researchers (Maddrell et al., 2017; Rourke & Kanuka, 2009) have argued, CoI data may not be sufficient. Consequently, like Moore's concept of learner interaction, research

using CoI suggests that both satisfaction and perception are highly retrospective and subjective measures that may not represent the instructor and learner's actual actions during course activities. Caskurlu et al., (2021) described these actions as accountability, being real, and supporting the learning process, which Vrasidas and McIsaac (1999) referred to as “evaluation of student performance”. Thus, Vrasidas and McIsaac (1999) suggest that observation methods should capture these actions during active instruction to inform the quality of learner performance.

2.6 Instructional Equivalence of F2F and OL Delivery Formats

Evaluation of learner performance in academic settings is directly related to ensuring the equivalence of high-quality instruction across courses and programs, irrespective of their format. This notion of equivalence is based on Simonson's (1999a) assertion that the equivalence of instructional experiences is essential to the quality of learning. The Equivalency Theory, introduced by Simonson (1999a), originally emphasized that distance education should be based on the principle of equivalence to ensure its success. According to the theory, the more similar the learning experiences are for distance (OL) and F2F learners, the more equivalent the outcomes will be. Simonson (2003b) further explained that although the learning experiences may not be identical, they can still be considered equivalent if they produce the same quality of learning outcomes.

To apply this theory to online assessments, Lapsley et al. (2008) suggested that F2F and OL learners should receive equivalent learning experiences to achieve equivalent learning outcomes. The authors argued that course designers should create learning experiences of the same value for learners, regardless of the course delivery format. Sitzmann et al.'s (2006) meta-analytic findings indicated that F2F and OL formats produced equivalent learning outcomes

when the same instructional methods were used. Thus, Bernard et al. (2004b) also suggested that online courses should be designed to resemble F2F instruction as closely as possible for optimal instructional effectiveness that leads to high-quality instruction.

Merrill's (2002) well-known work title, “First Principles of Instruction” emphasized the importance of optimizing instructional design strategies for effective instructional opportunities that lead to high-quality learning. Merrill’s (2002) proposed five fundamental principles of instruction as the basis for instructional design approaches. The principles explain that: (1) learning is promoted when learners are engaged in solving real-world problems; (2) learning is promoted when existing knowledge is activated as a foundation for new knowledge; (3) learning is promoted when new knowledge is demonstrated to the learner; (4) learning is promoted when new knowledge is applied by the learner; and (5) learning is promoted when new knowledge is integrated into the learner's world. Merrill's (2002) “First Principles of Instruction” is one of many principles and model that aligned with Bernard’s et al.'s (2004b) suggestion of designing for optimal instructional effectiveness that leads to high-quality learning. Other frequently used design models and principles include the ADDIE Model (Branson et al., 1975); Backward Design (Wiggins & McTighe, 2005), Dick and Carey Model (Dick et al., 2013) and ASSURE (Heinich et al., 1999). These principles are design guidelines for creating meaningful and relevant instructional experiences that provide opportunities for interactions that lead to high-quality learning. Thus, this study examines the level of interactions resulting from the equivalence or likeness in course structure, across different delivery platforms, predicted to lead to high-quality learning.

2.7 Structural Equivalence of OL and F2F Delivery Formats

The goal of instructional designers is to bring about desired cognitive and behavioral changes through effective instructional procedures, and well-structured courses can save time and resources and enhance the learning process in achieving that goal (Gropper, 1983; Reigeluth, 2018). To address the issue of well-structured courses, one possible starting point is the Elaboration Theory (Reigeluth et al., 1980). Elaboration Theory (Reigeluth, 2018) focuses on strategies for sequencing and synthesizing instructional content, aiming to facilitate the work of instructional designers to show interrelationships within the content (Reigeluth, 2018). Reigeluth et al. (1980) described a course structure as an instructional procedure that starts with introducing the learner to a broad view of the content to be taught; then advances to parts of the content, then subparts, all in a continuing manner until the desired level of detail and complexity is achieved.

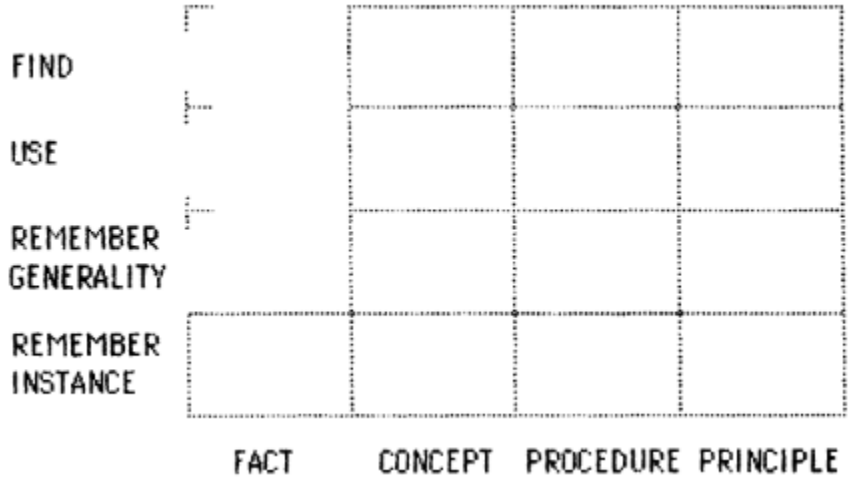
Reigeluth's Elaboration Theory (1980) has received very limited attention across literature since its introduction. Nonetheless, it appears to be a valued theory proposing specific approaches to structuring content in a simple-to-complex sequence (Orhan Karsak, 2018). The theory’s assumption is that a well-structured course is a critical foundation for determining how to sequence and synthesize instruction. In one of his seminal work, "Lesson Blueprints Based on the Elaboration Theory of Instruction," Reigeluth (2018) explained that “the nature of the simple-to-complex sequence must differ depending on the kind of content that is considered to be most important to the goals of the instruction” (pg. 248) .

Also elaborating on the nature of a simple-to-complex sequence, David Merrill introduced the Component Display Theory in 1987, which he later described as the Component Design Theory (1994). Both versions of Merrill’s theory complement Reigeluth’s seminal work;

in addition, Merrill argued that the earlier exertions did not include prescriptions for OL courses with different content (Merrill 1987). So, he proposed a two-dimensional classification system as a holistic prescription for all content. The two-dimensional classification system, as shown in Figure 2, includes performance level as one dimension and type of content as the other dimension. Performance levels sequentially are Remember, Use, and Find, while the types of content are Fact, Concept, Procedure, and Principle.

Figure 2.1

Merrill's Two-Dimensional Classification System



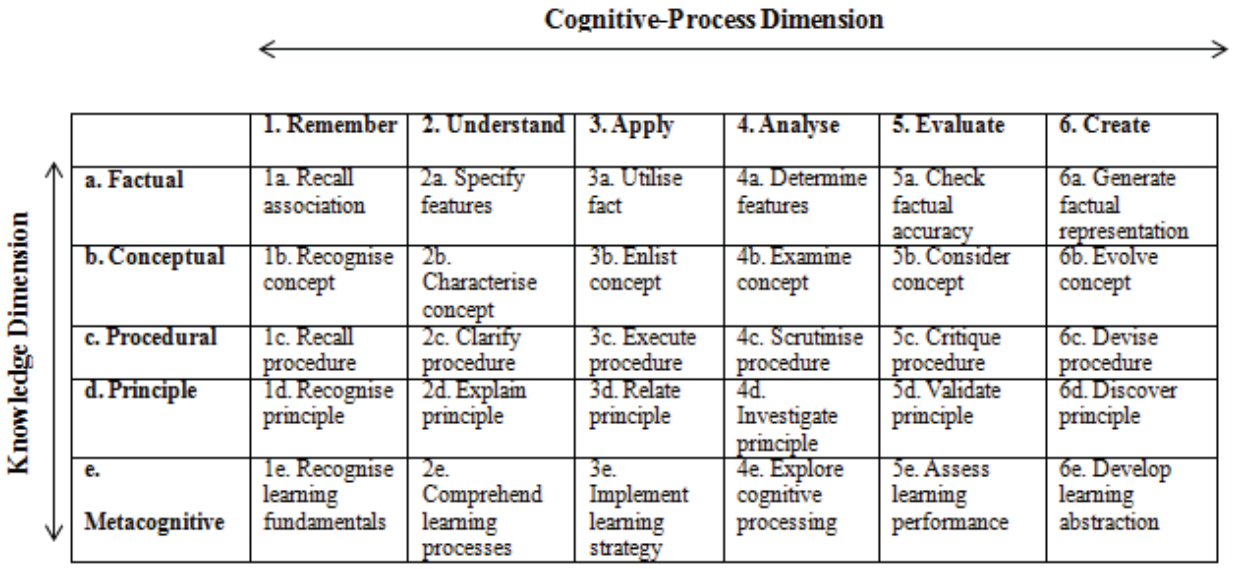
Adopted from Merrill (2018). A lesson based on the component display theory. Instructional theories are in action. (Page 204)

This intersection between performance and content in the classification system primarily focuses on cognitive outcomes, not affective and psychomotor outcomes. Several procedures and models have been used to address this intersection. A widely used procedure is Gagne's (2005) nine cognitive conditions or events of instruction, which are primarily used to guide the organization of content delivery and engage learners. McMahon and Garrett (2016) in their work 'A classification matrix of examination items to promote transformative assessment' developed the Instructional Activity Matrix (IAM) which is a combination of the taxonomies - Bloom's Taxonomy, Gagne's, Taxonomy, Merrill's Performance-Content Matrix, the Structure of

Observed Learning Outcome (SOLO) taxonomy, and the Revised Bloom's Taxonomy. IAM provides an informed basis for the autonomous classification of instructional statements which describe learning outcomes, learning tasks, and assessment tasks. (McMahon & Garrett, 2016). It assumes that human knowledge and behavior are discrete cognitive states that can be identified, specified, and measured reliably and validly through an autonomous structure or software .

Figure 2.2

Instructional Activity Matrix



	1. Remember	2. Understand	3. Apply	4. Analyse	5. Evaluate	6. Create
a. Factual	1a. Recall association	2a. Specify features	3a. Utilise fact	4a. Determine features	5a. Check factual accuracy	6a. Generate factual representation
b. Conceptual	1b. Recognise concept	2b. Characterise concept	3b. Enlist concept	4b. Examine concept	5b. Consider concept	6b. Evolve concept
c. Procedural	1c. Recall procedure	2c. Clarify procedure	3c. Execute procedure	4c. Scrutinise procedure	5c. Critique procedure	6c. Devise procedure
d. Principle	1d. Recognise principle	2d. Explain principle	3d. Relate principle	4d. Investigate principle	5d. Validate principle	6d. Discover principle
e. Metacognitive	1e. Recognise learning fundamentals	2e. Comprehend learning processes	3e. Implement learning strategy	4e. Explore cognitive processing	5e. Assess learning performance	6e. Develop learning abstraction

Adopted from McMahon and Garrett (2016). A classification matrix of examination items to promote transformative assessment.

The knowledge categorization inside the knowledge dimension has 30 individual classifications for classifying instructional activities. The intersection of the cognitive-process and knowledge dimensions in each cell of the instructional activity matrix describes the cognitive processes and subject-matter content involved. This enables a better structural understanding of the information and skills that learners will require in order to participate in the learning activity per the learning requirements for certain learning outcome.

For Reigeluth et al., (1980) Elaboration Theory, irrespective of the types of content involved, the nature of the simple-to-complex method remains sequencing, synthesizing, and summarizing. Sequencing refers to decisions about the order in which to present different "topics" of content; synthesizing refers to the interrelationships among those topics; and summarizing refers to previewing and reviewing the topics that are taught (Reigeluth et al. 1980). In the later work of Reigeluth and Carr-Chellman (2009) wherein they aimed to emphasize the work of instructional designers in using the simple-to-complex approach – they purposefully simplified that designing instruction must be intended to facilitate learning. Therefore, it is crucial to present content “topics” in an organized structure, demonstrating interrelationships among them to allow learners to preview and review the material being taught.

These course structures can be categorized as orientation structures or supporting structures, which, when combined, create a multi-structure (Reigeluth et al., (1980).

2.7.1 Orientation Structure: A structure that is highly inclusive in that it incorporates all or most of the content (Reigeluth et al., 1980). An orientation structure may be any of three types: conceptual, procedural, or theoretical. *Conceptual Structure*: This type of structure demonstrates superordinate, coordinate, and subordinate relations among constructs. It includes three important types: parts taxonomies, which display components of a given construct; kinds of taxonomies, which show different varieties of a given construct; and matrices or tables, which combine two or more taxonomies (Reigeluth et al., 1980). *Procedural Structure*: This structure reveals procedural relations among constructs, including procedural-prerequisite relations and procedural decision relations (Reigeluth et al., 1980). *Theoretical Structure*: It displays change relations among constructs, often in empirical or logical form (Reigeluth et al., 1980).

In this study, it was established that the course examined was procedurally structured equivalently for the F2F and OL delivery formats. It appears that the topic had a procedural-prerequisite relationship. For example, in Unit 5 learners covered topics around instructional analysis in the next section, Design, all in the performing order of the ADDIE model (see Table 3.1). The ADDIE model was created by Florida State University for the United States Military in the 1970s, with the acronym meaning Analysis, Design, Development, Implementation, and Evaluation. The model was meant to be and will continue to be used as a guideline to create effective training and instructional materials. The course examined was primarily designed in accordance with this model and the concept of instructional design.

2.7.2 Supporting Structure: A course structure that is much less inclusive than an orientation structure and is nested either within an orientation structure or within a more inclusive supporting structure (Reigeluth et al., 1980). A supporting structure can be any of the above three types or a learning structure that demonstrates learning-prerequisite relations among its constructs, helping learners grasp the essential components of principles or concepts.

2.7.3 Multi-Structure: Two or more related structures whose interrelationships are shown. To structurally provide learners with a conceptual overview of content, lessons can be subdivided and organized according to a taxonomy. Reigeluth et al., (1980) recommended, for procedural goals, starting with the simplest version of the procedure and progressively adding more steps and decision points. For theoretical objectives, begin with the most important principles and introduce qualifying or extending principles in subsequent lessons. Additionally, it's advisable for course units to align with the primary organizing structure, as this enhances meaningful encoding, retention, and retrieval.

2.8 Instructional Quality

Brown & Kurzweil (2017) describe instructional quality as an elusive concept, highlighting the challenges in defining and measuring it effectively. Studies show that instructional quality has been assessed through various means, including observations, curricular artifacts, student artifacts, tests of teaching skills, and student surveys ("Measuring Instruction in Higher Education," 2014). These efforts typically focus on inputs, such as instructional strategies, learning activities, and resources, and outputs like grades and other performance indicators (Brown & Kurzweil, 2017). However, these efforts tend to overlook interaction behaviors that result from these inputs or that facilitate the outputs.

Boston M. (2012) argues that while learners' learning progress (i.e., grades and other performance indicators) is unquestionably a crucial indicator of instructional quality they do not indicate which observable characteristics of active instructional practices may have caused the corresponding progress (Boston M, 2012). Thus, Mu et al (2022) refers to instructional quality as observable instructional characteristics led by the instructor that includes how they teach, how they engage learners that leads to the learning outcomes (Mu et al., 2022, p 2). This study adopts Mu et al (2022) definition of instructional quality as fundamental in addressing the gap between instructional practices and the corresponding progress.

Over the years, several tools have been developed during this debate about how better to assess observable instructional characteristics that lead to or predict the achievement of the desired learning outcomes (Schlesinger et al., 2018). The Teaching Dimensions Observation Protocol (TDOP) by Hora and Ferrare (2010) focuses on various aspects of classroom dynamics, categorizing them into basic dimensions (instructional practices, student-teacher dialogue, instructional technology) and optional dimensions (student cognitive engagement, pedagogical

strategies, time on tasks). Another example is the Classroom Assessment Scoring System (CLASS) developed by Pianta et al. (2004) at the University of Virginia, which assesses the quality of instructor-learner interactions in PK-12 classrooms. CLASS has a MyTeachingPartner (MTP) suite, which provides resources for professional development, including a video library, a college course, and individualized coaching. Overall, both TDOP and CLASS emphasize the importance of designing to enhance instructor-learner interactions such that predict achieving the desired learning outcomes. In essence, the degree of instructor-learner interactions in the scope of these tools demonstrates instructional quality.

Learner approaches to learning also play a critical role in the relationship between the instructor and learner (Ghufron & Hardiyanto, 2017). Research claims that the degree at which learners approach learning should be clearly defined by instruction (Enkenberg, 2001; Harvey, 2018; Lodge & Bonsanquet, 2013;). Generally, learners' approaches to learning are defined in two ways: surface learning and deep learning approaches.

Surface learning is a monotonous approach that focuses on learning without criticality. It is a form of repetitional learning carried out through duplicating knowledge or skills (Beattie et al., 1997; Trigwell & Prosser, 1991). *Deep learning*, as the name implies, is a deep approach that focuses on learning and implementing new ideas into real-life situations (Beattie et al., 1997; Trigwell & Prosser, 1991). This deep approach is committed to interacting vigorously and critically with the content and relating ideas to previous knowledge by analyzing the logic of the argument. Research on learning has shown that the latter approach results in quality learning experience during instruction in contrast to the former (Tal & Tsaushu 2018; Trigwell & Prosser 1991). For example, in an interpretative study, Tal and Tsaushu (2018) examined the deep learning associated with the course design in a first-year biology course. Through twenty-one

interviews and observations, they found that deep learning was associated with the course design through learning approaches that included collaborative peer learning; and activities that enabled learners to reflect on how they organized and applied knowledge. With those deep learning approaches, learners experience of quality learning during instruction was primarily the result of increased interactions between the learners, the instructor, and the content. Deep learning approaches were integrated into instruction through the design of learning activities connected to a coherent cognitive structure. It is with coherent cognitive structures that teaching methods and strategies are applied to yield quality learning experiences during instruction. Researchers suggest that employing a variety of teaching methods and strategies to generate the desired learners' interactions and engagements particularly results in learning and overall performance (Brinthaupt et al., 2014). Therefore, teaching methods and strategies are vital components of the design and development of instruction, whose desire instructional outcome is increase interaction between the instructor and learners as well as learners interaction with the content.

2.9 Instructional Methods and Strategies

Effective instruction relies heavily on teaching strategies and methods, which should be carefully chosen based on the instructional design framework or principles used in the development of F2F and OL courses. The selection of teaching strategies must align with the instructional design framework, as it directly impacts learners' attitudes towards the course content and their motivation to learn, ultimately influencing the quality of their learning experience (Djenic & Mitic, 2017). Research has demonstrated that a mismatch between teaching strategies and instructional design frameworks can have a negative effect on instructional practices (Djenic & Mitic, 2017; Merrill, 2002).

Further, research suggested that to create quality instruction in any learning environment, whether F2F or OL, it is essential to select teaching strategies that align with specific learning activities. When selecting appropriate strategies for a particular instruction, it is important to understand the instructional or teaching methods associated with specific teaching strategies (Orlich et al., 2012). To do that, it is fundamental to understand the meaning of teaching methods and strategies. Teaching methods refer to the procedures, ways of teaching, or principles used in a learning environment for instruction. Teaching strategies, on the other hand, are carefully planned learning activities based on teaching methods designed to ensure effective teaching and learning. See Table 2.1.

Table 2.1

Teaching Methods and Aligning Strategies.

Teaching Methods	Teaching Strategies
Teacher-Centered Methods	Direct Instruction
	Lecture-based Instruction
Learner-Centered Methods	Collaborative Learning
	Self-directed Learning

Two widely utilized methods are the teacher-centered method and the learner-centered method. In the teacher-centered method, the teacher is seen as the primary authority figure, and students passively receive information through lectures and direct instruction (Hasanova et al., 2021). Assessments are separate from teaching, and student learning is evaluated through objective tests. Teaching strategies that align with teacher-centered methods typically include:

- Direct Instruction: This strategy involves learning from pre-defined teaching material. Traditional direct instruction is passive; modern forms encourage active learning through internet platforms and interactive instructional materials.

- Lecture-based Instruction: The lecture format is a traditional approach to structuring classroom learning in which teachers explain information while students observe. Teachers led a lesson by presenting, showing visuals, and modeling examples of a topic. Students listen, watch, take notes, and copy the teacher's demonstrations. Though this approach has been widely used in face-to-face instruction, it can be adapted for different learning environments.

In learner-centered methods, both teachers and learners play an active role in the learning process (Orlich et al., 2012). Teachers act as facilitators, focusing on overall comprehension and student learning. Assessments are integrated into teaching, and student learning is continuously assessed. Teaching strategies that align with learner-centered teaching methods primarily include:

- *Collaborative Learning*: This strategy emphasizes communication and teamwork among teachers and students. It involves active student participation in problem-solving, projects, and online collaboration facilitated by web tools.
- *Self-directed Learning*: This strategy involves students researching and learning from the teaching material with minimal guidance from the teacher. It can include browsing printed material or online platforms such as web pages, wikis, blogs, and social networks. This strategy promotes active student involvement and individualized teaching approaches.
- *Situated Learning*: This strategy focuses on practical problem-solving, exercises, experiments, seminar papers, and projects. Teachers provide instructions and assistance, while learners evolve following instruction and being creative along the learning process.

- *Active Learning*: This strategy involves teachers prompting learners to construct a meaningful and personal understanding of the content by manipulating objects or abstract concepts in the learning environment. Instructional activities such as note-taking, concept mapping, graphing, and mnemonics enable students to mentally engage with and manipulate information.

It is crucial to choose the right teaching methods and strategies when it comes to effective instruction. To do this successfully, it is necessary to understand the meaning and characteristics of teaching methods and strategies. Abrami et al. (2011) argued that there is a lack of understanding about pedagogical (i.e., teaching methods and strategies) effectiveness in F2F and OL courses in various context areas. This exertion was made in a paper in which they further examined the findings of Bernard et al.'s (2009) meta-analysis study. Bernard et al. (2009) meta-analysis quantitatively verified the importance of interaction (L2L, L2I, L2C) in instructional and learning activities. Abrami et al. (2011) "maintains that the absence of pedagogical understanding stems from the lack of research investigating direct comparisons of pedagogical features" (p. 2). This study investigates and compares the same course offer in F2F and OL formats by capturing the levels of learner interaction happening in pedagogical or instructional features across both formats. The fact is, whether researchers understand pedagogical or instructional methods, in the end, it is the level of the interaction that will determine the quality of instruction learners experienced during instruction (Kanuka, 2011).

2.10 Interactions as Determinants of Instructional Quality

Interaction is univocally considered a core determinant for quality instruction and learning in F2F and OL learning environments (Baker et al., 2010; Bernard et al., 2004; Marco-Fondevila et al., 2022). Empirical evidence across several content areas suggests the integral role

that interactions – particularly between learners, instructors, and content, are presumed to play in all formal learning. Bernard et al. (2009) synthesized evidence to support this belief in a meta-analysis of 74 empirical studies comparing different formats of OL instruction. They found an overall effect size of 0.38 demonstrating positive achievement outcomes for more interactive treatments.

Schneider and Preckel (2017) also found a close relationship between interaction in courses and meaningful learning. This result was part of a study in which they focused on variables associated with achievement in higher education by analyzing 38 meta-analyses based on 3,330 effect sizes from almost 2 million students. Interactions was one of five instructional variables investigated in the meta-analyses. It proved to have a higher proportional effect size of 1.6 than any other instruction-related category. Unlike Schneider and Preckel (2017), the results of Bernard et al.'s (2009) meta-analysis supported the importance of three types of interaction: among learners, between the instructor and learners, and between learners and course content. These meta-analyses demonstrated that when there are opportunities for interactions (L2L, L2I, L2C) in the course structure, it can lead to improved learning outcomes. However, not just because opportunities for interaction are offered to learners means that learners availed themselves of them, or if they did interact, that they did so effectively (Abrami et al., 2011). Abrami et al. (2011) cautioned researchers and instructional designers to design to facilitate more purposeful interactions. Thus, most comparison studies define quality learning as an increase in the quantity of purposeful interactions during instruction.

For example, Simić et al., (2022) compared F2F and OL classes during the COVID-19 pandemic in a secondary school and found that learners engaged in purposeful interactions were the best achievers. Results were analyzed from 183 questionnaires. Analyses showed that

students were more engaged in face-to-face classes than in online classes. Unequivocally, interaction was the core determinant in the Simić et al. (2022) study, though the use of self-report was not the strongest methodological choice to report on the quantity of interaction and its impact on learning. This study highlights this methodological issue in the significance of the study section and recommends an observational approach to capture the quantity and quality of interaction during instruction. As Abrami et al. (2011) suggested, although opportunities for interaction are offered to learners does not mean that learners avail themselves to these opportunities. Therefore, it is important to track the quantity and quality of interaction as learners participate in instructional activities when gathering research data; because when there are opportunities for interactions (L2L, L2I, L2C) in the course structure it is important to validate if learners actually participate as these interactions can suggest measure that indicate improved learning outcomes.

2.11 Chapter Summary

This study compares the quality of instruction across both the F2F and OL sections of the same course. The study is informed by literature about learner interactions and quality instruction and learning demonstrated in both F2F and OL sections with same course stakeholders and content.

The research on learner interaction, specifically instructional interaction, suggests that interactions take place between the learner and learner's environment – including with other learners, the instructor, and course content – with a goal of changing the learners' observable behaviors toward achieving learning outcomes. Research reveals that the relationship between learner-to-learner, learner-to-instructor, and learner-to-content facilitates the acquisition of knowledge solely and/or independently in the social context. Additionally, with a course being

instructional and structural equivalent across several different delivery formats, research suggests that observation opportunities enable the collection of real-time interaction behavioral data.

Research comparing OL and F2F instruction has largely revolved around its impact on academic performance and perception of instructional design structures, respectively, after instructional events (or end of course). During F2F instruction, learners tend to favor interaction through active participation in collaborative activities that maximize academic performance. In the case of OL instruction, research suggests that the complexity of designing interaction due to the class size, feedback medium, and learners prior experience with technology all influenced the design of interactions. Thus, research relied on models like the Community of Inquiry (CoI) to address the complexity of designing for interaction through three main elements: social presence, cognitive presence, and teacher presence. These elements reflected the reciprocal relationship between the learner-to-learner, learner-to-instructor, and learner-to-content in the learning environment. However, research also revealed that the CoI, like other models designed to address the design complexity of interaction in OL, tended to rely on perception or subjective data, which potentially undermines the validity of evidence claims of influencing quality instruction and learning since self-report data, post instruction, is often unreliable in reporting on actual behaviors.

Research on instructional quality suggests that the frequency of interaction is a core determinant for both F2F and OL instruction. To achieve this goal, instructional designers and educators generally described two levels of learning outcomes that suggest approaches to design instruction: surface and deep learning approaches. Deep approaches result in quality learning experiences during instruction in contrast to surface approaches. Deep approaches when, designed appropriately, increased interactions between the learner-to-learner, learner-to-

instructor, and learner-to-content leading to application and evaluation types of outcomes, whereas surface approaches led to lower levels of thinking such as repeating facts.

To compare the quality of instruction (offered in F2F and OL formats of the same course), this study adopted Moore's interaction framework (2018). Moore's interaction framework (2018) suggested three (3) types of interaction: the learner-to-learner, learner-to-instructor, and learner-to-content. This widely used conceptual lens helped to determine the impact of instructional and learning relationships in facilitating quality instruction and learning in both delivery formats. Learner-to-learner interaction occurs among learners while working in group or person-to-person exchanges; Learner-to-instructor interaction happens between the instructor and learner(s), while learner-to-content interaction happens between the learner(s) and learning content resources. Learner interaction operationalized through these types of interactions will be the measure of instructional quality across the F2F and OL sections of the same course.

The lit review described existing literature and arguments that connect learner interaction and quality of instruction and learning. This study contributes to the literature and arguments by using an unobstructive observation method to gather data on the interaction behaviors of learners in a F2F and OL section of a graduate course to identify similarities and differences that may help predict the level of instructional quality. In Chapter 3 the methodological approach for this study will be described, including the rationale for the research design, a description of the study's context, research questions, data collection, and analysis. These sections will explain how the research was carried out, demonstrating the reliability and validity of the study.

Chapter 3 - Methodology

Comparative studies investigating F2F versus OL delivery have been criticized for using methods that do not include metrics that indicate actual behaviors observed during instruction to measure quality of learning experiences. The more general approach to looking at success and persistence data have failed to provide data on actual learner behaviors and information that may be used to inform course enhancements. The frequency of learner interactions in courses can provide a measure of quality instruction. This study proposes to undertake a comparative study of the quality of instruction between a F2F and fully OL section of the same course. This comparative study will be accomplished through a direct observation approach with an instrument designed to collect data during 'live' instructional events.

3.1 Research Design

The research design for this study is a comparative case study (CSS) with mixed methods (Misra-Hebert et al., 2018; Sakata et al., 2021; Yin, 2013). This approach involved a convergent mixed-method data collection approach and analysis, where the study compared results from two similar cases.

A similar approach was employed by Misra-Hebert et al. (2018) in a study titled 'Implementing team-based primary care models: a mixed-methods comparative case study in a large, integrated health care system. Their methodology included qualitative data collection methods like observations and quantitative data collection through surveys. Their analysis included thematic and statistical analysis using measures such as means, standard deviations, and percentiles. In another study by Sakata et al. (2021) titled 'Knitting the Comparative Case Study (CCS) with mixed methods: an attempt to extend the methodological application of CCS', they emphasized the application of mixed methods within a comparative case study design. They

"knitted" the three axes (transversal, vertical, and horizontal) representing three cases in a comparative case study with mixed methods. Their design demonstrated a qualitative dialogical perspective of the cases, and they aimed to show that mixed methods are significant for a holistic investigation of cases (Yin, 2013). Thus, this approach inspires and echoes this research aim to collect both qualitative and quantitative data and merge the analysis, then describe the similarities and differences of learner interaction within and between the two cases.

In this research, the two cases are F2F format and OL format – each case is a unit of analysis, and the unit of observation is the learner interaction. Data were collected independently per individual case, which included quantitative (i.e., frequency) and qualitative (i.e., descriptive fieldnotes) learner interaction data. These cases have previously been determined to be 97% instructionally and structurally equivalent.

3.2 Instructional Design I – the course examined

Instructional Design I is part 1 of a two-part course that covers content about instructional design and development with a specific focus on learning outcomes, instructional objectives, and strategies in the context of theory and practice. The course provides an in-depth review of the concepts of design, instructional system design processes, and instruction is designed based on learning outcomes. An in-depth review in the course covers content areas in needs assessment and analysis, planning (design), development and testing, implementation, evaluation, and management of materials and programs that facilitate, support, and promote learning and performance improvement. The course has campus-based class sessions (i.e., F2F delivery format) and online sessions (i.e., OL delivery format). The OL sessions were not self-paced; learners had to complete activities and assignments on scheduled due dates and attend synchronous video-based instructional sessions.

3.2.1 **Equivalent Instructions of F2F and OL sections**

To identify instructional equivalence across both F2F and OL formats, a walk-through of content (topics) and instructional and learning activities was carried out. During that process, it was established that both formats had 10 instructional units each with 97% similarity in content (topics) and instructional and learning activities. Out of the 10 instructional units, 5 F2F and 5 OL synchronous instructional sessions were selected for observations making them the units of analysis where observational data were collected to examine the overall quality of instruction in the course. These 5 instructional units were chosen because of the synchronous-live discussions and activities (one section held in the classroom, the other during video conferencing) that occurred with equivalent content (topics) and instructional and learning activities, in addition to both being live sessions.

Simonson (1999a) equivalence theory emphasized that learning experiences may not be identical across the same format, but they can still be considered equivalent if they produce the same learning experiences. In this study, the courses examined had 97% similar learning experiences (i.e., content (topics) and planned instructional strategies). These learning experiences encompass open discussion (ODs), project presentations or demonstrations, short team or collaborative events, and submissions meant to promote meaningful interactions across the instructional units. By identifying which content (topics) and planned instructional strategies were employed during a specific session provides in depth understanding of the impacts of instructional practices on learners' attitudes towards the course content and their motivation to learn, ultimately influencing quantity of interaction (Djenic & Mitic, 2017). Table 3.1 outline instructional units, the topics, instructional strategies and expected leaner outcomes for the course observed. Units mark asterisk were observed during the 5 observed sessions.

Table 3.1

Flow, Procedures, Topics, Strategies and Outcomes of Course Unit Structural Organization.

Flow	Procedures	Main Topics	Planned strategies and assignment reviews	Expected Learner Outcomes
*Unit 1 /Unit 2	Course Preview	Units 1-4 Introduction to Design, Defining design, ADDIE ***Units 1 & 2 covered in one session (observed)*** ^***Resources:*** text, readings, tutorials, project guidelines, digital case studies, assignment guides, rubrics	**Strategies:** [1]presentation / lecture; [1]demo with Q/A; [1]case reviews with Q/A; [1]case themes debriefs; [2,3]hands-on activity; [2,3]assgns shared & critiqued **Assgn 1**-Design infographic **Assgn 2**-Notes on obj, assessments, strategies readings & tutorials **Assgn 3**-Design cases analysis	• Describe and define instructional design • List major elements of instructional systems design
Unit 3 Unit 4			*Units 3 & 4 Not observed*	
*Unit 5	Review Analysis	**ADDIE-Analysis** Audience, Content Environment analyses ^***Resources:*** text, readings, tutorials, project guidelines and templates, assignment guide, rubrics	**Strategies:** [1]presentation of project requirements; [1]demo with Q/A; [1,2] inquisitive presentation on Analysis process; [1]case application with Q/A; [2,3]hands-on activity; [2,3]assgn shared & critiqued **Assgn 7**-Draft Analysis	• Describe the critical aspects of needs assessment and learner analysis • Create content hierarchy • Apply to project
*Unit 6	Review Design	**ADDIE-Design** Goals, objectives, assessment, strategies ^***Resources:*** text, readings, tutorials, project guidelines and templates, assignment guide; rubrics	**Strategies:** [1]overview presentation of design; [1,2] inquisitive presentation on design process; [1]demo with Q/A; [1]case application with Q/A; [2,3]hands-on activity; [2,3]assgn shared & critiqued **Assgn 8**-Draft Design **Assgn 9a**-Prepare storyboard	• Describe and develop different types of learning objectives • Match objectives, goals & measurements • Apply to project
Unit 7	Review Development	**ADDIE-Dev** Selecting Media / Storyboarding Check ID model	*Unit 7 not observed*	
*Unit 8	Review Implementation and Evaluation	**ADDIE-Impl & Eval** ^***Resources:*** text, readings, tutorials, project guidelines and templates, assignment guide, rubrics	**Strategies:** [1]overview presentation of Impl & Eval; [2,3]hands-on activity; [2,3]assgn shared & critiqued **Assgn 10**-Draft Impl & Eval	• Describe implementation and evaluation strategies • Apply to project
*Unit 9	Student Project Reviews and Critiques	Project Presentations ^***Resources:*** tutorials, project rubrics and critique forms	**Strategies:** [1]overview presentation setting up project reviews; [2,4]ID project videos shared & critiqued **Assgn 11**-Project report and video	• Demonstrate the ADDIE process & design competencies • Present and defend design of project

Notes: ***Design of CR section sessions -first half of class covered content and assignments, second half was teamwork and project reviews; online synchronous sessions were for content and assignment reviews and sharing of project drafts for review***; *units that were selected to be observed; ^all resources, in same digital format provided to both classroom and online students; [1]primarily instructor-led; [2]primarily student-led; [3]for OL sessions, hands-on activities completed before sessions and shared by students during sessions, residency students completed these activities in class; [4]all students completed these activities before sessions and shared during sessions,

3.2.2 Equivalent Structure of F2F and OL formats

Further to identify if the course was structurally equivalent, the first step involved classifications of the course or the primary goals of the instruction (Wilson & Cole, 1992). During this step, Instructional Design & Development-Part 1 revealed that it was designed as a competency-based course with a goal to engage learners in activities that help them develop an understanding of the nature of instructional design. To do that, the course orientation provides both a review of, and practice in, design, instructional design, and an in-depth review of the instructional system design process. The focus on the instructional systems design process suggests that it can be classified as a procedural structure course.

The second and final step involved identifying if the course structure follows a progressive, step-by-step process along with decision points. To accomplish this, the process or procedure being taught had to be identified. It was observed that Instructional Design & Development-Part 1 had been designed in the following order of content areas: – starting with the Analysis, design, development, implementation, and evaluation (ADDIE) and ending with a demonstration (see Table 3.1). This design shows to be highly inclusive in that it incorporated all or most of the content – ADDIE model (Reigeluth et al., 1980). More specifically, content was layout in a procedural-prerequisite progressive order (Reigeluth et al., 1980). This means the course was designed based on procedural relations among each element of the ADDIE model in a decision relations step-by-step process. Thus, it can be concluded that the course was designed in each format to be procedurally structured and equivalent.

3.3 Context Description

The formats (F2F and OL) of the course were the cases investigated. Each case was regularly scheduled as a section in the fall semester – a residency section for campus-based

learners and a fully online section that meets the needs of learners who are not able to attend campus-based courses. Learners did not mix across the sections, and each section was purposely designed to be as equivalent as possible in learning outcomes, resources, assignments, and activities, thus maintaining structural equivalence.

The study was conducted using these two equivalent formats of a course covering basic instructional design concepts over a 14-week semester, 97% equivalency in across both sections in terms of resources, activities, and expected outcomes (Koszalka, in development). This course has been running in these two delivery formats for 5 years, making it quite stable in design.

That choice of course and pre-determined level of equivalence made both cases convenient samples for this study. Each section ran during the same time period in the fall over a 14-week semester. Data were collected by observing two types of stakeholders: the same instructor who taught both F2F and OL formats; the learners who received instruction in both F2F and OL formats. There were eleven (11) F2F learners and fourteen (14) OL learners.

3.4 Data Collection

This research did not meet the definition of human subject as defined by the Department of Health and Human Services (DHHS) regulations (45 CFR 46.102(e). There was no intervention, interpersonal contact, or collection of identifiable private information. Thus, this study was determined to not required IRB approval to proceed. See Appendix A.

3.4.1 Data Collection Instrument - Behavioral Observation Checklist – BOC

This study used a modified version of the Behavioral Observation Checklist (BOC). The published BOC, which was modified in this study, had been validated and met the critical value of averaging 0.91, meaning that all items demonstrated clarity and relevance to the theory and contextual concept (Koszalka & Whorway, 2024). See Table 3.2.

Table 3.2

Values of Content Validity Index

Items	ne	N	CVR	I-CVs	Interpretation
Learner asks other learners questions	19	20	0.90	0.95	Relevance
Learner responds to other learners' questions	19	20	0.90	0.95	Relevance
Learner prompts other learners to respond	20	20	1.00	1.00	Relevance
Learner comment on/respond to other learners' prompts	19	20	0.90	0.95	Relevance
Learner responds to other learners' comments	17	20	0.70	0.85	Relevance
Learner responds to other with new responses or questions	19	20	0.90	0.95	Relevance
Learner asks instructor question	16	20	0.60	0.80	Relevance
Instructor responds to learner's question	20	20	1.00	1.00	Relevance
Learner comments on instructor	16	20	0.60	0.80	Relevance
Instructor responds to learner's comments	20	20	1.00	1.00	Relevance
Instructor presents content, objectives, directions, etc.	18	20	0.80	0.90	Relevance
Instructor asks learners questions	19	20	0.90	0.95	Relevance
Learner responds to instructor's questions	18	20	0.80	0.90	Relevance
Instructor gives learners directions, e.g., activity	18	20	0.80	0.90	Relevance
Learner responds to instructor's directions	18	20	0.80	0.90	Relevance
Learner performs task	18	20	0.80	0.90	Relevance
Learner completes task	16	20	0.60	0.80	Relevance
			S-CVI	0.911765	

Note: Ne = number of experts indicating "essential", N = the total number of experts, CVR = content validity ratio, and I-CVs = item levels of the content validity indexes

Further results showed that the instrument's items were deemed to demonstrate clarity with respect to achieving a 95% confidence interval (CI), and items achieving relevance above 90% of content validity indexes. Thus, based on the CIs and validity indexes, this observational instrument provides a valid measure of learner interactions and is thus a valuable instrument to support this study. The modified version of the validated Behavioral Observations Checklist incorporates recommendations from the Koszalka and Whorway (2024) validation study and additional literature reviews.

The validated BOC contains six L2L, nine L2I, two L2C indicators, totaling 17 items. Specific modifications included merging some indicators into a single item and adding the additional indicator, per feedback and additional review of the validated version. The merged

items address the challenges of granularity raised during the validation study. The author argued that some indicators were actually representing the same type of interaction but at different levels, thus duplicating the same interaction at a finer or coarser level. Thus, on the modified BOC, six L2L were merged into 2 indicators, four out of the nine L2I indicators were merged into 2 indicators, one L2I indicator was reworded and one new indicator for the L2C interactions was added. The new indicator added to this instrument was based on validation comments and literature suggesting that learners do interact and learn when they are physically reviewing and manipulating content resources (Moore, 1989; Wilhelm-Chapin & Koszalka, 2019; Xiao 2017). In addition, learners have indicated in previous studies that working with content resources directly was a better support for their learning than participating in online discussions about content (Wilhelm-Chapin & Koszalka, 2019).

The modified BOC contains two L2L, seven L2I/I2L, and three L2C indicators, totaling 12 items. This smaller number of robust indicators should make the instrument easier for observers to tally interactions as the lower number of indicators is more in line with other's recommendations (Patton, 1987) and successfully used observation instruments like the BERI, which contains 13 items (Lane & Harris, 2015).

Finally, it was noted in the validation study that some of the terminology was confusing, e.g., prompting and responding (Koszalka & Whorway, 2024). This modified BOC has some minor editing to avoid such confusion; however, these issues will be addressed in BOC training materials and sessions. Thus, as suggested in previous literature, instruments are often modified or customized to fit the study (Farah & Chandler, 2018); in this study, the BOC was modified to address previous comments and make it easier for observers to monitor behaviors without being distracted by having to interpret granular details of interactions. The modified BOC is designed

to support tracking (tallying) the number of times (i.e., frequencies) learners actively interact with other learners, the instructor, and content during instruction (See Appendix B).

3.4.2 Training of Observers

Observers were trained to aid researchers in data collection. Research suggests that using multiple observers can increase the accuracy and objectivity of data collection and ultimately improve the reliability and validity of research findings (Olsen, 2004). There were two observers – a graduate student and the researcher (author of this dissertation). Observers were provided with a data collection guide and trained during a workshop to use the instrument, collect fieldnotes, and follow basic observation procedures.

The data collection guide offered a step-by-step guide for using the modified BOC. The checklist items were defined in terms of the types of interactions and engagement activities, and examples of the observable behaviors will be provided. The data collection guide had specific details about the observation process, duration, and expectations. The training was organized and ran for 3 hours in one sitting. There were:

- 30-minute overview of the observation process with definitions/descriptions of specified behaviors to capture on the checklist; instructions on taking fieldnotes
- 30-minute practice/debrief sessions using the checklist with video examples
- 30-minutes of the observers using the checklist in a simulation-based practice setting as an authentic pilot test,
- 90-minute debrief to check the reliability of codes gathered during the pilot test, clarify procedures, and plan an observation schedule.

This process ensured that the observers were ready to collect data using the modified BOC. Observation was conducted unobstructively (with no interference with the audience) in 5

instructional periods specifically chosen for content consistency across the F2F and OL sections throughout the semester, beginning in the early weeks. Immediately after each observer had observed each of their scheduled sessions, they met to make sure data was being collected properly and fieldnotes were clear (e.g., interrater reliability check).

3.4.3 Inter-observer reliability of data set

With modifications to BOC, it was necessary to ensure that the instrument was consistent and stable and that the that the data collected could be trusted. Therefore, inter-observer reliability was assessed to ensure the consistency and stability of the instrument. Inter-observer reliability refers to the degree of agreement when different observers use the same instrument under the same conditions (L. Cohen, et al., 2018). If a measurement procedure consistently assigns the same equal values to the same behaviors, the instrument is considered reliable, thus making it reliable for this study to explore the quality of instruction between both formats – F2F and OL.

The two observers gathered sets of data from the same sessions of the course sections in both formats to assure the accuracy of the data collected and to conduct inter-rater reliability checks, establishing a high degree of agreement among the observers who used the same instrument under the same conditions (Creswell, 2014). These observers were well trained in how to use the instrument; thus, this study could safely rely on the level of agreement that determined interobserver reliability (McHugh, 2012).

Observers compared data and fieldnotes after each observation and participated in coding sessions to organize and clean the data between each observation. Using SPSS, Pearson correlation coefficients were computed to assess the agreement between observers, representing independent data (combined total [N=33] of the two observers tallies of L2L, L2I, Land L2C

interactions) collected for reliability testing. The Pearson correlation coefficients (often referred to as the reliability coefficient) were used with interval data to indicate the extent of agreement between the two raters' data (L. Cohen et al., 2018). Results suggested a strong correlation, greater than r = .892, and a significance level of p < .001 were achieved. See Table 3.3.

Table 3.3

Inter-observer Reliability for Two Observers with Absolute Agreement

		Score	Time Elapsed
Interval by Interval	Pearson Correlation	.892	1
	Sig.(2-tailed)	.001	
	N	33	33

*p < .001

This suggests that there was a positive agreement between observers when the instruments were administered independently and simultaneously during an active instructional period; thus, the instrument was considered satisfactory for further use in this study.

3.4.4 Description of observations

Since there was a positive agreement between observers, a decision was made to use one observer's data, the researcher's data. The data collection reflects the observations of one observer (dissertation author) data. The observation covered the same five equivalent sessions in each of the F2F and OL sections for the two observers. Data collection was planned for 10-minute intervals across five of the 2-hour and 45-minute sessions of the F2F sections and five of the 3-hour sessions of the OL sections. This suggests that there should have been approximately 11 observation periods during each session. Note that there were no observations in one of the planned F2F sessions due to scheduling issues; more on that later.

In between each observation period, a 5-minute period was used to write explanatory fieldnotes to further describe environmental conditions during data collection periods. These fieldnotes included information on the number of interacting learners, types of activities

occurring during the observations, and any other note deemed important in explaining the frequency counts.

Observation sessions (dates) were chosen so that the observations were made throughout the semester during sessions where learners had reviewed and covered equivalent topics in both the F2F and OL sections. Observation data were not collected when the instructor engaged in housekeeping activities, approximately five minutes at the beginning of each instructional period (i.e., checking in on individual students, asking how was their week), during the 10-minute refreshment breaks, or during the 5-minutes used by the observer to take fieldnotes.

There were approximately 8 observations per F2F session, with a total of 32 F2F observation interval sessions made across the semester. There were approximately 11 observations per OL session, with a total of 53 OL observation interval sessions made across the semester. These observations focused on examining interactions that engaged learners in equivalent content, resources, and events during observed instructional events. See Table 3.4.

Table 3.4

The Number of Learners, Intervals, Minutes Recorded per Observation Session

		Session 1	Session 2	Session 3	Session 4	Session 5	Total	Average
F2F	# of L per obs.	11	9	-	11	11		11
	# of intervals	11	7	-	9	5	32	8
	Obs. Minutes	110	70	-	90	50	320	80
OL	# of L per obs.	12	15	15	15	15		14
	# of intervals	11	11	10	11	10	53	11
	Obs. Minutes	110	110	110	110	100	540	108

Notes: number students registered for each format: F2F – 11 and OL – 15; data results above reflect 1 observer (primary researchers). Session 3 of F2F session was not observed, thus no (-) observation data were available.

Since the reliability test showed that both observers had positive agreement (high reliability; r = .892), the cleaned data presented in this study represents only the primary researcher's observations. The averages of these data suggested 11 learners per observation during an average of 8 observed intervals on each date observed and an average of 80 minutes

for four of the observed F2F sections. There were an average of 15 learners per observation during an average of 11 intervals on each date observed, and an average of 108 minutes for each of the five observed OL sections. The total time, across all observations, associated with the 10-minute intervals for the F2F observations was 320 minutes, while there was a total of 540 minutes for the OL observations. During each 10 minutes of observation, the observers tallied the number of times each observation behavior, per the BOC, occurred.

The discrepancy in the overall number of observation minutes was largely due to challenges that led to missing one planned data collection period for the F2F section. Data were not collected during the third (3^{rd}) planned observation session for the F2F format. Since the researcher was unable to make this third planned observation, a recording was made for the observer to code at a later time. The recording did not yield usable data. Thus, the number of sessions observed for the F2F section was 4 and 5 for the OL section. The total time covered for observation was therefore different between the F2F (32 obs; 320 min) and OL (53obs; 540 min) sections, indicating a significant challenge of missing data. (resolution discussed below)

3.4.5 Quantitative Data (frequency data)

The BOC was used to collect interaction counts or tallies (by type [learner-to-learner, learner-to-instructor, learner-to-content]) during the instructional sessions. The counts of these interactions were recorded on a hard copy of the modified BOC, then transferred to a Microsoft Excel sheet where they were organized for analysis. These counts or tallies represent the number of times each behavior per the modified BOC was observed occurring. See Table 3.5.

Table 3.5

Summary of Raw Frequency Tally Data for each Instructional Delivery Format

	Face-to-face tallies			Online delivery tallies		
	L2L	L2I	L2C	L2L	L2I	L2C
Observation Session 1	36	152	73	14	122	42
Observation Session 2	5	101	12	29	169	51
Observation Session 3	-	-	-	34	162	47
Observation Session 4	1	147	45	65	101	127
Observation Session 5	2	59	39	54	99	63
Total	81	575	213	196	653	330

Note: L2L = learner-to-learner, L2I = learner-to-instructor, L2C = learner-to-Content; (-) missing data

Missing Data. Missing data are known to introduce significant bias in parameter estimation, weaken the generalizability of the results, decrease statistical power, and increase standard errors; thus, they were addressed to mitigate these threats to the validity of this study (Madley-Dowd, et al., 2019; Peng et al., 2006). To address these missing data, an estimated number of observation intervals (N=7) approach was used based on the sum of observations (N=32) divided by the expected number of observation sessions (N=5) (Cheema, 2012).

The third observation session data were not missing at random (NMAR), which can lead specifically to biased parameter estimates (Graham, 2009). The missing data were due to the absence of the observer; thus, without addressing these data, the overall results cannot represent an equivalent comparison of both F2F and OL formats. Therefore, multiple imputation (MI) was used to create imputed datasets that closely represented the missing data (Enders, 2022). Multiple Imputation (MI) is regarded as a state-of-the-art technique because it improves accuracy and statistical power relative to other missing data techniques. MI uses Monte Carlo simulations to provide possible missing data outcomes (Peng et al., 2006).

In this study, five simulations were run using the default settings of the SPSS missing data imputation package. After the five simulations, the mean values were obtained for each type of interaction and rounded to the nearest integer, then rounded to values substituting for the missing data. Finally, a complete dataset with imputed data was created and used for analysis.

The data represents the total number of interactions per observation session and the types of interactions. The final dataset, as shown in Table 3.6 includes a tally of frequency data for all observed face-to-face (F2F) and online (OL) sessions.

Table 3.6

Summary of Raw Frequency Tally Data for each Instructional Delivery Format

	Face-to-face tallies			Online delivery tallies		
	L2L	L2I	L2C	L2L	L2I	L2C
Observation Session 1	36	152	73	14	122	42
Observation Session 2	5	101	12	29	169	51
Observation Session 3	37*	116*	44*	34	162	47
Observation Session 4	1	147	45	65	101	127
Observation Session 5	2	59	39	54	99	63
Total	81	575	213	196	653	330

Note: L2L = learner-to-learner, L2I = learner-to-instructor, L2C = learner-to-Content; * imputed data

3.4.6 Qualitative data (fieldnotes)

The BOC was also used to collect qualitative data collected through explanatory fieldnotes taken by the observer during live observation sessions. Fieldnotes data played a crucial role in describing the various interaction behaviors exhibited by learners during the observed sessions. Qualitative data were collected during the same period as quantitative data.

3.5 Data analysis

Data analysis was carried out on a case-by-case basis. Each section – F2F and OL were considered individual cases. Analysis of both quantitative and qualitative data was conducted across cases. Quantitative analysis provided answers for research questions 1, 2 and 3 and qualitative analysis of fieldnotes provided answers for research question 4. See Table 3.7.

Table 3.7

Summary of Data Analysis

Research questions	Data	Analysis
What is the frequency of learner interactions with each other, instructor, and course content during observed sessions of equivalent online and face-to-face instructional delivery formats?	Tallies	Frequency distribution i. frequency of interaction (*f*) ii. mean (M) iii. percentages of frequency (%)
Are there any variations in the frequency of learner interactions across observation sessions between and within the two formats of the courses being compared?	Tallies	Between-groups factorial ANOVA test i. F=value ii. p=value iii. Partial eta squared (η^2)
Do variations in the frequency of learner interaction suggest that either delivery format extends a higher or lower level of quality within specific observation sessions of the course?	Tallies	Confidence interval (95% CI) i. Critical value (Cohen *d*=.004) Multivariate analysis of variance (2 x 3 MANOVA) i. F=value ii. p=value iii. degree of freedom (df) iv. Pillai's Trace
What characteristics of instructional and learning behaviors during instruction may influence the interpretation of observed frequency data?	Field Notes	Direct content qualitative analysis

3.5.1 Quantitative analysis

Quantitative analysis generated patterns in the learner interaction frequency distribution, identified variations in those patterns, and established if there is statistical significance in those variations within and between F2F and OL formats. All quantitative analyses were done using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) software.

3.5.1.1 Research Question 1:

What is the frequency of learner interactions with each other, instructor, and course content during observed sessions of equivalent online and face-to-face instructional delivery formats?

To answer research question 1 frequency distribution statistics were used. Frequency distribution statistics "is a tally or count of the number of times each score on a single variable occurs" (Morgan et al., 2020, p. 47). In this study, frequency distribution is a representation of the L2L, L2I, and L2C frequency patterns within each case of delivery format. The statistics

covered the frequency of interactions (*f*) representing the sum of interactions tallies per interaction type; the mean (M) representing the average frequency of interaction per interaction type; and percentages of frequency (%) representing the *f* divided by the sum of the three types of interaction per format multiplied by 100.

3.5.1.2 Research Question 2

Are there any variations in the frequency of learner interactions during the observed sessions within and between the two formats of the courses being compared?

To answer research question 2 a between-groups factorial ANOVA test was conducted in an attempt to discover variations or differences in the frequency of L2L, L2I, and L2C interactions within and between both delivery formats. Each delivery format or case was considered an independent group – thus, there were two independent groups. Each type of interaction was considered a single dependent variable. A factorial ANOVA is used with continuous data across each group. The data in the study, which (an infinite measure), was spread out similarly across each group, as you will see in Chapter 4.

The factorial ANOVA test reported the F=value and p=value. The F=value reports on the statistical significance of variations in the frequency of each type of learner interaction across observation sessions within each format. The *p*=value then reports if those variations are not due to chance (i.e., due to chance if the p </= .001 and not due to chance if the p > 00.1). The between-groups analysis reports on how the found *p*=values are similar for each type of interaction between F2F and OL formats. Partial eta squared (η^2) is also reported to demonstrate the statistical strength of differences or variations found within and between groups. A partial eta squared $\eta^2 = 0.01$ will indicate a small effect, $\eta^2 = 0.06$ will indicate a medium effect, and $\eta^2 = 0.14$ will indicate a large effect.

3.5.1.3 Research Question 3

Do variations in the frequency of learner interaction suggest that either delivery format extends a higher or lower level of quality within specific observation sessions of the course?

To answer research question 3 The confidence interval (95% CI) was calculated for each specific observation session for each format. Morgan et al. (2020) suggest that in addition to statistical significance (which was calculated for in research question 2), confidence intervals should be considered as they provide more practical information about quality. The confidence interval (95% CI) in this study helped determine the extents (higher or lower) of variations in quality in specific observation sessions. This calculation is based on the theoretical understanding that the higher the level or quantity of learner interaction within instruction, the higher the quality of instruction. L. Cohen et al., (2018) emphasized that CI established an acceptable quality range (i.e., critical value). This study used Cohen *d*=.004 as its critical value for the 95% CI.

Further, to determine the overall quality of learner interaction between the F2F and OL formats based on L2L, L2I, and L2C interactions (2 x 3) a multivariate analysis of variance (MANOVA) was calculated. Unlike research question 2 where the factorial ANOVA test examined the differences between the two groups by measuring a single type of interaction at a time, MANOVA in research question 3 provides an opportunity to assess all three types of interaction simultaneously as a measure of the difference in the quality of instruction in the course. Statistics reported include F=value, p=value, degree of freedom (df) and Pillai's Trace. Particularly, Pillai's Trace Partial Eta Squared is useful in this study’s case because both sample sizes are unequal and small. It suggests that a value that ranges from 0 to 1 explains in this

study's case that the frequency of learner interactions (L2L, L2I, L2C combined) has a statistically significant effect on the quality of instruction in the course.

3.5.2 Qualitative Data analysis

Direct content qualitative analysis was adopted as the analysis approach for the qualitative data. Direct or directed content analysis is a more structured process that begins with identifying key concepts as initial coding categories (Hsieh & Shannon, 2005). Qualitative analysis provided answers to research question 4.

3.5.2.1 Research Question 4

What characteristics of instructional and learning behaviors during instruction may have influenced the interpretation of observed frequency data?

To answer research question 4, a direct qualitative content analysis was conducted to unpack and describe the frequency of characteristics of instructional and learning behaviors observed during instruction. Hsieh and Shannon's (2005) strategies for using direct qualitative content analysis were employed to analyze the data. The strategies include:

- Reading textual data, identifying and highlighting sections of the text that were related to the predetermined codes established by a theory or previous research results.
- Organizing the highlighted texts using the predetermined codes.

In this analysis, predetermined codes were established based on the characteristics of instructional and learning behaviors defined by the Behavioral Observation Checklist (BOC) (Koszalka & Whorway, 2024). These characteristics were analyzed under three predetermined categories (Moore, 2018) – learner-to-learner (L2L), learner-to-instructor (L2I), and learner-to-content (L2C). These categories were analyzed across each observed session for both formats. See Table 3.8.

Table 3.8

Categories, Codes and Indicators used for Thematic Analysis of Observer's Fieldnotes.

Categories[a]	Codes[b]	Indicator[c]
Learner-to-learner	L2L	Questions (*clarifications, asking, re-asking*)
		Encouragement (*Praises, agreements, confirm interpretations*)
		Critique (*comments, personal experiences, demonstration*)
Learner-to-instructor	L2I	Instruction (*present content, give directions, describes scenario/examples*)
		Questions (*clarifications, asking, re-asking*)
		Encouragement (*Praises, agreements, confirm interpretations*)
		Critique (*elaborate, personal experiences, demonstrations*)
Learner-to-content	L2C	Performance (*share, describe, discuss, critique*)
		Completion (*showcase, reflect*)

NOTES: Categories are the interactions between learners, instructors, and content; Codes are abbreviation of the categories; Indicators are observable behaviors that demonstrate the categories; *Italics* = indicator behaviors

In this dissertation, the direct qualitative content analysis of the fieldnote data was carried out manually. Data were extracted from the BOC and typed into a Word document in the form of a spreadsheet. The spreadsheet was printed into hard copies. Markers were used to highlight the indicators in the fieldnotes that align with each category.

3.6 Chapter Summary

The study aimed to examine the quality of instruction between a fully OL section and F2F sections of the same course. To conduct this examination, a comparative study design allowed the use of multiple sources of evidence—quantitative and qualitative data protocols – that provide accurate data during instruction for interaction measures (learner-to-learner, learner-to-instructor, learner-to-content). Data were collected by trained observers from the OL and F2F sections of a course (i.e., Instructional Design & Development – Part 1) scheduled for the fall semester, offering both a residency section for campus-based learners and a fully online section for online students. Both sections were purposely designed and found to be structural and instructional equivalent with similar learning outcomes, resources, assignments, and activities.

A modified version of the Behavioral Observational Checklist (BOC) was used to record the frequency of learner interaction during the five selected instructional sections. Additional qualitative data on the rationale for ratings were recorded in the observer's fieldnotes. Both frequency and fieldnotes data were collected using an unobstructive observational approach.

The next chapter, chapter 4 reports results based on the research questions. Results describe the frequency of interactions comparatively in and between each case (i.e., F2F and OL. Further results report on the differences or variations observed in frequency data within and between both formats, then between the types of the types of interaction. Also, the results report on the statistical significance of these results predicting the quality of instruction. Finally, there are descriptions of instructional and learning behaviors that may have influenced the quantified results, thus the quality of instruction.

Both quantitative and qualitative results highlight structural areas that may need design or redesign enhancement to provide equivalent learning experiences for learners in either the fully OL section or F2F sections of the same course. The design or redesign of those structural areas may be important in increasing interactions, thus predicting high-quality instruction.

Chapter 4 – Results

The goal of the study was to compare the quality of instruction within and across equivalent sections of F2F and OL delivery formats by gathering interaction data (tallies and fieldnotes) using a behavioral observation approach. A modified version of the Behavioral Observation Checklist (BOC) (Koszalka & Whorway, 2024) was used to collect quantitative data (i.e., counts of interactions) and qualitative data (i.e., fieldnotes) on learner interactions. This chapter highlights results from analysis of learner interaction – a determinant used to compare the quality of instruction in the same course taught in F2F and OL formats.

4.1 Quantitative Results

4.1.1 Frequency of learner interactions in F2F and OL formats

Research Question 1: What is the frequency of learner interactions with each other, instructor, and course content during observed sessions of equivalent online and face-to-face instructional delivery formats?

Research question 1 queries the frequency distribution of learner interactions with each other, the instructor, and course content during observed sessions of equivalent OL and F2F instructional sessions delivered in different formats. Frequency distribution "is a tally or count of the number of times each score on a single variable occurs" (Morgan et al., 2020, p. 47). The frequency distribution statistics included: the frequency of interactions (*f*) representing the sum of across all observations sessions; the mean (M) representing the average frequency of interaction per interaction type; and percentages of frequency (%) representing the *f* divided by the sum of the three types of interaction per format multiplied by 100. See Table 4.1.

Table 4.1

Frequency of Interaction during OL and F2F Instruction for L2L, L2I, and L2C.

		M	*f*	%
F2F				
	L2L	2.07	81	9
	L2I	14.74	575	66
	L2C	5.46	213	25
Total			869	
OL				
	L2L	3.69	196	17
	L2I	12.32	653	55
	L2C	6.22	330	28
Total			1179	

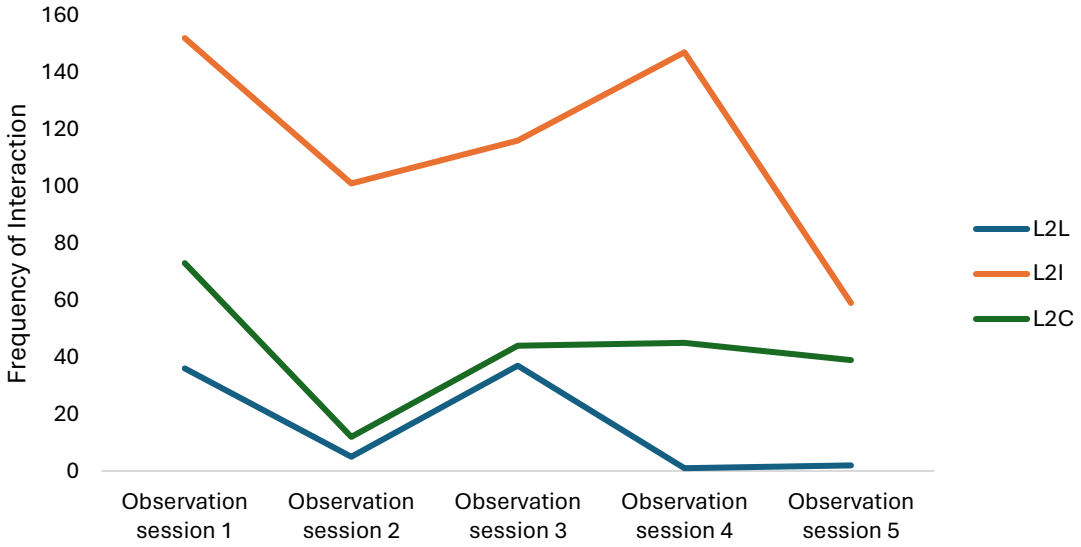
Note: M = means, *f* = frequency or number of interactions, % = percentages of frequency.

The statistical results show that overall frequency distribution patterns of learner interactions were similar (F2F [L2L - 9%,L2I - 66%,L2C - 25%] vs OL [L2L - 17%, L2I - 55%, L2C - 28%]) during the observed sessions. For the types of interaction, the L2I interaction had the highest frequencies (F2F [*M* = 14.74, *f* = 575, 66%] and OL [*M* = 12.32, *f* = 653, 55%]) during the observed sessions. Next the L2C interaction frequencies (F2F [*M* = 5.46, *f* = 213, 25%] and OL [*M* = 6.22, *f* = 330, 28%]) and then the L2L interaction frequencies (F2F [*M* = 2.07, *f* = 81, 9%] and OL [*M* = 3.69, *f* = 196, 77%]) during the observed sessions. This suggests that learners interacted most with the instructor, followed by the content, and finally interactions with other learners during the observed sessions of both instructional delivery formats.

In addition, a visual representation of L2L, L2I, and L2C interactions occurring over time in observed F2F sessions (i.e., session 1, session 2, session 3, session 4 and session 5) suggests a non-parallel pattern (see Figure 4.1). A similar non-parallel pattern was observed in the OL sessions, except for session 4 (see Figure 4.2).

Figure 4.1

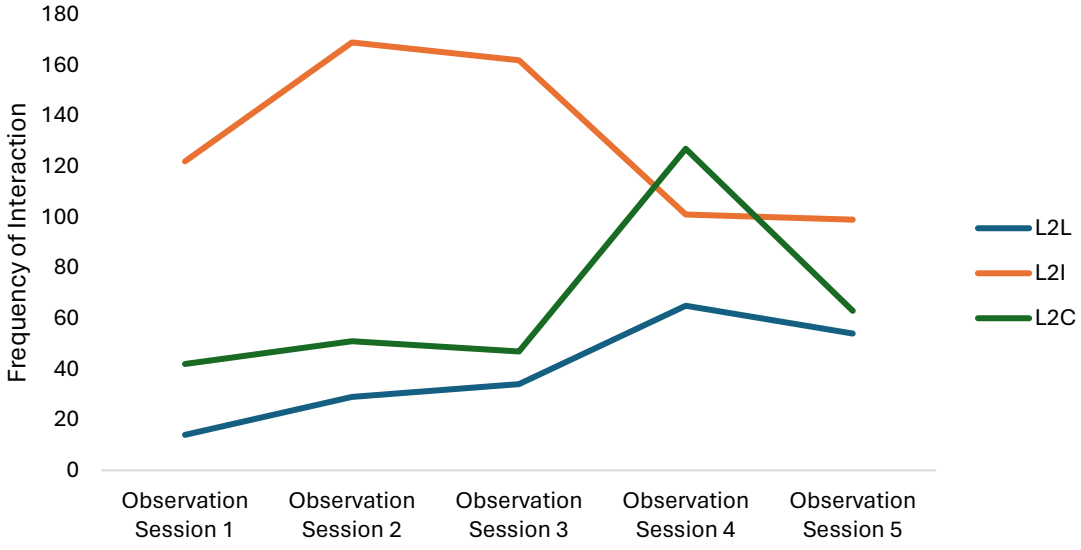
Frequency Pattern for F2F Learner Interactions during Instruction



Note: L2L = Learner-to-Learner, L2I = Learner-to-Instructor, L2C = Learner-to-Content

Figure 4.2

Frequency Pattern for OL Learner Interactions during Instruction



Note: L2L = Learner-to-Learner, L2I = Learner-to-Instructor, L2C = Learner-to-Content

In session 4, there were more interactions observed between the learners and the content than with the instructor and other learners. This indicates that there was an increase in the

frequency of learner interaction with the content and a decrease with the instructor. The visual representation suggests that the frequency of learner interaction maintained the same rank order (L2I = rank 1st, L2C = 2nd and L2L = 3rd) except for OL observed in session 4. Learners interacted more with the instructor, followed by the content, and then with other learners during each observed session. This suggests a consistent pattern in how learners interacted with each other, the instructor, and the content during the observed sessions.

Overall, research question 1 reported that the frequency of learner interactions with each other, instructor, and course content during observed sessions of the equivalent F2F and OL instructional delivery formats were consistent in rank order and had a similar pattern but non-parallel lines. The non-parallel lines from observations 1 to 5 suggest differences or variations in the interaction flow per type of interaction in each delivery format. Research question 2 explored the presence and significance of these variations within and between both formats.

4.1.2 Variations in the frequency of learner interactions between and within the two delivery formats.

Research Question 2: Are there any variations in the frequency of learner interactions during the observed sessions within and between the two formats of the courses being compared?

The results of variations between groups and within groups are presented in Table 4.2. Between groups, variations were analyzed across the five observed sessions in both formats. Within groups, variations were analyzed across the five observed sessions within each observed session. The units of analysis are L2L, L2I, and L2C interaction frequencies.

A factorial ANOVA test was conducted in an attempt to discover variations or differences in the frequency of L2L, L2I, and L2C interactions within and between both delivery formats. According to L. Cohen et al., (2018) “With regard to difference, effect size is a way of

quantifying the difference between two or more groups." (page 745). Therefore, the effect size (η^2) is reported along with the F value and *p*=value. Partial eta squared (η^2) demonstrates the statistical strength of differences or variations found within and between F2F and OL formats. The partial eta squared $\eta^2 = 0.01$ will indicate a small effect, $\eta^2 = 0.06$ will indicate a medium effect, and $\eta^2 = 0.14$ will indicate a large effect. The F=value reports on the statistical significance of variations in the frequency of each type of learner interaction across observation sessions within each format. The *p*=value then reports if those variations are not due to chance (i.e., due to chance if the $p < .001$ and not due to chance if the $p > 00.1$) for each type of interaction between F2F and OL formats. See Table 4.2.

Table 4.2

Factorial ANOVA Test to Determine Differences Between Groups and Within Groups

		ss	*df*	F	*p*	η^2_p
Face-to-Face Instructional Delivery Format						
L2L						
	Between groups	149.64	4	14.59	.001	.632
	Within groups	87.13	34			
	Total	236.77	38			
L2I						
	Between groups	99.57	4	.25	.906	.029
	Within groups	3357.87	34			
	Total	3457.44	38			
L2C						
	Between groups	147.49	4	2.03	.113	.193
	Within groups	618.20	34			
	Total	765.69	38			
Online Instructional Delivery Format						
L2L						
	Between groups	400.62	4	12.47	.001	.595
	Within groups	273.13	34			
	Total	673.74	38			
L2I						
	Between groups	437.20	4	2.17	.094	.203
	Within groups	1716.69	34			
	Total	2153.80	38			
L2C						
	Between groups	982.68	4	15.85	.001	.651
	Within groups	526.91	34			
	Total	1509.59	38			

Note: ss = sum of squares, df = degrees of freedom, η^2_p = Partial Eta Squared, F = F-value, *p* = significance value ($p < .001$)

The results revealed that there was a significant difference or variation for F2F_L2L [*F* (4, 34) = 14.59, *p* = .001, η2 partial = .632] and a significant difference or variation for OL_L2L [*F* (4, 34) = 12.47, *p* = 001, η2 partial = .595]. This suggests that there were significant variations or differences in the frequency of L2L interaction across the observed sessions for both formats. A literature review suggests that these differences may be attributed to uncontrolled factors such as the sample size inherited in this study (Kamal et al., 2020; Thai et al., 2020) or characteristics of instructional and learning behaviors, which will be reported in research question 4. However, comparatively, this statistical difference suggests that the frequency at which learners in both formats interacted with each other was significantly different.

On the other hand, there were no significant differences between F2F_L2I [*F* (4, 34) = .25, *p* = 906, η2 partial = .029] and OL_L2I [*F* (4, 34) = 2.17, *p* = 094, η2 partial = .203]. This report suggests there are no statistically significant differences between and within both formats in relation to the frequency of L2I interaction. However, the statistical strength of the difference shown (F2F_L2I η2 partial = .029, OL_L2I η2 partial = .203) in both formats indicates a larger effect that can be attributed to controlled factors like instructional strategies selected for specific instructional environments (Pham et al., 2019). Research question 4 later will report on those instructional behaviors that influenced a larger effect; however, this result of no significant difference suggests that there is not comparative differences in L2L interaction frequency within and between both F2F and OL formats.

Table 4.2 also shows that there is no statistically significant difference across observation sessions for F2F_L2C interaction [*F* (4, 34) = 2.03, *p* = .113, η2 partial = .193], but there is a statistically significant difference for OL_L2C interaction [F (4, 34) = 15.85, *p* = 001, η2 partial = .651]. Even though both formats show different levels of significance, the strength of their

differences still suggests a larger effect size (F2F_L2C η2 partial = .193, OL_L2C η2 partial = .651) indicating that the differences between these formats are largely similar. However, such reports of no significant differences in L2C interaction frequency within each group call attention to exploring the actual frequency of interaction in each observation session. Next, research question 3 delves into the frequency of each interaction type per observation session.

In summary, research question 2 highlights variations in the frequency of learner interactions within and between observed sessions across F2F and OL delivery formats. This effort revealed that L2L interactions vary (i.e., they interacted more or less interchangeably) across the observation sessions and between delivery formats. The same was not true for L2I interactions; the statistical results suggested similarity in the frequency or number of times that learners interacted with the instructor across the observed sessions and between both delivery formats. L2C interaction in the F2F delivery was also similar, showed no differences, across the observed sessions; however, the same behavior (i.e., L2C interaction) varies in the OL delivery format across the observed sessions. In comparison, learners in both delivery formats interacted with the content at different frequencies or numbers of times. Further, Research Question 3 explored the quality of these differences observed in the frequency of L2L, L2I, and L2C interactions, specifically within each observation session.

*Research Question 3**:** Do variations in the frequency of learner interaction suggest that either delivery format extends a higher or lower level of quality within specific observation sessions of the course?*

The confidence interval (95% CI) was calculated to determine the extent (higher or lower) of variations in quality in specific observation sessions. This calculation is based on the theoretical understanding that the higher the level or quantity of learner interaction within

Table 4.3

Frequency of L2L, L2I, and L2C Interaction Quality (95% CI) in 5 Observed Sessions for F2F and OL Delivery Format.

Variables		Estimate	SE	95% CI	
				LL	UL
F2F_L2L	1	3.273	.483	2.292	4.254
	2	.714	.605	-.515	1.944
	3	5.286	.605	4.056	6.515
	4	.111	.534	-.973	1.196
	5	.400	.716	-1.055	1.855
F2F_L2I	1	13.818	2.996	7.729	19.908
	2	14.429	3.756	6.795	22.062
	3	16.571	3.756	8.938	24.205
	4	16.333	3.313	9.601	23.065
	5	11.800	4.444	2.768	20.832
F2F_L2C	1	6.636	1.286	4.024	9.249
	2	1.714	1.612	-1.561	4.990
	3	6.286	1.612	3.010	9.561
	4	5.000	1.421	2.111	7.889
	5	7.800	1.907	3.925	11.675
OL_L2L	1	1.273	.855	-.464	3.009
	2	2.000	1.071	-.177	4.177
	3	3.143	1.071	.966	5.320
	4	3.111	.945	1.191	5.031
	5	11.600	1.268	9.024	14.176
OL_L2I	1	11.091	2.142	6.737	15.445
	2	14.571	2.686	9.113	20.029
	3	17.571	2.686	12.113	23.029
	4	15.222	2.369	10.409	20.036
	5	6.800	3.178	.342	13.258
OL_L2C	1	3.818	1.187	1.406	6.230
	2	3.143	1.488	.119	6.167
	3	5.857	1.488	2.833	8.881
	4	4.222	1.312	1.555	6.889
	5	19.000	1.761	15.422	22.578

Note. Number of cases = 2 (F2F and OL), total N = 2,048., SE = Standard error, CI = confidence interval; LL = lower limit; UL = upper limit, effect size d = 0.04.

instruction, the higher the quality of instruction. Morgan et al. (2020) suggest that in addition to statistical significance (established in research question 2), confidence intervals should be considered as they provide more practical information about quality. L. Cohen et al., (2018) emphasized that CI establishes how confidently a particular result falls within the acceptable

quality range (i.e., critical value). The critical value for the 95% CI in this study is Cohen *d*=.004. Confidence intervals (95%) were calculated for each type of interaction in each observation session across both formats. See Table 4.3.

Observation session 1

During observation sessions 1 across both formats, it was observed that variations in interaction frequency were at a higher level of quality for the three types of interaction, except for OL_L2L interaction. It was observed that there was a lower quality of OL_L2L interaction (95% CI [-.464, 3.009]). Practically, this suggests that learners in OL observation session 1 did not interact with other learners more or at a higher frequency. Contrary to this, it was observed that variations in interaction frequency were at a higher level of quality in all sessions for both F2F and OL formats, which suggests that learners interact with other learners more or at a level supposedly expected for the majority of the course.

Observation session 2

During F2F and OL observation session 2, it was observed that variations in interaction frequency were at a higher level of quality only for L2I interactions. However, there was a lower quality for L2L interaction frequency in both formats (95% F2F_CI [-.515, 1.944] and OL_CI [-.177, 4.177]). There was also a lower quality in the F2F_L2C interaction frequency (95% CI [-1.561, 4.990]). Practically, these results mean that learners interacted more with the instructor or at a higher or expected level during observation session 2 in both formats. On the other hand, the same did not happen between learners, thus it appeared to be at a lower level of quality during observation session 2 in both formats. In addition, learners interact with the content less or at a lower level of quality during observation 2 in the F2F format as compared to observation 2 in the OL format.

Observation session 3

During observation session 3, it was observed that variations in interaction frequency were at a higher level of quality for L2L, L2I, and L2C for both formats. Note that F2F data does not represent actual observations; it is imputed data (see missing data section on page 5). The practical significance of the data was only explored for OL data. As mentioned earlier, variations in interaction frequency were at a higher level of quality for L2L, L2I, and L2C for the OL format, too. Practically, this means learners interact with other learners, the instructor, and content during OL observation session 3 at a higher level compared to F2F observation 3.

Observation session 4

During observation session 4, it was observed that variations in interaction frequency were at a higher level of quality for L2I and L2C for both formats. Variations for L2L interaction frequency also show a higher level of quality in the OL format but a lower level of quality (95% CI [-.973, 1.196] in the F2F format. Practically, this means it was observed that during observation session 4, OL learners interacted with the instructor, the content, and other learners at a higher frequency level, while F2F learners did the same with the content and the instructor but not with other learners.

Observation session 5

During observation session 5, it was observed that variations in interaction frequency were at a higher level of quality for L2I and L2C for both formats. Variations for L2L interaction frequency also show a higher level of quality in the OL format but a lower level of quality (95% CI [-1.055, 1.855] in the F2F format. Practically, this means it was observed that during observation session 5, OL learners interacted with the instructor, the content, and other learners

at a higher frequency level, while F2F learners did the same with the content and the instructor but not with other learners.

Overall, research question 3 suggests that variations in the frequency of learner interaction extend a higher level of quality within all observation sessions of the course. However, there was a lower level of quality observed for L2L interaction in OL observation session 1, F2F and OL observation sessions 2, and F2F observation sessions 4 and 5. A similar lower level of quality was observed for L2C interaction in F2F observation session 2. The quality of these differences may be an effect of different instructional strategies employed across sessions, attendance during the sessions, or other non-controlling variables (Kurthen, 2014).

Thus, a multivariate (MANOVA) test for two independent variables or cases was conducted to further understand how much the impact of these differences and effects on the quality of instruction was in the course. See Table 4.4.

Table 4.4

Multivariate Tests for Two Independent Variables – F2F and OL Formats, and Three Dependent Variables – L2L, L2I, L2C (2 x 3 MANOVA)

		N	Mean	Std. Deviation	Df	F	Sig.	η^2
L2L	F2F	39	2.08	2.496				
	OL	53	3.70	4.012				
	Total	92	3.01	3.529	1	4.949	.029	042
L2I	F2F	39	14.74	9.539				
	OL	53	12.32	7.256				
	Total	92	13.35	8.338	1	1.916	.170	.010
L2C	F2F	39	5.46	4.489				
	OL	53	6.23	5.693				
	Total	92	5.90	5.204	1	.483	.489	.006
							Pillai's Trace (V)	.072
							Sig.	.085

N = number of observations, df = degree of freedom, F = F=value, Sig. = $p < .001$, η^2 = partial eta squared, V = Pillai's Trace

It appeared that the types of learner interaction combined across both instructional formats show no statistical differences ($p = .0.85$, V = .072) for the course overall. The frequency

of interaction between the learners (F (1) =4.949, p=.029, η^2 =042), instructor (F (1) =1.916, p=.170, η^2=.010) and course content ((F (1) = .483, p=.489, η^2=.006) in both formats did not have any significant difference, thus they were similar across the different formats of the same course. This suggests that learners had no significant difference in the frequency of their interaction with other learners, the instructor, or the content, irrespective of the delivery format.

More importantly, a higher Pillai's Trace value (V=.072) also suggests this study's explanatory variables (L2L, L2I, and L2C) had a statistically significant effect on the response variable (quality of instruction). This result aligns with the theoretical understanding that the higher the level or quantity of learner interaction within instruction, the higher the quality of instruction. Such results align with the structural equivalent of the course F2F and OL format, which is 97% in terms of their resources, activities, and expected outcomes. Therefore, the course examined suggests statistically that the F2F and OL formats are structural and instructional equivalent. Research question 4 delves into the characteristics of instructional and learning behaviors that occurred during the observed sessions, which may have influenced the frequency of learner interaction and thus the quality of instruction. The field notes can therefore provide qualitative evidence to support the statistical findings.

4.2 Qualitative Results

4.2.1. Instructional and learning behaviors that influenced frequency of learner interaction.

Research Question 4: What characteristics of instructional and learning behaviors during instruction may influence the interpretation of observed frequency data?

To answer this research question, direct qualitative content analysis was conducted on fieldnotes data collected during the 5 instructional periods – except for F2F session 3 that was not observed. Results are reported per type of interaction and observation sessions. These

observation sessions were instructional periods during which fieldnotes were collected. The results described instructional and learning behaviors during the instruction that may have had an influencing effect on the frequency or quantitative data reported previously. Detailed descriptions of instructional and learning behaviors are reported next per the types of interactions across each observation session.

4.2.1.1. Learner-to-learner interaction (L2L)

Characteristics of L2L instructional and learning behaviors observed included learners asking other learners questions for clarifications, encouraging others, requesting or re-asking questions to be answered, praising other learners, and sharing personal experiences in responding to other learners' questions/comments/demonstrations. The results reveal that these characteristics during instruction may have influenced the observed L2L interaction frequency data across the five (5) observed sessions in both formats.

Observation session 1

For example, in OL format observation session 1, results revealed similar characteristics of L2L instructional and learning behaviors during the small group and open class discussions. In the F2F format, similar characteristics were also observed, but there was inconsistency between learners as they were more likely interactive during small group activities than open discussions. Most behavioral characteristics observed in the F2F format were non-verbal, especially during group activities. The observer noted these non-verbal characteristics were "different behaviors like nodding head, smile, eye-contact, use of pen/pencil to take note was observed when other learner made a comment about the content" (Whorway, Fieldnotes, September 11, 2023) .

However, 6 out of the 11 F2F learners were observed to be verbally participating both in the open class discussions and in the respective groups. As the session progressed, a few more

learners attempted to share their experiences by verbally participating. The observer noted that "2/4 learner were found to be discussing within their groups…other learners were also found participating in the discussion through body gestures: nodding head" (Whorway, Fieldnotes, September 11, 2023) .

The characteristics of L2L instructional and learning behaviors observed during F2F observation session 1 reflect 67% of the total number of learners present. There were also 44% of learners who were actively engaged with their technology. In the observer's excerpt a description of this behavioral characteristic during an open class discussion read, "4/11 learners were observed to be engrossed/engaged in using the laptop kept in front of them on the student table. They were not necessarily making any eye-contact with their peers or the instructor" (Whorway, Fieldnotes, September 11, 2023).

For the OL format, there are L2L characteristics of instructional and learning behaviors occurring during open discussions and small group activities. During the group activity, almost all (~90%) of the total number of learners actively interacted with other learners. The observer noted that "during breakout room discussion, 3/3 learners were observed to be active participating in the small group discussion" (Whorway, Fieldnotes, September 06, 2023) .

During open class discussion, it was mostly 7 out of the 13 learners who interacted among themselves. That number accounts for 91% of the total number of learners present during instruction. These are the same learners who appeared highly interactive even in the small group discussion. The observer noted that "although it seemed like there were multiple interactions taking place during activities. The same 3 or 4 students who have been actively participating in the class continued to be part of the verbal conversation and discussion" (Whorway, Fieldnotes, September 06, 2023).

Comparatively, more than half of the learners in both formats appeared to demonstrate characteristics that appeared to influence the frequency data. The uninstructed use of technology by 44% of F2F learners could particularly contribute to the low quality of frequency data.

Observation session 2

During observation session 2, the characteristics of L2L interaction behaviors observed appeared to be similar in both F2F and OL formats, especially when learners were engaged in group activities. Group or collaborative activities were the instructional and learning opportunities that had the highest frequency of interaction**.** Characteristics observed included learners making comments, asking questions, or providing clarity on a content topic among themselves.

While there was an increase in the frequency of interaction for both formats, F2F-observed session 2 had a lower frequency of interaction during open discussion. About 45% of the learners were observed taking the lead in responding to other learners' comments or questions on behalf of their group during the open discussion. For example, the observer wrote that "it was observed that only one student volunteered to share their perspective with the class while the other remained passive or they did not make an attempt to share their perspective or comments with the class" (Whorway, Fieldnotes, October 02, 2023).

On the other hand, the OL observed that session 2 had an increase in frequency of interaction due to the instructor's encouragement of learners to ask or make comments about other teams' work. This behavior influenced the frequency data of L2L interaction to about 90% (i.e., at least 2 learners from a group of five demonstrating characteristics that include, making comments and asking for clarifications). However, these characteristics were observed among a few learners, and they were not reciprocal. Comparatively, between both formats, characteristics

of L2L interaction influenced the frequency data in observation session 2, though the observed increase or decrease in frequency does not reflect the number of learners that were engaged in those behaviors.

Observation session 3

Results showed that there were characteristics during group activity and open class activity that appeared to influence the frequency data for OL delivery formats. For example, learners were highly engaged or interacted among themselves in group activities, thus increasing the frequency count. They volunteered to lead the group collaboration, answer questions, and take notes.

However, there was a decrease in the frequency of L2L interaction characteristics during open discussions, especially during group presentations. One behavior that contributed to that decline was learners being in a silent mood during and after group presentations. On one occasion, a learner noticed the silence from other learners and directly asked them to participate. This is how the observer recorded that incident, “Each learner/presenter in group 2 took 5 to 6 minutes to share their project work once the learner presented the project. He invited his teammate to add points that were specifically not discussed by him” (Whorway, Fieldnotes, October 11, 2023). This approach by this learner was repeated by other learners who led the presentation. Few learners responded, and there was a spark in the frequency of L2L interactions.

Observation session 4

During observation session 4 there were many small groups, collaborative activities, and open discussions. Characteristics of L2L interaction behaviors observed during these activities were generally learners sharing and reflecting on the content. They made comments, asked questions, and shared personal experiences. These characteristics were observed more during

collaborative activities than open-class activities in both formats. Overall, they were observed among 70% of the learners. During the collaborative or group activity in the F2F observation session 4, the observer reported that “Learners were observed to be discussing and asking each other some of the questions pertaining to the reading material within the group” (Whorway, Fieldnotes, November 6, 2023). Further, the observer reported that “One of the learners in the team was observed to be sharing his/her perspective” (Whorway, Fieldnotes, November 6, 2023).

Similar characteristics were observed in the OL format, but even better was an increase during open discussions. Learners were more engaged and interacted with other learners during open discussions than they did when they collaborated in groups. During the presentation of their work in open discussions, they asked questions on their team's behalf and provided comments for clarity. This is an excerpt of how the observer reported these behaviors:

> As the learner was presenting, some of the learners from other team commented or asked question for clarification…there were follow-up questions asked by learners from other teams for which learners from group 1 took turns to answer…all 3 members were involved in active discussion; they were taking turns to share their points and perspectives. (Whorway, Fieldnotes, October 25, 2023)

In addition, learners encouraged their team members to participate and answer questions or make comments concerning feedback they were receiving from their peers. These behaviors increased the frequency of interaction and indeed influenced its interpretation. Overall, there were similar characteristics across both formats; however, OL learners were observed as more engaged and interacted often in both groups and open discussions.

Observation session 5

During the final observation session for both delivery formats, there were similar characteristics of L2L interaction that influenced the frequency data. However, F2F observation session 5 had a lower frequency of L2L interaction. For example, during the F2F observation session 5, learners did not interact with other learners during and after their presentations. Particularly after the presentation, there were no comments or questions from other learners to the learner presenting. Even with a guest lecturer who presented at the end of learners' presentations, there were very few interactions with the guest. In fact, the observer wrote that "learners seated in front were looking at the presenters and nodding their head at times during the discussion while the learners seated in behind were busy using laptop" (Whorway, Fieldnotes, December 4, 2023).

These were questions asked and comments made in the OL observed in session 5. There were two channels that enable learners to communicate with other learners: direct conversation through the Zoom video platform and a chat box within the Zoom platform. The observer noted that "peer provided feedback both verbally and via zoom chat box" (Whorway, Fieldnotes, November 29, 2023).

There were sparingly direct conversations, but the chat box was the most interactive space in the OL format. Comparatively, behavior characteristics were the same across both formats; however, the added technological advantage (e.g., zoom chat box) in the OL format influenced the increase in its frequency data.

Table 4.5

Comparison Summary of Learner-to-Learner (L2L) Interaction Characteristics and Observed Frequency Data (95 % CI).

Observation sessions	Characteristic of instructional and learning behaviors		95% confidence Intervals			
			F2F		OL	
	F2F	OL	LL	UL	LL	UL
Observation session 1	Share personal experiences, work in groups, nodding and smiling, discussed findings, provided feedback to other's comment.	Share personal experiences, work in groups, nodding and smiling, discussed findings, provided feedback to other's comment.	2.292	4.254	-.464	3.009
Observation session 2	Passively interacted during open discussions and highly interactive during small group activities.	Passively interacted during open discussions and highly interactive during small group activities.	-.515	1.944	-.177	4.177
Observation session 3		Volunteering to participate during open discussion and highly interactive during small group activity.	4.056	6.515	.966	5.320
Observation session 4	Discuss, ask questions, taking notes during small group activities.	Discuss, ask questions, taking notes, encouraging team members during small group activities.	-.973	1.196	1.191	5.031
Observation session 5	Very less comments, questions during and after presentations.	More comments, questions, praises during and after presentations.	-1.055	1.855	9.024	14.176

Note: CI = confidence interval; LL = lower limit; UL = upper limit, effect size d = 0.04.

Learner-to-Learner (L2L) Interaction characteristics Summary: Table 4. 5 demonstrates a summary of characteristics of L2L instructional and learning behaviors during instruction that influenced the actual interaction observed in frequency data. The results revealed a significant similarity in behaviors between F2F and OL formats across observation sessions. The differences in the frequency data are also reflected in the way learners interacted and how they interacted among themselves. Overall, observation sessions across both formats had similar behavioral characteristics that appeared to have influenced the frequency data.

4.2.1.2 Learner-to-Instructor interaction (L2I)

Characteristics of L2I instructional and learning behaviors observed included both learners and instructors asking content-related questions, seeking clarity, describing scenarios

/examples, giving directions, sharing personal experiences, critiquing thoughts/work, confirming interpretations, and praising, agreeing, and disagreeing with each other, respectively. The analysis covered the characteristics of both the instructor and the learner because research suggests that both can lead to this type of interaction (Fredericksen et al., 2020). The behaviors observed in this study aligned with Koszalka and Whorway's (2024) baseline of reciprocal behaviors between both learners and instructors during instruction.

Observation session 1

Results revealed that observed session 1 in both F2F and OL formats had similar characteristics of instructional and learning behaviors between learners and the instructor. However, a large portion of the frequency of interaction was influenced by behavioral characteristics, mostly initiated by the instructor. The instructor posed questions, described scenarios/examples, and gave directions. In response, learners volunteered to respond accordingly or used body gestures as feedback on the instructor's interaction.

For example, in the F2F observation session 1, the instructor posted questions to solicit learners' views on a specific content area or a given task. On this account the observer wrote that the “instructor presented the content (ppt), posed question to whole class encouraged learners to present their reflection journal to the whole class” (Whorway, Fieldnotes, September 11, 2023).

As mentioned above, there were also gestures and body movement responses as characteristics of instructional and learning behaviors observed during this session. Those gestures and body movements included the movement of the instructor around the class during lectures and small group activities, carefully observing and appearing to provide feedback to individual and group members. Gestures from the learners, like a smile or nod, signaled agreement with the instructor's comments, critiques, and directions. These body movements and

sometimes gestures could not be easily observed in the OL environment. Learners most often turn off their video when the instructor was making comments, giving directions, or presenting content; and this prevented observation of gestures. On the other hand, the instructor used the Zoom chat box to interact with learners when they were working in small groups. Specifically in the zoom chat, the observer noted that "instructor posted the question & reading prompts in the CHAT for learners to have access to it" (Whorway, Fieldnotes, September 6, 2023).

During open-class discussions, the instructor followed up with questions, and learners took turns responding to the instructor. The observer described that incident occurring in both delivery formats in this manner: "Follow up the whole class discussion: instructor asked follow-up questions which learner's took terms to answer. After sharing multiple discussion points, learners were posted with the following question: 'Why would it be a design problem?" (Whorway, Fieldnotes, September 6, 11, 2023).

Overall. Both formats had similar characteristics of instructional and learning behaviors that were observed to influence the frequency data. In addition, the instructor's moderation and stimulation behaviors appeared to represent the frequency of interaction data.

Observation session 2

Like observation session 1, observation 2 had similar characteristics of instructional and learning behaviors, mostly led by the instructor. There was an increased frequency of behaviors observed in OL than in the F2F formats. In the F2F format, the instructor approach yielded no benefit in terms of increasing interaction frequency. Learners were more engaged with their laptops, and efforts to get them to interact with the instructor did not work. However, there was a high frequency of interaction during small group activities when the instructor and learners asked each other about clarity and progress pertaining to the final project. The observer wrote that the

“instructor moved around the classroom to different groups, learners were taking turns to share their progress then instructor also took turn in answering specific questions pertaining to their final projects” (Whorway, Fieldnotes, September 11, 2023).

In the OL format, there were similar characteristics of instructional and learning behaviors observed in session 2 which appeared to influence the frequency data. However, those characteristics were observed consistently among 60% of the learners present at the time. The observer noted that those 60% of learners were the “same students who are mostly enthusiastic in class are the ones who were volunteering to discuss and be part of the whole class discussion” (Whorway, Fieldnotes, September 06, 2023).

Overall, in both delivery formats, the characteristics of instructional and learning behaviors between the learners and instructor appeared mostly similar. There was more interaction in the group activities than open discussion, particularly among the same group of learners. Though there were efforts by the instructor to have F2F learners engaged more, those did not yield results. Those efforts were not necessarily needed in the OL format, as learners were observed to be highly engaged with the instructor.

Observation session 3

Results revealed that L2I interaction characteristics of instructional and learning behaviors in the OL delivery format were mostly portrayed through the instructor encouraging the learner to answer questions asked, the instructor asking questions, and at times, the learner asking questions. There were also directions from the instructor to the learners on how to perform a task. The frequency of these behaviors directly influenced the frequency data.

The instructor asked questions verbally or posted them on PowerPoint, followed by examples that provided clarity. Those questions had follow-up questions and, in most cases, led

to high-quality interactions between learners and the instructor. Approximately 36% (i.e. 4/11 learners) were observed engaging with the learners in open discussions. In group activity, the instructor was observed spending time reviewing components of the group work and providing feedback in the form of asking follow-up questions to the learners.

Overall, characteristics of instructional and learning behaviors observed and recorded as frequency data during open class discussion represented approximately 36% of learners present at the time. It is important to note that this number increased when learners worked on group activities.

Observation session 4

The analysis reveals that similar instructional and learning behaviors were observed in both F2F and OL formats. Standout behaviors between the learner and the instructor in the F2F delivery format were questioning, encouragement to interact, and note-taking. Whether it was during group work or open class discussions, it was the same group of learners who exhibited these characteristics. Those learners represented about 63% of the entire class during this observed session. They usually raise their hands most of the time, signaling their readiness to answer the questions. The observer noted that "7/9 learners volunteered to answer or attempted to answer these questions posed" (Whorway, Fieldnotes, November 6, 2023).

Unlike in the F2F format, where learners demonstrated readiness to interact, OL learners needed to be directly encouraged to demonstrate certain behaviors. The instructor called out the learners by name to have them answer questions. During the presentation of group tasks, the instructor had to ask specific questions to specific learners to solicit answers. The observer noted that "the instructor asked questions related to some of the motivational strategies that could be

part of the storyboard. The instructor asked one last question on where your team is standing in terms of implementation and evaluation" (Whorway, Fieldnotes, October 25, 2023).

This direct encouragement approach by the instructor appeared to influence an increase in the frequency data. Particularly during the collaborative activity of 3 learners each per group, the observer noted that "all 3 members were interacting & trying to address the three-question posed by the instructor" (Whorway, Fieldnotes, October 25, 2023).

Overall, these characteristics of instructional and learning behaviors influenced the frequency of the data. Though both formats had different frequency data, the behaviors were similar.

Observation session 5

The presentation of final projects was the main instructional and learning activity during this observation session. Instructional and learning behaviors observed between the instructor and learners included giving directions, presentations, questioning, comments, and clarifications.

For example, in F2F observation session 5, the instructor asked questions after each presenter or learner concluded their presentation. There were times when the instructor also asked the entire class questions to solicit interaction between the presenter and other learners. The observer described one of those times in this manner "the instructor posed a second question: Why do you think this project was assigned at the end of the course? Three students chose to answer this question" (Whorway, Fieldnotes, December 4, 2023).

Similar behaviors were observed in OL session 5, in addition to encouragement and agreement from the instructor with the learners. The observer noted that the "instructor encouraged and acknowledged the comments made by each learner in terms of their learning in this course" (Whorway, Fieldnotes, November 29, 2023).

Further, the instructor also shared specific comments and praise for parts of the final project being presented. For example, the observer noted that the instructor said praises like “I like the sticky-notes, is a good example of the ID representation” (Whorway, Fieldnotes, November 29, 2023).

Overall, similar characteristics of instructional and learning behaviors were observed in session 5 for both formats. However, in the OL observed session, the instructor encouraged, agreed, and praised learners, behaviors, which appeared to influence the increase in the OL frequency data as compared to F2F frequency data.

Learner-to-Instructor (L2I) Interaction characteristics Summary: Table 4.6, a summary of the characteristics of instructional and learning L2I behaviors, demonstrates that those behaviors influenced the frequency data. For example, a significant difference between both formats was observed in observation session 1 frequency data (F2F CI [-.515, 1.944] and OL CI [-.177, 4.177]. The increase in OL interaction frequency data could be a result of learners volunteering to interact, while F2F learners did not interact more even with the instructor's direct questioning approach. All other observation sessions showed similar characteristics in both F2F and OL formats, with differences in the frequency of interaction as reflected in how often they interacted and how many interacted. This suggests that the characteristics of instructional and learning behaviors observed influenced the interpretation of the frequency data.

Table 4.6

Comparison Summary of Learner-to-Instructor (L2I) Interaction Characteristics and Observed Frequency Data (95 % CI).

Observation sessions	Characteristic of instructional and learning behaviors		95% confidence Intervals			
			F2F		OL	
	F2F	OL	LL	UL	LL	UL
Observation session 1	Posed questions, described scenarios/examples, and gave directions mostly led my instructor.	Posed questions, described scenarios/examples, gave directions and learners volunteer response	7.729	19.908	6.737	15.445
Observation session 2	Questioning, encouragement to participate and note taking across group work and open discussions.	Like F2F but did not increase due to learners' engagement with laptops.	6.795	22.062	9.113	20.029
Observation session 3		Questioning, follow-up questioning, providing feedback.	8.938	24.205	12.113	23.029
Observation session 4	Questioning, encouragement to participate and note taking.	Instructor called out learners by names and ask specific questions.	9.601	23.065	10.409	20.036
Observation session 5	Questioning, response and giving directions	Questioning, response, gave directions, specific comments and praises	2.768	20.832	.342	13.258

Note: CI = confidence interval; LL = lower limit; UL = upper limit, effect size d = 0.04.

4.2.1.3 Learner-to-Content Interaction (L2C)

Results revealed that characteristics of instructional and learning behavior between learners and content were similar across the observed sessions for both formats. These characteristics included descriptions, critiques, reflections, and showcasing the content. Together, these behaviors influence the interpretation of the frequency data.

Observation session 1

In observation session 1, the behaviors observed were learners reading the content through resources provided by the instructor, taking notes while listening, and reflecting on the content when completing or demonstrating an assigned task. These instructional and learning behaviors were observed during individual activities and group activities.

For example, in the F2F format, learners reflect on the content through a resource (e.g., a portable document format (pdf) containing specific content knowledge. They demonstrated reflections by writing on Google Docs, one note, and other technology tools. About 30% of learners reflected in an open discussion when they demonstrated the outcomes of the tasks. The observer noted that "3 learners out of the 11 presented their journal reflections to the whole class. Learners were found to be referring to the content material during the class" (Whorway, Fieldnotes, September 11, 2023).

Similar behavioral characteristics were observed in the OL format, but there were few differences. OL learners referred both to content posted in the Learning Management System (LMS) and shared personal experiences. They were observed volunteering to interact with the content once instructed. The observer noted:

> Learners were observed referring to the content/reading materials that were provided by the instructor via blackboard. One student seemed to be quite enthusiastic and was trying to share about themselves and their knowledge & understanding of 'Design' with the class. (Whorway, Fieldnotes, September 06, 2023)

Overall, the characteristics of instructional and learning behaviors in L2C interaction were similar in both formats. They showed that they had influenced the frequency data. Learners in the OL delivery format interacted by sharing personal experiences and referring directly to content posted on the LMS. These differences influenced the interpretation of the observed frequency data.

Observation session 2

Results revealed similar characteristics of instructional and learning behaviors across both formats. They included learners taking notes on their laptops or tablets, reading aloud from

content resources, completing assigned individual and group tasks, and then reporting. However, there were observed differences in the frequency data between both formats. L2C interaction during F2F observed session 2 was encouraged by additional instructor's questioning and directions. The OL session did not need those additional questions or directions, as learners were highly engaged with the content continuously.

In the observed F2F session 2, for example, at one point the instructor noticed that 4/9 of the learners sitting in the left corner of the classroom were not interacting with the content (i.e., answering the questions asked or taking notes), so the instructor asked them directly to answer specific questions that were posted on the PowerPoint. During group activities, the instructor moved between groups, giving directions to ensure that learners interacted with the content. In return, a few learners asked content-related questions and critiqued final projects.

In the observed OL session 2, learners demonstrated quality and increased frequency of interaction with the content. They posed questions to the instructor, answered the instructor's questions, and made comments. During their elaboration, they connected personal experiences to help unpack the complexity of the questions posed by the instructor. These behaviors were mostly observed during a journal presentation activity. Journals notes were recorded using technologies platforms (i.e., one-note, google document, etc.) and traditional methods (i.e., using books to pen down reflection) The observer noted that "2 students volunteered to share their understanding of ID competencies. Followed by students asking questions/comments & sharing information related to ID competencies" (Whorway, Fieldnotes, September 27, 2023).

Overall, the characteristics of instructional and learning behaviors between the learners and content were similar as observed. The observed differences in the frequency data are a reflection of learners' level of engagement with the content.

Observation session 3

Results revealed that instructional and learning behaviors for OL L2C interaction were observed as instructors encouraged learners to interact with the content by asking learners to read notes on the slides and respond to questions. In response, learners were observed using prior knowledge to connect with the current understanding or questions posted about the content.

Further, behaviors that demonstrated interactions with the content were observed when learners presented progress made on the final project. An example of instructor encouragement for learners to engage in these behaviors was noted here by the observer:

> The instructor encouraged learners to answer these questions, while the instructor did spend some time to elaborate on the answers provided by the learners. Learners were making connections by connecting to their previous knowledge (reference materials posted on blackboard) and earlier class discussion. (Whorway, Fieldnotes, October 11, 2023)

Learners also interacted with the content by asking content-related questions and follow-up questions. The observer noted that "learners started to pose questions related to mastery learning. 4/11 learners were asking instructor follow-up questions and sharing comments about 'assessment" (Whorway, Fieldnotes, October 11, 2023).

Overall, characteristics of instructional and learning behaviors appeared to influence the interpretation of the frequency data. OL learners increasingly interacted with the content through the instructor's questions and directions.

Observation session 4

Results revealed that the characteristics of instructional and learning behaviors observed during this session were learners answering content-related questions and taking notes while the

instructor presented content. There were also read-aloud activities and working in groups or collaborative activities. These behaviors were observed in both face-to-face and online observation sessions. Particularly, they were observed during warm-up activities and lectures.

For example, F2F learners volunteered to answer questions and shared their understanding of the content during the warm-up activity. When the instructor presented the content, they were observed taking notes on their tablets or laptops. They also interacted with the content when working as a group on the project. During group or collaborative activities, the observer noted "one of the learners in the team was observed to be sharing his/her perspective while the other learners were observed to be listening & taking notes" (Whorway, Fieldnotes, November 6, 2023).

Similar characteristics were observed in the OL observation session 4. In contrast to the F2F session, learners used Google Drive as a collaborative space to work on and store projects. When they presented, other learners interacted with the content through the same medium. They also interact with the content by asking questions and critiquing their peers' work. Overall, these additional media influenced the increase in the frequency of OL-observed data. This was not true for the F2F, and it was reflected as well in the lower observed frequency data.

Observation session 5

Most of the L2C interaction behaviors observed during this session centered around the final project presentations. Presentations observed in F2F observation session 5 were continuations from the previous class, which this study's data collection effort did not cover. The OL session, however, covered all final projects' presentations for the total number of learners registered in the class. Results revealed that behaviors observed were learners presenting content, sharing lessons learned, and individual experiences.

For example, in the F2F observation session 5, learners enthusiastically shared their project, and when the instructor posed content-related questions, it increased the frequency of interaction with the content. The observer wrote this about a learner's response to a question from the instructor "I think I will go back to learning theories, practices, & the KB. I will wear my teachers hat to analyze and choose different learning theories that best suit a given situation" (Whorway, Fieldnotes, December 4, 2023).

Similar situations throughout the session increased the frequency for learners to interact with the content by demonstrating, contextualizing, and delving deeper into understanding.

During OL observation session 5, besides learners presenting or demonstrating the final project, there was a lower frequency of interaction from other learners toward the presenter's content. However, the presenters themselves were critical of their own work. They were observed providing rationale and critiquing specific parts of the project. A significant frequency of L2C interaction during the OL session was observed after each learner project presentation when the instructor asked learners to share lessons learned from the course. Overall, these behavioral characteristics influence the frequency data of L2C interactions for both F2F and OL sessions. The fact that OL had more learners enrolled than F2F reflected that numerical advantage in the observed frequency data.

Learner-to-Content Interaction Characteristics Summary: Table 4.7, a summary of the characteristics of instructional and learning L2C behaviors and the frequency data. The results showed that L2C behaviors influenced the frequency data.

However, there was a significant difference (F2F CI [-.515, 1.944] and OL CI [-.177, 4.177]) in the frequency data in observation session 5. This significant difference aligned with the characteristics of behaviors demonstrated in observation session 5. In comparison to F2F

observed session 5, there were more occurrences and additional behaviors observed in the OL observed session 5. Those behaviors were self-critiqued and reflections. Other observation sessions beyond session 5 showed that the characteristics of instructional and learning behaviors were influenced by the frequency data.

Table 4.7

Comparison Summary of Learner-to-Content (L2C) Interaction Characteristics and Observed Frequency Data (95 % CI).

Observation sessions	Characteristic of instructional and learning behaviors		95% confidence Intervals			
			F2F		OL	
	F2F	OL	LL	UL	LL	UL
Observation session 1	Read aloud content in resources, take notes, reflect on tasks, present	Read aloud content in resources, take notes, reflect, share personal experiences, present	4.024	9.249	1.406	6.230
Observation session 2	Take notes, read aloud from content resources, complete assigned individual and group tasks	Take notes, read aloud content in resources, complete assigned individual and group tasks	-1.561	4.990	.119	6.167
Observation session 3		Read aloud, respond to questions, connect prior knowledge to current understanding, demonstrate progress.	3.010	9.561	2.833	8.881
Observation session 4	Answer content related questions, take notes, present outcomes of collaborative task.	Answer content related questions, take notes, present and self-critique outcomes of collaborative task.	2.111	7.889	1.555	6.889
Observation session 5	Present content, share lessons learned and experiences.	Present content, share lessons learned from projects. self-critique.	3.925	11.675	15.422	22.578

Note: CI = confidence interval; LL = lower limit; UL = upper limit, effect size d = 0.04.

*Summary of research question 4***:** Overall, research question 4 aimed to understand the characteristics of instructional and learning behaviors during instruction that supported the interpretation of observed frequency data. A content analysis was conducted using direct qualitative content analysis strategies, which focus on three predetermined categories: learner-to-learner, learner-to-instructor, and learner-to-content. Each category was analyzed for each observation session, which consisted of instructional sections purposefully selected to collect

observation data. The OL format had the most observations, with 53 sessions, 530 minutes (about 9 hours) covered, and 4578 words recorded in the fieldnotes.

The results showed that during the OL instructional period, learners were consistently engaged and interacted at the same level both during small group and open class discussions. However, this level of consistency was not observed among learners during the F2F instructional period. During F2F observations, the observer noted that half of the learners in each group were observed either actively participating or not participating. During OL observations, the observer noted that when discussions were open, learners appeared silent and did not interact with other learners, especially if the instructor did not encourage interaction. These findings suggest that the characteristics of instructional and learning behaviors during instruction influence the interpretation of observed frequency data.

4.3 Chapter Summary

This study undertook a comprehensive comparison of the quality of instruction within and between equivalent F2F and OL delivery formats of the same course, taught by the same instructor. This study captured the frequency of actual interactions, accompanied by descriptive fieldnotes, and provided an in-depth analysis of the instructional quality that occurred during live instructional sections.

Table 4.8

Quality (95% CI) of Learner Interaction with other Learners, the Instructor, and Content in F2F and OL Delivery Formats.

						95% CI	
	Frequency, *n* (%)	*df*	*F*	*p*	Obs. sessions	LL	UL
F2F_L2L	81 (4)	4	14.59	0.01	1	2.292	4.254
		34			2	-.515	1.944
					3	4.056	6.515
					4	-.973	1.196
					5	-1.055	1.855
F2F_L2I	575 (28)	4	.25	.906	1	7.729	19.908
		34			2	6.795	22.062
					3	8.938	24.205
					4	9.601	23.065
					5	2.768	20.832
F2F_L2C	213 (10)	4	2.03	.113	1	4.024	9.249
		34			2	-1.561	4.990
					3	3.010	9.561
					4	2.111	7.889
					5	3.925	11.675
OL_L2L	196 (10)	4	12.47	001	1	-.464	3.009
		34			2	-.177	4.177
					3	.966	5.320
					4	1.191	5.031
					5	9.024	14.176
OL_L2I	653 (32)	4	2.17	094	1	6.737	15.445
		34			2	9.113	20.029
					3	12.113	23.029
					4	10.409	20.036
					5	.342	13.258
OL_L2C	330 (16)	4	15.85	001	1	1.406	6.230
		34			2	.119	6.167
					3	2.833	8.881
					4	1.555	6.889
					5	15.422	22.578

Note: *df* = degrees of freedom, *F* = F-value, *p* = significance value ($p < 001$),CI = confidence interval; LL = lower limit; UL = upper limit, cohen d =

Table 4.9

Summary of Qualitative Results Showing the Characteristics of Instructional and Learning Behaviors in the F2F and OL Delivery Formats

	Learner-to-Learner (L2L)		Learner-to-Instructor (L2I)		Learner-to-Content (L2C)	
Obs. Sessions	F2F	OL	F2F	OL	F2F	OL
1	Share personal experiences, work in groups, nodding and smiling, discussed findings, provided feedback to other's comment.	Share personal experiences, work in groups, nodding and smiling, discussed findings, provided feedback to other's comment.	Posed questions, described scenarios/examples, and gave directions mostly led my instructor.	Posed questions, described scenarios/examples, gave directions and learners volunteer response	Read aloud content in resources, take notes, reflect on tasks, present	Read aloud content in resources, take notes, reflect, share personal experiences, present
2	Passively interacted during open discussions and highly interactive during small group activities.	Passively interacted during open discussions and highly interactive during small group activities.	Questioning, encouragement to participate and note taking across group work and open discussions.	Like F2F but did not increase due to learners' engagement with laptops.	Take notes, read aloud from content resources, complete assigned individual and group tasks	Take notes, read aloud content in resources, complete assigned individual and group tasks
3		Volunteering to participate during open discussion and highly interactive during small group activity.		Questioning, follow-up questioning, providing feedback.		Read aloud, respond to questions, connect prior knowledge to current understanding, demonstrate progress.
4	Discuss, ask questions, taking notes during small group activities.	Discuss, ask questions, taking notes, encouraging team members during small group activities.	Questioning, encouragement to participate and note taking.	Instructor called out learners by names and ask specific questions.	Answer content related questions, take notes, present outcomes of collaborative task.	Answer content related questions, take notes, present and self-critique outcomes of collaborative task.
5	Very less comments, questions during and after presentations.	More comments, questions, praises during and after presentations.	Questioning, response and giving directions	Questioning, response, gave directions, specific comments and praises	Present content, share lessons learned and experiences.	Present content, share lessons learned from projects. self-critique.

Table 4.8 is a summary of the quantitative results which reveal that frequency of actual learner interactions between both formats had similar pattern for each type of interaction. However, a closer look revealed that the frequency within and between observed sessions across F2F and OL delivery formats showed that learners' interactions with other learners and the instructor varied. On the contrary learner interaction with the content in the F2F OL delivery formats showed no differences within but differences between both formats. Further exploration showed that the quality of these differences was specifically lower in a few observed sessions (i.e., observation sessions 1, 2, 4, 5) mostly in the F2F format. These differences were minimal and did not show significant impact on the level of learner interaction with other learners, the instructor, or the content, irrespective of the delivery format. These results support the conclusion that there were similar levels of interaction in both formats of the same course per the types of interaction.

In addition, Table 4.9, a summary of the qualitative findings revealed that the characteristics of instructional and learning behaviors during instruction in each observed session supports the interpretation of frequency data. OL delivery format had more interaction frequency, and this was demonstrated consistently through high-quality engagement and interaction during small groups and open class discussions. F2F delivery format had less than OL interaction frequency due to fewer learners actively participating or intseracting during small groups and open class discussions. Overall, both the characteristics of instructional and learning behaviors and the frequency data provided direct evidence that suggest quality instruction occurred during the observed sessions.

The next chapter (5) discussed these findings through the concept of Moore's interaction framework and relevant literature. It provides practical recommendations for instructional

designers and developers based on those behaviors observed in equivalent F2F and OL formats of the same course, taught by the same instructor. The chapter will address the limitations of this study and conclude with future research suggestions.

Chapter 5 – Discussion and Conclusion

This dissertation study contributes to the field of instructional design, development, and evaluation, specifically the quality of instruction in face-to-face (F2F) and online (OL) delivery formats. The study examined learner interaction, a core determinant of quality instruction, by using a comparative case study (CSS) with a mixed-methods research design using an observational data collection approach. Chapter 1 introduced the research problem emphasizing the importance of learner interaction measures to compare instructional quality in F2F and OL courses. Chapter 1 also highlighted the challenges of comparative research typically using self-reported data – an inaccurate reflection of actual learner interaction during instruction. It follows that this study used behavioral observation data – an accurate reflection of learner interaction during instruction – to conduct this comparative study. Chapter 2 synthesized literature assumptions regarding learner interaction as a fundamental determinant for evaluating quality instruction and provided support for the methodological approach to this study. Chapter 3 described the methodological approach used in this study, including the Behavioral Observation Checklist (BOC) – an observation instrument developed and validated to collect learner interaction data during instruction. Chapter 4 presented findings from the analysis of learner interaction data, [i.e., both quantity (tallies) and quality (fieldnotes)] used to describe instructional quality within and across each observed F2F and OL section.

Chapter 5 starts with a summary of the study, followed by a discussion of the study's findings through the concept of Moore's interaction framework and relevant literature. Further practical recommendations for instructional designers and developers are discussed that may increase the frequency of learner interaction and thus the quality of instruction based on the

finding of this study. Finally, chapter 5 addresses the limitations of this study and concludes with future research suggestions.

5.1. Summary of the study

The purpose of this study was to conduct a comparative analysis of instructional quality between structurally equivalent face-to-face (F2F) and online (OL) delivery formats of the same course, taught by the same instructor. The study examined learner interaction during instruction as a core determinant for comparing the quality of instruction between both formats. The goal was to highlight instructional and learning behavioral characteristics that demonstrate the equivalence of (or lack thereof) quality instruction within and between two equivalent delivery formats.

To carry out such an extensive empirical examination, the study was guided by Moore's (2012) conceptual understanding of learner interaction during instruction. Moore (2012) described learner interaction during instruction as observable relationships among learners, instructors, and content resulting in learning outcomes.

In order to examine learner interaction for comparing the quality of instruction within and between both formats, this study employed a comparative case study (CSS) with a mixed-methods approach (Misra-Hebert et al., 2018; Sakata et al., 2021; Yin, 2013). This approach allowed a convergence of both quantitative (i.e., tallies of interaction) and qualitative (i.e., fieldnotes) data to examine instructional quality within each format and then compare that quality of instruction between both equivalent F2F and OL formats of the same course, taught by the same instructor.

Both quantitative and qualitative data were collected through an unobtrusive observational approach that allowed the researcher direct access to 10 instructional sections (i.e.,

5 sections per delivery format). This data collection approach was inspired by Bernard et al.'s (2004) suggestion that studies using learner interaction as a determinant for comparing F2F and OL courses should focus on actual learner interactions that occur during instruction. During the unobtrusive observational approach, real-time instructional and learning behaviors were tallied that appeared to influence the quality of instruction during active instruction. Creswell (2014), a prominent proponent of the real-time observation approach, claimed that it gives researchers direct access to the research setting, providing firsthand knowledge of learner experiences during instruction.

Analysis of learner interaction data showed there were similar frequency patterns across both F2F and OL delivery formats: – Learner-to-instructor (L2I) interaction had the highest, followed by learner-to-content (L2C) interaction, and learner-to-learner (L2L) interaction. The analysis also showed that between both formats, there were no significant statistical variations for L2I and L2C, while there was a significant statistical variation for L2L. Overall, there was no statistical difference in the quality of instruction between the two delivery formats. Further analysis of the characteristics of instructional and learning behaviors aligned with the quantitative analysis. To unpack the complexity of these findings, the study's contribution to literature are discussed through the concept of Moore's (2012) three types of interaction.

5.2. Discussion

5.2.1 Learner-to-Learner (L2L) Interaction

In this study, L2L interaction frequency had similar patterns across both formats (F2F [M = 2.07, f = 81, 9%] and OL [M = 3.69, f = 196, 17%]). In comparison, learners in both formats interacted with each other at the same frequency level across the observed sessions. This observable result did not support previous self-reported studies that learners perceived the F2F

delivery format to have better L2L interaction opportunities than OL instruction (Julien & Dookwah, 2020; Paulsen & McCormick, 2020; Wut, & Xu, 2021). A closer look at the differences in percentages between these formats [F2F (4%) and OL (10%)], suggested that learners appeared to be more engaged with other learners during OL instruction than in F2F instruction, contrary to self-report studies. The differences in percentages in this study are likely due to descriptions noted in the fieldnotes like OL learners self-initiating interaction with other learners, while F2F learners in most cases waited for prompts from the instructor to engage other learners.

Also reported in this study is L2L interaction, which ranks the least frequent interaction of the three types of interactions. There was also a significant statistical difference in the interaction frequency within and between F2F [F (4, 34) = 14.59, p = .001, η2 partial = .632] and OL [F (4, 34) = 12.47, p = 001, η2 partial = .595] delivery formats. Particularly, the low ranking and statistical differences between both formats highlighted a growing concern that L2L interaction is not always necessary and does not necessarily significantly improve learning (Kuo et al., 2014; Stein et al., 2005). Kuo et al. (2014) highlighted this concern when they examined learner satisfaction in OL learning settings. They reported that L2L interaction did not appear to have any effect on learners' satisfaction. It is important to note that Kuo et al.'s (2014) exertion is based on learners' perceptions and not actual L2L interactions or behaviors during instruction. However, this study provides real-time evidence that amplifies the need to enhance purposeful L2L interaction relationships that lead to meaningful learning.

L2L interaction behaviors during instruction can foster purposeful relationships that lead to meaningful learning (Garrison, 2019). In a related study, Mehall (2020) proposed a purposeful interpersonal interaction (PII) framework for identifying L2L interactions that lead to meaning

learning. PII uses the Rubric for Assessing Interactive Qualities of Distance Courses (RAIQDC) (Robyler & Wienke, 2003). RAIQDC is a self-report instrument that primarily collects data on learners' perceptions of a course. This study used the Behavioral Observation Checklist (Koszalka & Whorway, 2024) designed to collect actual L2L interactions and behaviors data directly relating to the frequency of communication (tallies) and description of relationships (fieldnotes) that influence the quality of instruction. Future research using the PII framework to explore concerns about L2L interaction in either OL or F2F instructions may benefit from also using and instrument like the BOC to collect real-time data. These tools may help to further clarify similarities and differences as informed by perceptions or actual behaviors.

5.2.2 Learner-to-Instructor (L2I) Interaction

Literature suggests L2I interaction embodies motivational and emotional support that enhances learning (Bernard et al., 2009; Costley et al, 2022; Pharm et al.,2014). This study reports that learners interacted with the instructor at similar patterns (F2F [M = 14.74, f = 575, 66%] and OL [M = 12.32, f = 653, 55%]) across the two delivery formats, except for OL observation session 4. This demonstrates a purposefully designed L2I interaction for two different learning formats that actualizes predictions of the same degree of learning behaviors (Kang & Im, 2013).

There was no significant difference in the interaction frequency within and between F2F_L2I [F (4, 34) = .25, p = 906, η2 partial = .029] and OL_L2I [F (4, 34) = 2.17, p = 094, η2 partial = .203] interactions in both delivery formats. Though this difference proves not to be statistically significant, the presence of differences shown in this result prompted previous questions about "Who starts the interaction process? How do participants maintain interaction throughout the course?" (Pham et al., 2019 pg. 687). In answering these questions, Pham et al.

(2019) suggested that variations in L2I interaction depend on these key observable patterns: instructor-initiated, learner-initiated, one-way, two-way, and multi-direction. In this study it was found that L2I interaction observable patterns during F2F instruction were mostly instructor-initiated, while OL interaction was a mix of learner- and instructor-initiated or multi-directional. This means that during most F2F observed sessions the instructor led the exchanges, while during OL observed sessions the instructor and learner led the exchanges interchangeably. As a result, the OL format recorded more L2I interaction than the F2F format. Multi-directional approaches can have a positive influence on L2I interaction during instruction (Wahid et al., 2020).

Regardless of the instructional approaches and frequency of L2I interaction observed in both formats, learners demonstrated similar interaction behaviors when interacting with the instructor. Learners posed questions and made comments in response to instructor prompts, while the instructor gave directions, asked questions, made comments, and praised learners in response to the comments and answers they provided.

In this study, L2I interaction had the highest frequency among the three types of interactions. This observed result supports previous self-report study suggestions that L2I interaction is the most valued interaction, especially in the OL setting (Bernard et al., 2009; Martin & Bolliger, 2018). For example, Martin and Bolliger's (2018) survey-based research examined student perceptions of various engagement strategies used in OL courses based on Moore’s (2018) interaction framework. They reported that learners perceived OL L2I engagement strategies to be most valued among the three types of interaction. In this study, it was observed that the value of L2I interaction was due to OL learners having the advantage of

communicating with the instructor through several media technologies, like Zoom chat, text, or email, during instruction.

Ullah and Anwar (2020) suggested that "the use of media technology and interactive activities has a positive impact on promoting learning and, therefore, learner engagement." (pg. 16). In this study, the Ullah and Anwar (2020) suggestion was observed mostly during OL instruction rather than F2F instruction. Currently, media technologies are rapidly integrating into learning environments, and this study's empirical evidence also supports the assumption that they have a positive influence on L2I interaction. Therefore, the F2F delivery format should also adapt so that, like the OL format, it embodies motivational and emotional support with flexible technologies.

5.2.3 Learner-to-Content (L2C) Interaction

Learners interacted with the content at a similar frequency distribution pattern across both delivery formats (F2F [M = 5.46, f = 213, 25%] and OL [M = 6.22, f = 330, 28%]). Results show that learners in both delivery formats interacted with the content at the second highest frequency in comparison to the other two types of interaction. Their taking second place comparatively was due to just a few learners consistently interacting with the content during instruction, despite the availability of equivalent learning activities designed to engage all learners with the content. For example, during observation sessions 5 both formats had learners perform the same activity, the final project presentation. However, F2F learners were observed not interacting much with the content; there were very few critiques and feedback on peers' work. Literature suggests that the presentation of projects or papers is the most beneficial strategy used to enhance L2C interactions (Martin & Bolliger, 2018). This study found that F2F learners did not take advantage of this strategy to enhance interaction with the content.

In addition, the results show that statistical differences in L2C interaction frequency in both formats had a larger effect (F2F_L2C η2 partial = .193, OL_L2C η2 partial = .651) on the quality of instruction. The qualitative analysis revealed that the effect demonstrated by the differences was due to OL learners engaging more with the content through self-critique and reflections using the Zoom chat feature, Google Shared Documents, and open discussions. This result aligns with Allen and Seaman's (2014) suggestion that technologies selected to mediate interaction during instruction promoted participation in an online learning environment. Owusu-Agyeman and Larbi-Siaw (2018) also confirm this exertion in a survey study that explored underlying features that influenced L2C interaction in OL learning environments. Owusu-Agyeman and Larbi-Siaw (2018) found there was a positive relationship between mediating technology and L2C interaction. In this study, mediating technologies were used to facilitate self-critique and reflection behaviors through brainstorming and collaborative learning activities. These behaviors were mostly observed during project presentations in OL instruction rather than F2F instruction. Thus, F2F L2C interactions were descriptively less than OL L2C interactions, despite the critical role they play in ensuring course objectives were achieved.

However, the literature suggests that L2C interactions require far less research in both F2F and OL learning environments (Xiao, 2017). The critical role of L2C interactions is mostly overshadowed in the interrelationship between L2C, L2L, and L2I interactions (Bannan-Ritland, 2002). Bernard et al. (2009) in a meta-analysis of 74 studies, reported that only 22 studies dedicated to learners' perceptions of interacting with the content were categorized as learner–content interaction. This study goes beyond perception and was dedicated to learners' actual behaviors when interacting with the content.

5.3. Recommendation for Practice

As mentioned in chapter 1, this dissertation ultimate goal is to provide evidence that support instructional designers, learning scientists, and educators in designing and redesigning online and face-to-face courses (i.e., instructional design features) to enhance the quantity and quality of learners interactions. The study's findings, both quantitative and qualitative showed similar quality of instruction in the two formats. However, there were nuances observed, some of which were revealed in the quantified differences of interaction frequency between learners, the instructor and content.

To address these nuances or differences practically, three principal themes are recommended: participation, collaboration, learner autonomy. Within each theme, I will discuss recommendations based on conceptual understanding of the study's findings and additional literature review aimed at elucidating their benefits in increasing learner interaction during active instruction.

The first theme, *Participation*, – discuss interaction behaviors that described learners' active engagement with other learners and the instructor during instruction. *Collaboration* – discuss interaction behaviors that describe learners interacting with the content, especially when working together with other learners in groups. *Learner Autonomy:* – discuss interaction behaviors that describe learners' ability to take control of or initiate their own learning, especially during active instruction.

5.3.1 Participation

Participation during instruction is widely considered a fundamental indicator of the effectiveness of the learning process (Mercer & Dawes, 2014; Simonsmeier et al., 2021) which leads to quality learning outcomes (Tao et al., 2022). When a person engages in active

participation, it fosters critical thinking skills and enhances their intellectual development (Mustapha, 2010). Vonderwell and Zachariah (2005) identified learner roles and instructional tasks as critical factors that influenced patterns of participation during instruction. Learner roles encompass interactions with other learners, the instructor, and the content during open discussions.

5.3.1.1 Open Discussions (ODs)

This study recommends ODs as an effective strategy for facilitating interaction among learners, instructors, and content. This study revealed that the frequency of interaction increased and was consistent between the instructor and the OL learners during open discussions. Learners who participated during open discussions were more likely to participate in collaborative activities. They were also more likely to lead group presentations on behalf of their groups and respond to questions from both the instructor and other learners.

F2F open discussions were not as effective as OL open discussions regarding the frequency of interaction. This was highlighted in results that show F2F learners having less interaction with other learners than OL learners. Such a difference could be due to the instructional strategies employed – dialogic and non-dialogue instructional strategies (Decristan et al., 2023). This was true in the Decristan et al. (2023) study, where they explored the conditions and consequences of classroom participation. They found in the two separated cases (a mathematics and science classrooms) explored that about 41.1% of the 861 learners had to be called on or directly questioned by the instructor in a dialogic teaching style, while 62.1% of the learners raised a hand to answer questions without being called on by the instructor in a non-dialogic teaching style.

In this study, the same instructor taught the F2F and OL delivery formats of the same course. There were equivalent open discussion opportunities across both formats. However, in the F2F session, the instructor asked questions repeatedly, yet there was no response and sometimes a few responses. The non-responsiveness of learners could be a result of logistical issues and learners' confidence (Rocca, 2010). This study did not examine learner confidence, but logistical issues were observed. Unlike F2F learners, OL learners used media technologies – zoom chat features, Google documents, and emails to interact with other learners and the instructor when needed during instruction. Though the study did not examine learner confidence, it became clear that F2F learners demonstrated an unwillingness to participate. For example, the same F2F learners who did not or only passively participated in small groups were the same learners who did not or only passively participated in open discussions. Similarly, OL learners who enthusiastically participated in small groups did the same during open class discussion. In the F2F instruction, the instructor's direct questioning of a specific learner did not appear to be reflected in the observed frequency of interaction. This behavior aligns with suggestions that learners' willingness to participate is associated with their actual participation (Caspi et al. 2006). Thus, learner roles must be clearly defined when the instructional expectations are laid out for open discussions. Learners need to be told if they need to ask questions (how many), make a comment, or critique a work.

5.3.2 Collaboration

Collaboration activities emerged as one of the prime activities wherein the frequency of interaction increased. There are several definitions for collaborative learning. Van Leeuwen and Janssen (2019) characterized collaborative learning as a collective intellectual endeavor aimed at achieving a common objective. When learners collaborate, they enhance their ability to provide

each other with simplified input, engage in negotiation over content meaning, and constructively receive feedback from other learners without fear of individual judgment (García Mayo & Pica, 2000; Sato & Lyster, 2007).

To ensure there are collaborative learning activities during instruction, there needs to be an intentional design that facilitates interactions within a given situation (Dillenbourg, 1999). This situation typically revolves around group activity or collaborative activity that allows individual or collective engagement with the content.

5.3.2.1 Group or Collaborative Activity

During this study, there was an increase in interaction and engagement within both F2F and OL observation sessions during collaborative activities. Learners consistently engaged in activities such as reading content resources, taking notes, reflecting on assigned tasks, and engaging in deep discussions while sharing personal experiences during group interactions. The consistency in behavior patterns is evidenced by similarities in L2C frequency patterns across both formats. Such results underscore the intentionality of the instructional component (i.e., collaborative activities) to produce an equivalent experience across both delivery formats. This study directly observed behaviors in those intentional collaborative activities, and they provided insights about the frequency of behaviors that drive meaningful learning.

Smith and Regan (2004) encouraged instructional designers to be intentional about designing instructional strategies and activities. According to Smith and Regan (2004) instruction '…is the intentional facilitation of learning towards identified learning goals' (pg. 4). Over the observation periods of this study, the instructor was observed intentionally engaging with learners by asking questions, providing feedback, and offering clarification during collaborative activities across both F2F and OL formats. These behaviors are characteristics

associated with successful collaborative learning experiences, including group composition (Lee & Lee, 2016), activity structure (Kapur & Kinzer, 2009), scaffolding availability (Gu et al., 2015), and learner self-efficacy (Wilson & Narayan, 2016). Both formats in this study had an equal number of groups to ensure similarity with group sizes, maintained consistent activity structures, provided instructional guidance, and encouraged learner self-efficacy by allowing learners to take charge of the group project and report accordingly. Thus, intentional collaboration proved vital to increasing the frequency of interaction and, thus, the quality of instruction.

5.3.3 Learner Autonomy

Learner autonomy like other themes discussed above was not specifically studied in this research, however, there are indications from this study's findings that shows learner autonomy may played a role in the frequency of learner interactions. Besides (on section 2.5, page 32), it was noted previously in this study that OL learners valued interaction, especially when their autonomy was encouraged (Caskurlu et al., 2021). Notably, Caskurlu et al. (2021) arrived at this conclusion in a thematic synthesis of 35 qualitative studies in which learners reported satisfaction when they were allowed or given the opportunity to construct their knowledge through (a) interaction (content-related and social); (b) comprehension and reflection; and (c) active participation in collaborative and cooperative activities.

Learner autonomy refers to an individual's ability to assume responsibility for their own learning process (Holec, 1981 as cited in Thanasoulas, 2000). Autonomous learners possess the ability to monitor their learning trajectory and assess their progress (Little, 1991). It is essential to note that learner autonomy does not imply that learners come into learning environments with the knowledge and skills to effectively plan, monitor, and evaluate their learning experiences

(Thanasoulas, 2000). Instead, Palfreyman and Smith (2003) argue that autonomy is a fundamental human right, and empowering learners to take control of their learning enables them to make the most of available resources. Therefore, to enhance learner autonomy, thus interaction during instruction, it is important to ensure and observe that learners demonstrate self-initiation in their learning endeavors (Smith, 2015).

5.3.3.1 Self-Initiation

Self-initiation is one of the many autonomy factors extensively studied, mostly in language learning literature, and has been characterized as learners taking responsibility for their learning and doing so through independent learning activities that suit their interests (Collier, 2022). In general, taking responsibility during instruction or self-initiating means learners setting goals, taking the necessary actions to achieve those goals, and relying on their own abilities to attain them (Collier, 2022). While self-reports typically capture these behaviors prior to instruction, this study suggests that learners can display self-initiation during instruction by demonstrating acknowledgement to reach the desired instructional goals, taking actions during instruction without being prompted or asked, and taking up responsibility during instruction without being prompted or asked.

In this study it was observed that learners who enrolled in the F2F and OL formats mostly attended and remained throughout the observed sessions. Their attendance in class as scheduled and staying throughout each instructional period demonstrated acknowledgment towards achieving the instructional goals.

The study also observed that there were opportunities for all learners to take action during instruction. Those opportunities included reflections after a read-aloud activity, presentations, and critiques of group projects and individual projects. During these activities, nearly all learners

across both formats participated, even at the minimum frequency. Notably, certain learners displayed dominance during group activities by leading the group task, volunteering to present, and becoming increasingly interactive with the instructor and other learners during presentations. However, the dominance of these learners differs for each format. For example, F2F learners who were observed initiating interactions with other learners during small group activities were the same as those who initiated interactions with the instructor and other learners during presentations. OL learners who enthusiastically initiated interactions in small groups did not appear to do the same during presentations.

Regarding learners taking responsibility during instruction, the study observed that the same learners who dominated collaborative activities mostly did the same during open discussions. Nevertheless, learners in both F2F and OL delivery formats had the chance to demonstrate taking responsibility when they presented their individual projects and resolved technical issues independently when necessary. This suggests that learners are capable of taking charge of their own learning when instructional components are intentionally structured to facilitate such behavior.

5.4. Limitations of the study

The research design for this dissertation study is crafted as a comparative case study using the convergent mixed method. This design can function in two ways: as a mixed-methods design that uses a case study for the qualitative component and as a case study design that uses mixed methods by collecting, analyzing, and integrating qualitative and quantitative data for interpretation (Guetterman & Fetters, 2018). The latter was employed in this dissertation study and described as a multiple-case convergent mixed-methods design. The multiple case study part is because the data came from two cases, and the convergent mixed method part demonstrates

how I collected and integrated data from these two cases for a more complete understanding of the quality of instruction.

Nonetheless, it is not easy to follow the logic of a multiple-case study with a convergent mixed-methods design. First, it must be established that each case meets the required selection criteria, which leads to a better understanding of the phenomenon. Second, the data collection instrument must be adaptable to guide the data collection process based on the study's conceptual framework. Lastly, there may be data collected or not collected that is relevant to the conceptual framework, and justifying its inclusion and exclusion can be challenging.

In general, the decision to use a comparative case study design with a mixed-methods approach provided findings that answered the research questions. Most importantly, these findings inform the improvement of instructional and learning experiences, which leads to quality instruction. However, there are a few limitations to this study.

The first limitation is the generalization of the findings to a broader population. Case studies, in particular, are often focused on specific contexts, making it difficult to generalize findings. In addition, differences in the number of learners enrolled in each format pose challenges for generalization. On the other hand, the study relied on tallies and descriptions of interaction behaviors, not the learners themselves, so the number of learners enrolled in each format was not necessarily relevant to understanding the phenomenon in this context.

By using a mixed-methods approach, these challenges were mitigated by focusing solely on the quantitative data and then using qualitative data to describe behaviors that provided meaningful interpretation for the quantitative data. Even with such mitigation' strategies, there may be risk of generalization considering specificity of the study's context and an unequal sample size, which is a result of unequal enrollment. As a result, this study offers a caveat when

interpreting the findings; thus, replicating studies with equivalent enrollment could address this limitation in the future.

The second limitation is the study's focus on specific behaviors' characteristics, thereby not capturing those that could have influenced learner interactions during instruction. The rationale, purpose, and design of the study, coupled with the structural nature of the data collection instrument, did not include learner characteristics like prior knowledge (Simonsmeier et al., 2021), gender and group size (Tenenbaum et al., 2020). Details about these characteristics could provide an understanding of non-observable factors that influence the frequency of learner interactions. However, studies show that these characteristics are usually captured before or after the instruction to inform instructional strategy decisions. This dissertation study focused on behaviors during instruction rather than behaviors before or after instruction.

The aforementioned limitations are largely due to the intentional design of this dissertation study. The adoption of a comparative case study research design coupled with a mixed-methods approach to data collection, analysis, and interpretation, along with the utilization of a structured instrument, was intentional and aimed to provide a comprehensive understanding of the research phenomenon. Regardless of these limitations, it is essential to note that they did not compromise the validity and trustworthiness of these research findings.

This dissertation study thoroughly followed the principles of the chosen research design, ensuring that the results offered deep insights into the complexities of learner interactions within and between two instructional delivery formats of the same course taught by the same instructor. By adhering to the established research design, the study was able to uncover nuanced patterns in instructional and learning experiences across both instructional formats. Such nuanced patterns

highlight the quality of instruction based on the frequency and descriptions of observable reciprocal relationships between the learners, the instructor, and the content.

However, it is imperative to also acknowledge the validity of these limitations and recognize the necessity of addressing them in future research endeavors. The intentional nature of the research design has facilitated a thorough exploration of research questions, but acknowledgeably, there remains a need for further understanding of learner interaction behaviors during instruction. As such, these limitations serve as valuable pointers for future research directions, highlighting areas where additional investigations can have relevant impacts.

5.5. Recommendations for future research

Based on this study's trajectory, three recommendations for future research are proposed: a replication study, formative research, and video recording as a data collection technique. Before providing details on these recommendations, it is essential to note that this study employed a naturalistic observation approach utilizing an unobtrusive observation technique that allowed direct access to research settings while minimizing variable manipulation. Additionally, it utilized a comparative case-based research design and a mixed-methods data collection, analysis, and interpretation approach. All of which provided a deeper understanding of the complexity of learners' interactions within and between the two cases.

As mentioned, the first recommendation is to replicate this study. A replication of this study may further enhance the reliability and external validity of the research design and methodology. This study rigorously followed the comparative case study mixed-methods research design, so anyone interested in transferring this approach has a solid framework for comparison. Particularly, transferability will strengthen the external validity when this design is employed in diverse content areas across the learning environments (Creswell & Creswell 2018).

In addition, replicating this design in other contexts would expand the scope of cases and provide insights into specific instructional design assumptions across various content areas.

The second recommendation is to have future research utilize the summative findings of this study to inform formative research endeavors. This study unpacked the complexity of learning experiences that influenced the quality of instruction. To accomplish this outcome, this study tracked interactions and behaviors by tallying their occurrences and describing accompanying characteristics in real-time, then providing a detailed understanding of those experiences that influenced instructional quality. Future research could use such summative findings to inform formative research endeavors. Reigeluth (1989) suggests that the outcomes of a formative research approach could be used to enhance the knowledge base for instructional practices. Reigeluth and Frick (2013) refer to formative research as "action research that is intended to improve design theory for designing instructional practices or processes" (pg. 1). By conducting formative research based on this study, future researchers may explore generalized design interventions that predict specific quantities and qualities of learner interactions during instruction. Findings may then be instrumental in designing instructional practices and processes that provide equivalent learning experiences in both F2F and OL instructional delivery formats.

Lastly, future research may consider employing video recording as a data collection technique to address the challenges of missing data encountered with the current use of a naturalistic observation approach. Video recordings are an excellent source of data that can be used to evaluate behaviors that occur in real-time. In fact, it is widely used in medical education research (Truong, et al., 2022) and special education research (Jasper, et al., 2015) where video recording has proven effective in assessing adherence to procedures and determining the effectiveness of interventions, respectively. This study suggests that capturing learners'

interactions and behaviors through video recordings can provide valuable insights into adherence to instructional strategies and behavior outcomes that align with intentional instructional design.

5.6. Conclusion

The dissertation study utilized a comparative case study (CSS) with mixed methods (Misra-Hebert et al., 2018; Sakata et al., 2021; Yin, 2013). By employing this design, data were collected simultaneously, analyzed separately, and convergently interpreted comparatively between two cases, allowing for a comprehensive examination of learner interactions and their influence on the quality of instruction.

Based on the literature review, the study found a methodology gap, which specifies the need for a detailed approach to unpacking the complexity of learner interaction during instruction. The Behavioral Observation Checklist (Koszalka & Whorway, 2024) presented a unique opportunity to explore this complexity by gathering data from multiple sources, or in this study's context, two cases (Yin, 2013). Quantitative and qualitative data were collected for each case across five instructional periods, providing rich empirical insights into learner interaction during instruction.

The analysis of the empirical data revealed interesting findings. Specifically, the study identified similarities in the frequencies of the L2L, L2I and L2C types of interaction across face-to-face (F2F) and online (OL) formats. There were variations in the frequency of interaction across both formats per type of interaction, but they were not statistically significant except for the L2C type of interaction. Overall, statistically, the quality of instruction for one instructional format was not better or worse than the other by measuring learner interaction during instruction.

However, variations, especially for the L2C type of interaction, need to be addressed by instructional solutions that are informed by design principles, a framework, and the

recommendations for practice that this study proposes. This study has shed light on the need to unpack and constrain the probability of variations that influence the quality of instruction, especially L2C interaction. Furthermore, this demonstration of a robust observation approach to examining the influence of learner interactions on the quality of instruction is empirical evidence that aligns with previous scholars calling for a better way to examine learner interactions (Bernard et al., 2004).

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Appendix A: IRB Letter

Syracuse University

INSTITUTIONAL REVIEW BOARD
MEMORANDUM

TO: Tiffany Koszalka, D. Garmondyu Whorway
DATE: August 23, 2023
SUBJECT: IRB Review Not Required
IRB#: 23-281
TITLE: *Behavioral Observations of Learner Interactions*

It has been determined by the Office of Research Integrity and Protections that the information submitted pertaining to the above referenced protocol does not meet the definition of human subjects research ("a systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge involving any intervention or interaction with a living individual about whom an investigator conducting research obtains data through an intervention or interaction, or identifiable private information.") and does not require IRB oversight for the following reason/s:

Not Human Subjects Research – Data involves tally of interactions that does not include any information about individuals.

Should there be any change in the nature of the activity originally proposed (e.g., testing results used for research purposes), a new protocol application specific to these changes must be submitted. Thank you for your cooperation in our shared efforts to assure that the rights and welfare of people participating in research are protected.

Sincerely,

Tracy Cromp,
Director
Office of Research Integrity and Protections

Appendix B: Modified Behavioral Observation Checklist

Learner Interaction: Behavioral Observation Checklist (BOC)

Course:	Session duration:	No. of learners:	Observer:	Date: Time:

Complete one form for EACH observation. Be sure to record start and end times for each observation period.

Primary Delivery: ☐ face-to-face ☐ live digital synchronous-hyflex ☐ asynchronous (text/ chat)		
(Check all that apply) ☐ blended synchronous/ asynchronous ☐ Other (describe):		
Observations were for ____ minutes	observation start time: _____	observation end time: _____

Typically, observations will be for 3 to 5 minutes plus 5 minutes to take brief fieldnotes immediately after observation.

NOTE: Place a tally mark [𝍸 ||] in the correct table cell below for each time a specified behavior is observed within an observation time period. Approximately 3 observational periods during each 30 minutes, allowing for observational time plus fieldnote time.

Observation	*Interaction Description*	*Tally -- 𝍸 ||*
11. Instructor presents content to learners	***state/ demonstrate; describe*** examples/ expectations	
9. Instructor asks learners questions	***pose*** questions, examples, or scenarios for response	
12. Instructor gives learners directions, e.g., activity	***state/show/demonstrate; describe*** materials/ expectations/ deliverables	
10. Instructor responds to learner questions and comments	***state*** answers; ***agree*** or ***disagree; share*** story/ experience; ***share*** examples; **elaborate**; ***praise*** or ***critique***	
4. Learner responds or comments on instructor questions	***state*** answers, ***repeat***, ***agree*** or ***disagree***, ***share*** story/ experience, shares or ***add*** examples/ experiences, **ask** clarifying/ follow-up questions, ***praise*** or ***critique***	
3. Learner asks instructor question	***pose*** questions, examples, or scenarios, ***seek*** clarification; ***ask*** for verification or critique; ***request*** feedback, directions	

Brief Notes on Tallies for items above: ***Average percentage of LEARNERS involved in these interactions, during this time period? ____%***

Observation	*Interaction Description*	*Tally -- 𝍸 ||*
1. Learner prompts other learners to participate	***ask*** questions or for clarifications/ examples; ***encourage*** others, ***re-ask*** questions to others, ***request*** peers to answer questions	
2. Learner responds or comments on other learner questions or prompts (Class or small group activities)	***state*** answers, ***repeat***, ***agree*** or ***disagree***, ***share*** story/ experience, shares or ***add*** examples/ experiences, **ask** clarifying/ follow-up questions, ***praise*** or ***critique***	
5. Learner responds to or asks questions on instructor directions	**ask** clarifying/ follow-up questions about directions; ***repeat***; ***request*** feedback, ***confirm*** interpretations	
6. Learner performs task (individual or group)	***study, interact, describe/ share/ discuss/ verbally critique*** own work and/or tasks with others	
7. Learner interacts with resources (digital, non-digital, physical) to perform task	***discuss*** content in resource with others; ***critique*** content; ***describe*** content	
8. Learner completes task	***verbally present/ showcase/ describe*** task outcome; ***verbally reflects*** on task outcome	

Brief Notes on Tallies for items above: ***Average percentage of LEARNERS involved in these interactions, during this time period? ____%***

After observation period fieldnotes: Please summarize ALL OBSERVATIONS and describe entire event, rationale for tallies, other factors that may have been related to tallied level of interaction including specific activities that seem to influence the level of interaction, specific learning resources used by instructor and learners, any other comments about this period of observation that will help interpret level of interaction.

Vita

D. GARMONDYU WHORWAY

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DEGREE IN PROGRESS
PhD Candidate, Syracuse University (SU), Syracuse, NY *August 2019 - Present*
Doctor of Philosophy Candidate in Instructional Design, Development & Evaluation (IDD&E)

DEGREE AWARDED
Master of Science, Syracuse University (SU), Syracuse, NY *January 2018 – May 2019*
Master of Science in Instructional Design, Development & Evaluation (IDD&E)
Bachelor of Science, Carver Christian University, Liberia *August 2006 – December 2013*
Bachelor of Science Christian Education (emphasis Education Administration)

CERTIFICATIONS
Articulate Storyline 360: Advanced Elearning, *LinkedIn* – January 2024
Learning Articulate Rise, *LinkedIn* – January 2024
Advanced Google Analytics 4 (GA4), *LinkedIn* – September 2022
Brightspace D2L, *LinkedIn* – July 2022
Artificial Intelligence Foundations, *LinkedIn* – November 2021
Canvas, *LinkedIn* – March 2021
Moodle 3.9, *LinkedIn* – February 2021

TEACHING & RESEARCH EXPERIENCES
Graduate Teaching Assistant, Teaching & Leadership Department, School of Education, SU *Aug. 2022 - Present*

- Assist to develop the course 366/640 Safe and Healthy Learning Environments (three sessions)
- Organize instructional materials and equipments for daily teaching.
- Moderate instructional activities, including organizing learners into groups for learning activities.
- Maintain class record, including daily attendance and grade calculation for each learning activities.

Graduate Research Assistant, Dean's Office, School of Education, SU *August 2019 - May 2022*

- Assist to create organize content for the Office of Research and Grants Administration website project.
- Assist to develop the course FYS.101-First Year Experience via Blackboard
- Assist to develop the course CFE.600-Ed Equity/Ethics: Pandemic via Blackboard
- Contacted and submitted manuscripts to peer reviewers for Excelsior Journal online portal.
- Assisted with the Fulbright DAI Program Grant as directed by the Principal Investigator (PI) and Co-PI

Graduate Research Assistant, Lawrence B. Taishoff Center, SU *August 2018 – May 2019*

- Built a student demographic data repository using Microsoft Excel for faculty use.
- Created grant repository for faculty interested in applying for external and internal grants.
- Assist other graduate assistants providing weekly support and additional instructional services to students.
- Taught communication skills as an extracurricular course to students once every week

Teacher, Ministry of Education**,** Paynesville, Liberia *January 2012 - November 2017*

- Taught Social Studies to 5th graders for three years at Morris Farm Public School
- Taught Literature to high schoolers at Wein Town Public School for three years

RESEARCH PUBLICATIONS

Koszalka, T. A., & Whorway, D. G. (2024). Development and Validation of a Learner Interactions Behavioral Observation Checklist (BOC). *American Journal of Distance Education*, 1–19. https://doi.org/10.1080/08923647.2024.2303334

Whorway, G. & Koszalka, T. A. (2024). Development and Validation of a Learner Interactions Behavioral Observation Checklist (BOC). Proceedings of the Annual AECT Convention, 2023. The Journal of Applied Instructional Design, 13(2). https://dx.doi.org/10.59668/1269.15635

RESEARCH PRESENTATIONS

Whorway, Garmondyu (May 12, 2024) Comparing Equivalent Face-to-Face [F2F] and Online [OL] Instruction: Observations of Learner Interactions to determine instructional quality. *Examinations of Teaching and Learning From Pre-School to Graduate School Roundtable Session*. American Education Research Association Annual Meeting, Philadelphia, Pennsylvania.

Whorway, Garmondyu D & Koszalka, Tiffany A. (October 15-19, 2023) Development and Validation of an Observation Checklist to examine Interactions in Face-to-face and Online Instruction. *Learning Analytics Concurrent Session*. Association for Education Communications & Technology (AECT), Orlando, Florida

Whorway, Garmondyu (2019). INTL: Case Studies on The Role of ICT Development And Implementation In Education, AECT 2019 conference in Nevada, Las Vegas

Whorway, G. (April 2019). ICT in Education for underdeveloped countries: A case study on Liberia. 51st Annual Liberian Studies Association Conference, Concordia University, Chicago, Illinois

ACHIEVEMENTS

2020 - National Association of Graduate-Professional Students - Graduate Professional Student Leader - USA
2019/23 - Graduate Students Organization Conference Travel Grant
2019 - Instructional Design Award
2019/23 - School of Education (SOE) Conference Grant
2018/23 - Graduate Student Travel Award

LEADERSHIP

Editor, IDD&E Department Newsletters/Syracuse University *January 2019 - May 2021*

- Led publications of three annual newsletters

Interim President, African Graduate Student Network/Syracuse University *August 2019 - May 2020*

- Founded, registered, and led African Graduate Student Network to its first election.

Peer Mentor, School of Education/Syracuse University *August 2019 - May 2020*

- Welcomed and helped new students navigate and access campus resources.

ADDITIONAL INFORMATION

Member American Education Research Association (AERA)
Member of the Association for Educational Communications & Technology (AECT)
Member of "PHI BETA DELTA" honorary society for International Education
Professional and Organizational Development Network in Higher Education