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Establishing Teaching Presence in Higher Education Online Mathematics Courses: A Phenomenological Study

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Establishing Teaching Presence in Higher Education Online Mathematics Courses: A Phenomenological Study

by
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Approval Page

This applied dissertation was submitted by Deltrye Eagle Holt under the direction of the persons listed below. It was submitted to the Abraham S. Fischler College of Education and School of Criminal Justice and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

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Statement of Original Work

I declare the following:

I have read the Code of Student Conduct and Academic Responsibility as described in the *Student Handbook* of Nova Southeastern University. This applied dissertation represents my original work, except where I have acknowledged the ideas, words, or material of other authors.

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Abstract

Establishing Teaching Presence in Higher Education Online Mathematics Courses: A Phenomenological Study. Deltrye Eagle Holt, 2020: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education and School of Criminal Justice. Keywords: Community of Inquiry (CoI), higher education, mathematics, online, phenomenology, teaching presence

The purpose of this phenomenological study was to describe, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. Teaching presence, which is one of the three core elements of the community of inquiry (CoI) framework, is necessary for achieving learning outcomes and student satisfaction. The three main research questions were:

1. How do mathematics instructors establish teaching presence in online higher education mathematics courses?
2. How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?
3. What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?

The participants for this study were employed by a public university system at the time of the study. The criteria for participation were:

a) The participants must have experienced the phenomenon of establishing teaching presence in higher education face-to-face mathematics courses.
b) The participants must have experienced the phenomenon of establishing teaching presence in higher education online mathematics courses.
c) The participants must have the ability to explain their everyday conscious experiences when establishing teaching presence.

Data for this study were collected from face-to-face and online mathematics course syllabi and in-depth, semi-structured interviews. The interview data were subjected to a phenomenological analysis, and the syllabi were subjected to a content analysis.

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Chapter 1: Introduction

Statement of the Problem

A mathematics instructor searching the literature for information on teaching and designing online mathematics courses will find a wealth of information pertaining to best practices, strategies, and standards for online education; however, information specific to designing and teaching online mathematics courses is scarce (Engelbrecht & Harding, 2005; Juan, Huertas, Trenholm, & Steegmann, 2012). This scarcity includes information on teaching presence, which is necessary for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush, Castelli, Lowry, & Cole, 2010). To fill a gap in the literature, this phenomenological study documents the process by which teaching presence is established in higher education online mathematics courses.

Teaching presence is one of the three core elements of the community of inquiry (CoI) framework, which was developed by D. Randy Garrison, Terry Anderson, and Walter Archer to fill a gap in distance education theory (Garrison, Anderson, & Archer, 2000). The CoI framework provides order and a methodology for distance education research (Garrison, Anderson, & Archer, 2010; Kineshanko, 2016). Garrison et al. (2010) explains that the CoI framework provides the theoretical foundation for the CoI survey instrument (see Appendix F), which has enabled a wide range of empirical studies that otherwise could not have been conducted qualitatively. Kineshanko (2016) conducted a thematic analysis of CoI research from 2000 to 2014 and discovered that the CoI framework, terminology, and concepts were continuously being adopted independent of the technology being used. The themes emerging from the analysis were *used to measure, used to describe*, *used as a treatment*, and *validation or extension of the framework.*

Google Scholar (n.d.) reported that Garrison et al.'s (2000) seminal article had been cited 6035 times as of June 24, 2020.

Phenomenon of Interest. Teaching presence pertains to course design and facilitation of learning (Garrison et al., 2000) and is essential for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010). Facilitating learning can be performed by both the instructor and students; however, designing the course is commonly accomplished by the instructor (Garrison et al., 2000). "Teaching presence is not possible without the expertise of a pedagogically experienced and knowledgeable teacher who can identify worthwhile content, organize learning activities, guide the discourse, offer additional sources of information, diagnose misconceptions, and provide conceptual order when required" (Garrison, 2017, p. 76).

Teaching presence supports cognitive presence and social presence. The relationships between the presences can be illustrated by a Venn diagram (Garrison et al., 2000), as shown in Figure 1. Teaching presence and social presence intersect to create the climate for the educational experience. Teaching presence and cognitive presence intersect to select content for the educational experience. Social presence and cognitive presence intersect to support discourse for the educational experience. Most importantly, the three presences intersect to form the educational experience.

Garrison (2017) suggests that designing and organizing an online course is initially more challenging than designing and organizing a similar face-to-face to course. First, instructors must use technology for teaching and learning in a manner that maximizes the potential of online learning. Second, the architecture and entire content for an online course must be determined before the course begins. Finally, designing the

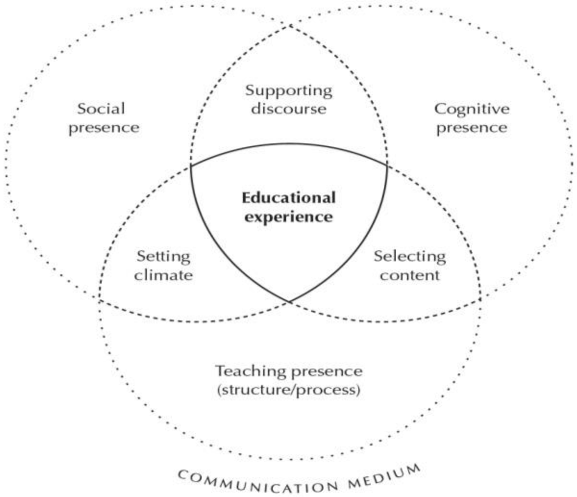

Figure 1. Community of Inquiry: Elements of an Educational Experience (Garrison et al., 2000, p. 88).

online course may be a major task for instructors who have only delivered content by lecturing.

Furthermore, Anderson, Rourke, Garrison, and Archer (2001) note that designing and organizing an online course is initially more extensive and time-consuming than designing and organizing a similar face-to-face course. In most cases, an instructor plans an online course thoroughly because colleagues and administrators may have access to the course. Also, when an instructor designs an online course, the instructor is forced to think through the processes of teaching and learning related to the course, as well as the structure, evaluation, and interaction between components of the course. In addition, the instructor is forced to be transparent and detailed; teaching and learning online requires a different skill set than those required for face-to-face teaching and learning.

Garrison (2017) notes that facilitating discourse—that is, managing and monitoring discourse—in an online learning environment is at least as important as facilitating discourse in a face-to-face environment. When an instructor facilitates reflection and discourse in order for students to build understanding, the instructor affects the learning experience. Students are enabled to construct personal meaning, as well as collaborate with peers to develop mutual understanding.

Indicators of teaching presence can be divided into three categories: (a) instructional management, (b) building understanding, and (c) direct instruction (Garrison et al., 2000). The category of instructional management includes selecting curriculum, designing methods and assessment, establishing due dates and the flow of the course, and navigating the learning environment (Garrison et al., 2000).

The category of building understanding refers to transferring valid knowledge through discourse. The process of building understanding enables the community to develop an effective group consciousness by sharing meaning, identifying areas of agreement and disagreement, and seeking to reach consensus and understanding (Garrison et al., 2000).

The category of direct instruction refers to the teacher presenting content, engaging students with questions and answers, assessing learning outcomes, and providing constructive feedback (Garrison et al., 2000). Direct instruction enables the instructor to provide intellectual and scholarly leadership and engage students by sharing subject matter knowledge (Anderson et al., 2001).

Indicators of social presence can be divided into three categories: emotional expression, open communication, and group cohesion (Garrison et al., 2000). In the context of a learning environment, emotional expression refers to ability and confidence with regards to expressing feelings pertaining to the educational experience. Emotional expression coexists with task motivation and persistence. Open communication refers to acknowledging the comments of others and responding to comments in a respectful manner. Group cohesion involves building and sustaining the group.

Cognitive presence is based on the practical inquiry (PI) model (Garrison et al., 2000). This model is a recursive, two-dimensional process. The deliberation-action dimension is represented along the vertical axis, and the perception-conception dimension is represented along the horizontal axis. According to Garrison and Vaughn (2008), the PI model has four phases: (a) triggering event, (b) exploration, (c) integration, and (d) resolution. These four phases are the categories for indicators of cognitive presence (Garrison et al., 2000).

Background and justification. A study of teaching presence—course design and facilitation of learning (Garrison et al., 2000)—is relevant for instructors who teach online courses. Teaching online requires instructors to adapt to an environment where the primary technology for communication and instruction is the Internet (Ko & Rossen, 2010). In addition, teaching online requires a change in how instructors understand their work as teachers (Major, 2015).

Teaching presence is necessary for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010). It is one of the three presences comprising the CoI framework; the other two presences are social presence and cognitive presence (Garrison et al., 2000). Note that the CoI is descriptive and does not explain how to establish teaching presence (Dunlap, Verma, & Johnson, 2016).

Teaching presence is also important because of its role in supporting cognitive and social presences (Garrison & Akyol, 2013). In a study conducted by Bush et al. (2010), participants who reported satisfaction with both the course and knowledge acquired also reported perceiving high levels of teaching presence. Similarly, participants who were strongly dissatisfied with the course and knowledge acquired reported perceiving low teaching presence.

When the researcher for the present study began teaching online higher education mathematics courses, she had no prior knowledge of establishing teaching presence in online courses. She taught an online higher education mathematics course for the first time after having taught face-to-face higher education mathematics courses for 17 years. The researcher found teaching online for the first time to be challenging, intimidating, and fulfilling. She knew what it was like to learn mathematics face-to-face; however, she had no idea of what it was like to learn mathematics, or any subject, online. Therefore, she was concerned with how she would help her students learn mathematics online. The researcher knew how to adjust face-to-face instruction based on students' body language and facial cues; she was concerned with how she would know what adjustments were needed in the absence of these cues. Also, teaching mathematics face-to-face involves guiding students while they engage in problem-solving activities and mathematical dialog. The researcher questioned how she would replicate these activities online. To assist her with designing and facilitating her online mathematics course, the researcher elicited assistance from an instructional technologist on the staff at her university.

Over time, the researcher has studied distance education theories, becoming better equipped to address concerns related to establishing teaching presence in online mathematics courses. Therefore, relating to establishing teaching presence in online courses, the researcher is biased toward pedagogy that aligns with distance education theory, standards, best practices, and strategies. However, she was willing to consider effective pedagogy that had not been discussed by experts in distance education because a careful search of the literature produced very little information about how mathematics instructors establish teaching presence in online courses.

To fill a gap in the literature, this study documented the process by which teaching presence is established in higher education online mathematics courses. In addition, this study compared the lived experiences of mathematics instructors establishing teaching presence in higher education online mathematics courses versus establishing teaching presence in higher education face-to-face mathematics courses. Data were gathered from in-depth, semi-structered interviews and course syllabi.

When conducting a phenomenological study, the researcher is "interested in trying to slow down and open up how things are experienced" (Vagle, 2016, p. 22). Therefore, a university system was chosen as the setting for studying the phenomenon of establishing teaching presence in online higher education mathematics courses. The university system chosen offers both online and face-to-face mathematics courses. This university system is composed of 26 public academic institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges—an archives, and a public library service. The participants for this study have experienced establishing teaching presence both online and face-to-face at a research institution, comprehensive university, state university, or state college within the university system.

Deficiencies in the evidence. According to Engelbrecht and Harding (2005), "pedagogy for driving online courses in mathematics is still only in its development phase" (p. 253). Seven years later, Juan et al. (2012) said, "there remains a dearth of research to inform best practices specific to the disciplinary particularities of

Mathematics e-learning in higher education" (p. x). In 2016, Appelbaum, Ingrassia, and Langsdorf (2016) explained that many math teachers have not participated in teaching or learning mathematics in an online environment. Furthermore, Akyol & Garrison (2008), Coll, Engle, & Bustos (2009), and Shea, Hayes, & Vickers (2010) explain that studies on teaching presence have not considered entire courses but mainly focused on gathering data from discussion boards.

Audience. The audience for this study includes mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators. First, mathematics instructors and mathematics educators, who are actively involved in professional mathematics organizations, validate and distribute best practices, strategies, and standards for teaching mathematics (MAA, 2018; NCTM, 2018). Second, mathematics educators teach preservice teachers how to teach mathematics in order to achieve learning outcomes. Therefore, mathematics educators will gain insight into how to provide an online learning experience in mathematics education courses that their students can emulate when teaching mathematics online. Third, mathematics instructors will gain insight into designing and facilitating higher education online mathematics courses that are equivalent (Simonson, Schlosser, & Hanson, 1999) to the same courses offered in a face-to-face format in terms of achieving learning outcomes. Furthermore, when a course is designed effectively, instruction will be effective (Simonson & Schlosser, 2009). Fourth, instructional designers are trained in best practices and standards for teaching online (Pennsylvania State University, 2018); however, this study will inform instructional designers of the process by which mathematics instructors establish teaching in online mathematics courses. Therefore, instructional designers will be better equipped to fulfill their primary responsibility of designing instruction (Morrison, Ross, Kalman, & Kemp, 2013). Finally, higher education policy makers and higher education administrators will gain a more complete understanding of the training, technologies, and infrastructure needed for higher education mathematics instructors to establish teaching presence in higher education online mathematics courses. This study will equip them to make informed decisions regarding online education policy and funding (Simonson et al., 1999).

Definition of Terms

The following are terms relevant to this study.

Best practices most often refer to “a set of documented strategies, procedures, or methods employed by highly successful organizations to effectively achieve results in particular circumstances” (Orellana & Hudgins, p. ix, 2009).

Consciousness was viewed by Husserl as a whole that was made of parts such as perceptions, emotions, memories, and sensations (Belousov, 2016).

In a *culture of inquiry*, learners share in the responsibility for their learning. These learners share in acquiring and disseminating knowledge, as well as assessing learning (Harasim, 2012).

Distance education is “teaching and planned learning in which teaching normally occurs in a different place from learning, requiring communication through technologies as well as special institutional organization” (Moore & Kearsley, 2012, p. 2).

E-Learning occurs when a student interacts with electronic media—such as videodisc, compact disc, videotapes, audiotapes, etc.—to learn a skill or topic (Schlosser & Simonson, 2006).

Learning outcomes are what the learner should learn after receiving instruction (Allen, 2006). Learning outcomes are observable, measurable behaviors (Simonson, Smaldino, Albright, & Zvacek, 2012). Learning outcomes are the foundation for curriculum development, review, and assessment (Allen, 2006).

Mathematics is “the group of sciences (including arithmetic, geometry, algebra, calculus, etc.) dealing with quantities, magnitudes, and forms, and their relationships, attributes, etc., by the use of numbers and symbols” (Agnes & Guralnik, 2001, p. 887).

Online learning is “the use of online communication networks for educational applications, such as: course delivery and support of educational projects, research, access to resources and group collaboration” (Harasim, 2012, p. 27). Therefore, online learning can occur synchronously and asynchronously. According to Harasim, online learning emerged during the late 1970s and early 1980s, and became increasingly accepted, adopted, and mainstreamed during the mid-1990s.

Phenomenology is described by Husserl (1965) as the “science of science” (p. 23) because (a) phenomenology explores the essence of objects that provide the foundations for other sciences and (b) the other sciences fail to explore these objects at the same level of detail. Furthermore, Husserl (1981) described phenomenology as the “science of consciousness” (p. 12).

According to Patočka (1996), Husserl viewed a phenomenon as “the entire lived experience of perceiving with all of its components,” “the object which appears in lived experience with all its qualities, moments, and relations,” and “the component of my lived experience…that serves as the pivot of my apprehension in its orientation to the object” (p. 62).

Purpose of the Study

The purpose of this phenomenological study was to describe, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. Teaching presence pertains to course design and facilitation of learning (Garrison et al., 2000) and is essential for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010). The participants for this study were selected from mathematics teaching faculty employed by a public university system and who have taught both face-to-face and online mathematics courses. This university system is composed of 26 academic institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges—an archives, and a public library service.

Summary

There is a paucity of information on teaching mathematics online; therefore, studies on establishing teaching presence in mathematics courses are scarce. To further complicate this issue, pedagogy informing strategies, best practices, and standards for online mathematics courses is in a stage of infancy (Engelbrecht & Harding, 2005; Juan et al., 2012), and many math teachers have not participated in teaching or learning mathematics in an online environment (Appelbaum et al., 2016).

This study filled a gap in the literature by documenting the process by which teaching presence is established in higher education online mathematics courses. Data were gathered from a phenomenological analysis of semi-structured interviews and a content analysis of course syllabi. This study was justified because teaching presence, as described by the CoI framework, is necessary for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010). The audience for this study includes mathematics educators, mathematics instructors, instructional designers, policy makers, and administrators.

Chapter 2: Literature Review

This literature review is divided into six sections. The first section contains an overview of five generations of distance education, as well as a description of its history. The second section contains an overview of distance education theory. The third section contains a discussion of the CoI framework and related research pertaining to teaching presence. The fourth section contains an overview of online education and a discussion of faculty's motivation to participate in distance education. In the fifth section, teaching and learning mathematics online is discussed. The final section contains information regarding course syllabi with emphasis on online and learning-centered syllabi.

History of Distance Education in US Higher Education

Generations of distance education in US higher education. For Moore and Kearsley (2012), distance education can be divided into five generations. Each generation is based on a dominant communication technology of the era (Moore & Kearsley, 2012).

Correspondence study, which dates to the late 1800s in the United States (Saba, 2003), comprised the first generation of distance education (Moore & Kearsley, 2012). The United States postal system was the communication technology used by teachers and students to exchange information and instructional materials (Caruth & Caruth, 2013; Moore & Kearsley, 2012). One of the first correspondence schools in the US was established by the Society to Encourage Studies at Home, which was based in Boston and founded by Anna Eliot Ticknor in 1873 (Simonson et al., 2012). The first college-level distance education program was developed in 1892 by the University of Chicago (Casey, 2008).

The second generation, which was characterized by broadcasting technologies, began in the 1920s (Moore & Kearsley, 2012). During this generation, instruction was delivered by radio and, later, by television (Moore & Kearsley, 2012). The Federal Communications Commission (FCC) granted educational radio licenses to more than 200 colleges between 1918 and 1946 (Casey, 2008). The University of Salt Lake City, the University of Wisconsin, and the University of Minnesota were the first universities to receive licenses.

Educational television began in 1934 (Moore & Kearsley, 2012). During this year, the University of Iowa began delivering instruction by television (Moore & Kearsley, 2012). The 1950s era marked the beginning of Johns Hopkins University's Continental Classroom being televised by a commercial station.

The FCC also created a band of 20 television channels in 1963—the Instructional Television Fixed Service (ITFS)—for universities to broadcast courses (Casey, 2008). The ITFS was an inexpensive, limited-range subscriber-based system. To receive transmissions, educational institutions were only required to purchase an antenna (Moore & Kearsley, 2012).

The third generation, which occurred during the late 1960s and early 1970s, was based on a systems approach (Moore & Kearsley, 2012). During this period in time, new instructional techniques and new instructional theories emerged as a result of several experiments that reorganized human and technology resources. According to Moore and Kearsley (2012), the University of Wisconsin's Articulated Instructional Media (AIM) Project and Great Britain's Open University were the two most important experiments during the third generation. The AIM Project was created in 1964 by the University of Wisconsin, Madison (Casey, 2008), funded by the Carnegie Cooperation from 1964 to

1968 (Moore & Kearsley, 2012), and directed by Charles Wedemeyer (Moore & Kearsley, 2012). The purpose of the project was to "test the idea of joining (i.e., articulating) various communication technologies, with the aim of delivering high-quality and low-cost teaching to off-campus students" (Casey, 2008, p. 32). The AIM Project provided the foundation for the design and development of the British Open University, which was established in 1969 (Casey, 2008).

The fourth generation, which began in the 1980s, was characterized by teleconferencing (Moore & Kearsley, 2012). The first type of teleconferencing was audio-conferencing, which enabled teachers and students to engage in synchronous communication via telephone or technology allowing groups of individuals to interact using a speaker and microphone. The University of Wisconsin was the first university to house an audio-conference system, a product of the AIM Project.

The launching of ATS-6 in 1974 made it possible to use satellite communications for education (Moore & Kearsley, 2012). The University of Alaska was one of the first universities to deliver courses via satellite. In the beginning, satellite services had two disadvantages: (a) low power and (b) costly equipment. These issues were resolved when satellite television systems became cost-effective in the 1980s (Casey, 2008) and the Direct Broadcast Satellite made it possible to deliver educational programs directly to homes and schools in the 1990s (Moore & Kearsley, 2012).

The fifth generation, which also began in the 1980s, is characterized by computer-based and Internet-based instruction (Moore & Kearsley, 2012). The invention of the Intel microprocessor in 1971 and the availability of the first personal computer in 1975 made computer-based instruction less difficult to develop and more accessible in the

1980s. Over time, computer-based instruction evolved. The availability of Mosaic, the first web browser, in 1993 enabled universities to offer web-based learning via the Internet.

Distance Education Theory

Saba (2003) explains that the United States has not approached distance education based on theory, but on pragmatism. Theory is important because it provides “a shared perspective for those who have studied it, as well as a common vocabulary for discussing, analyzing, or criticizing it” (Moore & Kearsley, 2012, p. 205). Europeans, Australians, and Canadians have primarily conceptualized and developed distance education theories (Saba, 2003). Black (2007) credits Börje Holmberg in Sweden and Otto Peters in Germany with the beginning of scholarly writings, which began in the 1960s. A decade later, Michael Moore, an American, developed the theory of transactional distance (Moore, 2007).

Holmberg published *On the Methods of Teaching by Correspondence*, which described his theory of distance education, in 1960 (Diehl, 2013). At this time, Holmberg was a professor at the Fernuniversitat (Distance Unviersity) in Hagen, Germany (Moore & Kearsley, 2012, p. 205). Holmberg’s theory “is based on the very general observation that feelings of empathy and personal relations between learner and teacher support motivation for learning and tend to improve the results of learning” (Holmberg, 2007, p. 69). Garrison (2000) explains that Holmberg’s theory focuses on teaching. Birochi and Pozzebon (2011) explains that Holmberg’s theory focuses on bridging the distance between teachers and students. Six postulates listed form the foundation for Holmberg’s theory:

1. Feelings of a personal relation between the learning and teaching parties promote study, pleasure, and motivation.
2. Such feelings can be fostered on the one hand by well-developed self-instructional material, and on the other hand by interaction.
3. Intellectual pleasure and study motivation are favorable to the attainment of study goals and the use of proper study processes and methods.
4. The atmosphere, language, and conventions of friendly conversation favor feelings of personal relations according to postulate 1.
5. Messages given and received in conversational form are easily understood and remembered.
6. The conversation concept can be successfully applied to distance education and the media to it. (Holmberg, 2007, p. 70)

Initially, Holmberg characterized his theory as "guided didactic conversation" (Diehl, 2013) in order to describe the conversational nature of distance education (Holmberg, 2003). However, he later began to refer to his theory as "teaching-learning conversation" because the word didactic conveyed an authoritarian approach, which was unintentional (Holmberg, 2003). Garrison (2000) considers Holmberg's theory a seminal work. Holmberg (2007) suggests the rationale for the teaching-learning conversation theory has been accepted "on the whole" (p. 72).

Otto Peters published *Das Fernstudium an Universitaten und Hochschulen* (Distance Teaching and Industrial Production) in 1967 (Moore & Kearsley, 2012, p. 205). This publication resulted from a study Peters conducted in 1960, which involved correspondence educational systems (Diehl, 2013). From this study, Peters concluded that the structure and process of distance education paralleled industrialization (Diehl, 2013)—"professional planning and preparation, formalization, standardization, mechanization, automation, digitalization, rationalization, division of work, mass production, repeatability, and centralization" (Peters, 2007, p. 58).

Garrison (2000) explains that Peters' theory "is about organizing the educational process to realize economies of scale" (p. 6). From this theory, it follows that distance education can be industrialized, becoming a commodity that can be mass-produced and distributed to students in various locations (Peters, 2007). Garrison (2000) explains that Peter's industrial model for distance education contributed to the creation of the British Open University. Garrison (2000) also asserted that Peter's industrial model dominated the field of distance education.

In 1972, Michael Moore from Pennsylvania State University developed the theory of transactional distance, which was the first American theory to give meaning to the field of distance education in terms of pedagogy (Moore, 2007). Moore & Kearsley (2012) explains that Moore's theory of transactional distance has provided a theoretical framework for a vast body of research. This theory describes transactional distance, which refers to the "effect of geographical distance on teaching and learning" (Moore & Kearsley, p. 209, 2012), as a function of dialog, structure, and learner autonomy (Moore, 2007).

Transactional distance is a function of structure and dialogue (Moore & Kearsley, 2012). Course structure consists of elements in the course's design, such as "learning objectives, content themes, information presentations, case studies, pictorial and other illustrations, exercises, projects, and tests" (Moore & Kearsley, p. 211, 2012). Dialogue is interpersonal interaction where the instructor and students communicate via print, audio, video etc. for the purpose of students creating knowledge (Moore, 2007). “Dialogue” versus “interaction” was chosen because “Interaction is not always constructive, but dialogue by definition is” (Moore, 2007, p. 92). Factors affecting dialogue between an instructor and students are: (a) structure of the course (Moore, 2007), (b) media available for communication (Moore & Kearsley, 2012), (c) subject matter of the course, (d) educational philosophy of instructor or course designer (Moore & Kearsley, 2012), (e) personality of the instructor and students (Moore & Kearsley, 2012), and (f) cultural and language differences between the instructor and students (Moore, 2007).

When an instructor and students have ongoing dialogue and students are permitted to make personalized modifications to course structure, the course has a small degree of transactional distance (Moore, 2007). The degree of transactional distance changes as the degree of dialogue and the degree of structure changes (Moore, 2007).

As the degree of transactional distance changes, the degree of learner autonomy changes (Moore, 2007). For example, a high degree of transactional distance results in a high degree of learner autonomy and vice versa (Moore, 2007). Learner autonomy reflects the decisions students must make regarding when, where, and how to engage in dialogue with the instructor, participate in discussions with classmates, and interact with course content (Moore, 2007).

The Community of Inquiry Framework

The Community of Inquiry (CoI) framework, which was developed by D. Randy Garrison, Terry Anderson, and Walter Archer to fill a gap in distance education theory (Garrison et al., 2000), has provided order and a methodology for distance education research (Garrison et al., 2010; Kineshanko, 2016). During Garrison, Anderson, and Archer's tenure at the Faculty of Extension at the University of Alberta, the Faculty of Extension created a partly online graduate program in communications and technology (Garrison et al., 2010). As a result, Garrison, Anderson, and Archer began to research content, teaching, and technology related to this program.

The CoI framework differs from traditional distance education theories, which focus on students working independently (Garrison et al., 2010). The CoI framework focuses on transactions occurring in asynchronous, text-based group discussions (Garrison et al., 2010). Furthermore, the CoI framework is essential for a worthwhile higher education experience (Garrison et al., 2000).

The terms, concepts, processes, and tools pertaining to the CoI framework continue to be relevant in regards to online education independent of the technology being used (Kineshanko, 2016). Kineshanko (2016) conducted a heterogeneous thematic synthesis of 329 empirical studies published between 2000 and 2014 that cited Garrison et al.'s seminal 2000 article. The emerging themes were *used to describe*, *used to measure*, *used as a treatment*, and *validation or extension of the framework*. The theme, *used to describe*, was an unexpected outcome. It shows that the CoI framework has had a major role in developing nomenclature relating to online education.

Core elements of the CoI framework consist of teaching presence, social presence, and cognitive presence (Garrison et al., 2000). The manner in which the presences interact is dependent on the subject matter, the learners, and the communications technology (Garrison et al., 2010; Garrison, Cleveland-Innes, & Fung, 2010). Teaching presence and social presence intersect to create the climate for the educational experience. Teaching presence and cognitive presence intersect to select content for the educational experience. Social presence and cognitive presence intersect to support discourse for the educational experience. The three presences intersect to form an educational experience where deep and meaningful learning occurs (Akyol & Garrison, 2011; Garrison et al., 2000), as indicated by Figure 1.

Teaching presence pertains to course design and facilitation of learning (Garrison et al., 2000). Indicators of teaching presence can be divided into three categories: instructional management, building understanding, and direct instruction. Instructional management includes selecting curriculum, designing methods and assessment, establishing due dates and the flow of the course, and navigating the learning environment. Building understanding refers to transferring valid knowledge through discourse. The process of building understanding enables the community to develop an effective group consciousness. During this process, the group shares meaning, identifies areas of agreement and disagreement, and seeks to reach consensus and understanding. Direct instruction refers to the teacher presenting content, engaging students with questions and answers, assessing learning outcomes, and providing constructive feedback. According to Arbaugh (2008), teaching presence influences student satisfaction, perceived learning, and sense of community.

Shea et al. (2010) suggested researchers consider entire courses, not only threaded discussions or survey data, when evaluating teaching presence. This position was based on research conducted by Shea et al. (2010) involving instructors for two identical sections of a fully online course. One of the research questions was, “Where does teaching presence occur in online courses?” (Shea et al., 2010, p. 134). Discussion and non-discussion teaching activities were explored. Non-discussion teaching activities included communicating with students via emails, private folders, bulletin board/announcements, and question areas. Instructor A's teaching presence measure was mostly determined by non-discussion activities (88%). Similarly, instructor B's teaching presence measure was mostly determined by non-discussion activities (90%). These findings indicated that "the work of the online instructor may be significantly underrepresented by conventional analyses originating in research on computer conferencing" (Shea et al., 2010, p. 140). Therefore, Shea et al. (2010) proposed that the majority of instructional effort does not involve discussion forums. As a result, future research should explore instructional effort throughout entire courses (Shea et al., 2010).

Indicators of social presence can be divided into three categories: emotional expression, open communication, and group cohesion (Garrison et al., 2000). In the context of a learning environment, emotional expression refers to ability and confidence with regards to expressing feelings pertaining to the educational experience. Interestingly, emotional expression coexists with task motivation and persistence. Open communication refers to acknowledging the comments of others and responding to comments in a respectful manner. Lastly, group cohesion involves building and sustaining the group.

Cognitive presence is defined as "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication" (Garrison et al., 2000, p. 89). Cognitive presence is based on the practical inquiry (PI) model (Garrison et al., 2000). This model is a recursive, nonlinear, two-dimensional process. The deliberation-action dimension is represented along the vertical axis, and the perception-conception dimension is represented along the horizontal axis. Garrison and Vaughn (2008), explains that the PI model, which is shown in Figure 2, has four phases: (a) triggering event, (b) exploration, (c) integration, and (d) resolution. These four phases are the categories for indicators of cognitive presence (Garrison et al., 2000).

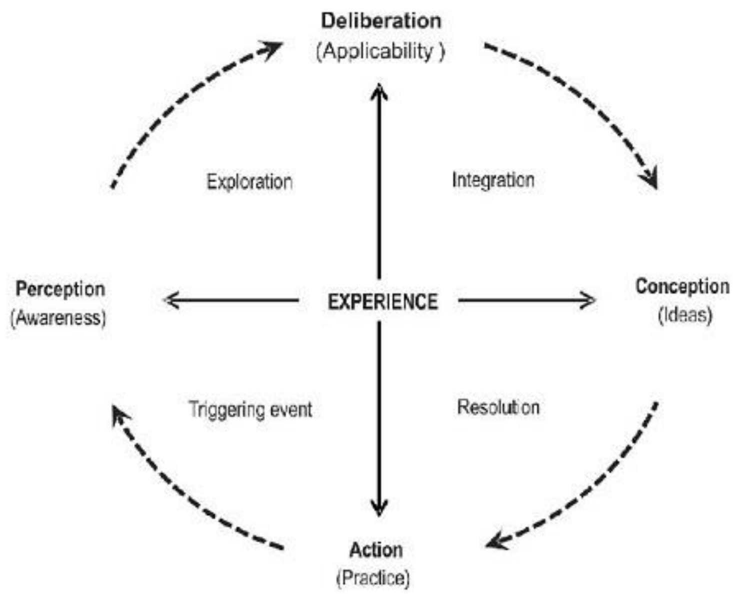

Figure 2. Practical Inquiry: Critical Inquiry in a Text-Based Environment (Garrison et al., 2000, p. 99).

Arbaugh, Bangert, and Cleveland-Innes (2010) conducted a study to examine perceptions of teaching, social, and cognitive presences across disciplines at two US universities. School A was a mid-sized western U.S. university where the participants were enrolled in fully online (57%) and blended (43%) courses during spring semester 2008 via WebCT. The courses included education, nursing, business, allied health and technical, engineering, and science and math courses, of which 31.4%, 25.1%, 9.3%, 8.8%, 7.0%, and 6.8% of the participants were enrolled, respectively. Courses across other disciplines enrolled 11.6% of the participants.

The participants from School A completed the Community of Inquiry (CoI) survey voluntarily during the last two weeks of the spring 2008 semester. The researchers analyzed the data using two-way factorial ANOVAs to test for significant differences across course disciplines and delivery mode for teaching presence, social presence, and cognitive presence factors. For the teaching presence factor, there was a significant difference for the course discipline main effect. That is, course discipline affected the students' perceptions of teaching presence. For the social presence factor, there were significant differences for both the course discipline main effect and the delivery mode main effect. That is, course discipline and whether or not the course was delivered in an online or blended format had an effect on the students' perceptions of social presence. Similarly, for the cognitive presence factor, there were significant differences for both the course discipline main effect and the delivery mode main effect.

In addition, general perceptions for teaching, social, and cognitive presence were significantly higher for students enrolled in allied health and technical courses than for students enrolled in nursing, business, engineering, science/math, social sciences, and other. However, for teaching presence, there was not a significant difference between the perceptions of allied health and technical students and science and math students. For all three factors, education students had significantly higher mean scores than did engineering students.

School B was a Midwestern U.S. university where participants were enrolled in online courses associated with an MBA program during four semesters from September 2007 through December 2008. The instruction in the courses was delivered primarily through asynchronous web-based interactions via the Desire2Learn learning management system. The courses were grouped into six categories, which were dependent on the subject areas of organizational behavior, international business, business strategy, human resource management, project management, operations management, information systems, finance, accounting, ethics, and professional development. The six categories were: (a) Macro-Management (Strategy and International Business), (b) Operations (MIS, Project Management, and Decision Analysis), (c) Micro-Management (Organizational Behavior and Human Resources, (d) Quantitative (Accounting and Finance), (e) Marketing, and (f) Other (Business Law, Ethics, and Business Literature).

Participants from School B completed the CoI instrument. The researchers analyzed the data collected from School B's participants using two-way factorial ANOVAs to test for significant differences between teaching, cognitive, and social presences across course categories. The differences between teaching presence were the most noticeable.

According to a post hoc analysis for the significant category main effect, the participants enrolled in marketing courses and “other” courses perceived teaching presence significantly higher than did students enrolled in courses from the remaining categories. The participants enrolled in macro-management, operations, micro-management, marketing, and “other” courses perceived cognitive presence significantly higher than did students enrolled in quantitative courses. In addition, students enrolled in “other” courses perceived social presence significantly higher than did students enrolled in macro- and micro-management courses.

Arbaugh et al. (2010) suggested the significant differences in students’ perceptions of teaching presence across disciplines and courses are due to the differences in knowledge dissemination, acquisition, and application inherent across courses and disciplines, as described by Neumann (2001) and Neumann, Parry, and Becher (2002).

For example, hard disciplines, which are characterized as having a dominant paradigm for approaches to teaching, depend on direct and focused instruction from the instructor (Arbaugh et al., 2010). Pure disciplines emphasize knowledge acquisition, whereas applied disciplines emphasize application and integration (Arbaugh et al., 2010). It follows that the CoI framework may need modification when used as a theoretical framework for designing online courses for hard, pure disciplines (Arbaugh et al., 2010).

The CoI framework has not existed without controversy. Rourke and Kanuka (2009) conducted a synthesis of 252 reports dated from 2000-2008 that cited Garrison et al.'s (2000) seminal article. Rourke and Kanuka first argued that even though deep and meaningful learning was the outcome of the CoI framework, most of the studies in the literature did not focus on learning, but on peripheral issues such as student satisfaction and educational measurement. Second, Rourke and Kanuka concluded that deep and meaningful learning does not materialize in communities of inquiry because evidence of cognitive presence did not exist in the five articles from the synthesis that focused on learning. According to data, students engaged only the first two levels of the practical inquiry process—triggering events and exploration. Moreover, the data on learning reported in these studies were self-reported by students via surveys.

Akyol et al. (2009) offered a rebuttal to Rourke and Kanuka (2009), noting, first that the CoI framework is a process model and does not focus on learning outcomes. The model is also transactional and the presences are dynamic. Second, the framework should not be dismissed because it is a new theoretical model that guides research in distance education. In addition, it has been validated by studies. Third, some of the articles from the Rourke and Kanuka (2009) study were classified improperly and taken out of context.

Fourth, Rourke and Kanuka (2009) did not make use of the PI model when reporting data. Last, Akyol et al. (2009) suggested that self-reported data may be relevant to CoI research at the point in time for the studies explored by Rourke and Kanuka (2009).

Archer (2010) recommended applying the CoI framework to entire courses, not just discussions. A research group centered at the University of Alberta conducted a study of critical thinking in entire courses, including courses without online components, based on the CoI framework (Archer, 2010). The motivation for investigating critical thinking in entire courses was the lack of instances of the integration and resolution phases of the cognitive presence in online discussions. The group considered the possibility that students may engage integration and resolution phases in assignments that comprised a large portion of the overall course grade, as well as practicums.

Online Education

Online teaching and learning. Online learning, which often encompasses teaching and learning (Moore & Kearsley, 2012), is defined as "the use of online communication networks for educational applications, such as: course delivery and support of educational projects, research, access to resources and group collaboration" (Harasim, 2012, p. 27). Furthermore, Means, Toyama, Murphy, Bakia, and Jones (2009) define online learning as a pedagogical approach where course content is delivered partially or totally via the Internet. Online learning, which occurs synchronously, asynchronously, or both (Means et al., 2009), combines "flexibility, personalization, interaction, independence, and rich media" (Cavanaugh, 2009, p. 18). According to Harasim (2012), online learning emerged during the late 1970s and early 1980s, and became increasingly accepted, adopted, and mainstreamed during the mid-1990s.

Allen, Seaman, Poulin, and Straut (2016) defined online courses as those in which at least 80% of content is delivered online. Overall, rates of enrollments in higher education online courses are increasing faster than those in higher education. Note that institutions with online courses continue to consider online learning as critical to their long term strategic planning.

Faculty attitude toward online education. Even though a meta-analysis conducted by the U.S. Department of Education reported that purely online instruction is as effective as face-to-face instruction (Means et al., 2009), Allen et al. (2016) report that lack of acceptance by higher education faculty is a major challenge for online education; faculty generally have not accepted the “value and legitimacy of online education” (p. 26).

Tabata and Johnsrud (2008) conducted a study to explore how attitudes and demographics contribute to an increased or decreased likelihood of faculty participation in distance education. The theoretical framework for this study was the diffusion of innovation theory. According to Rogers (2003), “diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system” (p. 5). The population for this study consisted of 4,534 higher education faculty from a western public university system who had an assigned teaching load during fall semester 2003.

Data were collected with a 25-item survey, which was based on the literature pertaining to technology-related experiences and perceptions of faculty in higher education, as well as information collected from discussions with faculty. The items were grouped according to four dimensions: (a) technology use, (b) attitude toward technology, (c) attitude toward distance education, and (d) adoption of innovation. The respondents indicated the level of importance or level of agreement to the items in regard to their involvement in distance education.

There were 2048 responses, for a 45% return rate. There were 2% more males than females. Just over half of the participants were identified as Caucasian. Most of the respondents were professors, followed by assistant professors, associate professors, lecturers, instructors, and graduate/teaching assistants. In addition, 45% of the respondents were not on tenure track, 41% were tenured, and 14% were on tenure track, but not tenured. Most of the responses were from the research university, with the least amount from the baccalaureate colleges.

Using the demographic data, survey data, and format of courses taught, the researchers performed an ordinal regression analysis to explore the magnitude and effects of the data on faculty participation in distance education. For each year a respondent's age increased, the likelihood of participating in distance education increased by 1%. For minority respondents, the likelihood of participating in distance education decreased by 19%. In addition, respondents from colleges characterized as both associates' and baccalaureate had a decreased likelihood of participating in distance education by 22% and 32%, respectively.

In regards to a decreased likelihood of participation in distance education, five variables were found to be significant. Under the dimension of attitude toward technology, the significant variable was "resources are available to support technology needs." Under the dimension of attitude toward distance education, the significant variable was "the institution values distance education." Finally, under the dimension of adoption of innovation, the significant variables were (a) “participation in distance education is voluntary;” “the advantages of distance education outweigh the disadvantages;” and (c) “I am able to share the results of using distance education with others.”

Tabata and Johnsrud (2008) concluded that developing distance education policies that meet the needs of both faculty and the institution is challenging for matters involving institutional planning and decision-making. They suggest including distance education in the institution’s long-term strategic plan, as well as including distance education instruction as a part of faculty teaching load. They mentioned fair and equitable compensation for faculty, and providing technology and course design support for faculty.

Student satisfaction with online education. Watson, Bishop, and Ferdinand-James (2017) conducted a descriptive study with a survey design to explore master’s students’ experiences that influenced their feelings of satisfaction or dissatisfaction with online courses. Master’s students were chosen for this study due to their tendency to provide meaningful responses to survey questions (Watson et al., 2017). When asked, “What specific things would you like your online instructors to do to help you learn successfully?” (p. 422),

> the top ten responses ranked from highest to lowest were: (a) be available and responsive to students, (b) engage/interact with students, (c) provide prompt feedback, (d) foster interaction/communication among students and instructor, (e) provide expectations, (f) provide learning guidance, (g) organize course, (h) provide meaningful coursework, (i) provide synchronous sessions, and (j) use

various instructional methods. (p. 422)

Teaching and Learning Mathematics Online

The literature does not include a documented, comprehensive approach for designing or teaching online mathematics courses. As Engelbrecht and Harding (2005) noted, "a pedagogy for driving online courses in mathematics is still only in its development phase" (p. 253). Seven years later, Juan et al. (2012) said, "there remains a dearth of research to inform best practices specific to the disciplinary particularities of Mathematics e-learning in higher education" (p. x). In 2016, Appelbaum et al. (2016) observed that many math teachers have not participated in teaching or learning mathematics in an online environment.

Description of mathematics. Mathematics is defined "as the group of sciences (including arithmetic, geometry, algebra, calculus, etc.) dealing with quantities, magnitudes, and forms, and their relationships, attributes, etc., by the use of numbers and symbols" (Agnes & Guralnik, 2001, p. 887). Kilpatrick, Swafford, and Findell (2001) explain that mathematics proficiency includes five strands: (a) conceptual understanding, (b) procedural fluency, (c) strategic competence, (d) adaptive reasoning, and (e) productive disposition. A conceptual understanding occurs when a student understands the connections between mathematical concepts, operations, and relations. Procedural fluency occurs when a student has the ability to solve problems accurately and efficiently using different and appropriate procedures. Strategic fluency occurs when a student understands the components of a mathematical problem, has the ability to express the problem using mathematics, and can solve the problem. Adaptive reasoning occurs when a student has the ability to construct, explain, and justify logical solutions to a problem.

Finally, productive disposition occurs when a student

- sees sense in mathematics;
- perceives it as both useful and worthwhile;
- believes that steady effort in learning mathematics pays off; and
- sees oneself as an effective learner and doer of mathematics. (Kilpatrick et al, 2001, p. 131)

These five strands of mathematical proficiency do not occur in isolation but are intertwined.

Contemporary teaching practices. This section describes contemporary practices for teaching higher education online mathematics classes. Best practices for teaching higher education online mathematics classes have not been clearly articulated in the literature.

Gleason (2006a, 2006b) describes his experiences preparing and teaching "Discrete Mathematics for Teachers" online. This course was created for a master's degree program; however, doctoral students also enrolled in the course. When preparing to design and teach this course, Gleason read literature on distance education and reviewed other courses in the program to obtain ideas for designing and teaching an online course. Gleason designed his course in a manner in which he believed would enable students to gain mathematical knowledge and develop mathematical thinking. His course included two hours of synchronous interaction per week via web conferencing that featured both instructor-student and student-student interaction. Students submitted typed and handwritten homework, which counted as a majority of the student's grade, via Blackboard. Gleason graded the homework and provided feedback. Content was delivered by PowerPoint slides containing definitions, theorems, and problems. Instead of a final exam, the students were required to submit a group project. Gleason had a great experience teaching mathematics online (Gleason, 2006c).

Gleason (2006c) offers instructional and technology advice to mathematics instructors planning to teach their first online course. In the absence of facial cues, online instructors must determine how to assess student understanding when students interact with course content. In addition, Gleason recommended requiring students to submit homework electronically and allowing students to ask questions via chat when web conferencing. Furthermore, Gleason recommends online instructors feel confident when using computers and have the ability to troubleshoot technical problems. Gleason also recommends online instructors receive technology training, as well as become familiar with technical support at the institution where the online course is being offered.

Akdemir (2010) provided additional insight into the experiences of instructors teaching mathematics courses online in his exploration of "current practices of teaching mathematics online" (p. 50). There were four participants, all of whom were teaching mathematics online for Turkish universities. The data were collected from open-ended interviews.

The themes emerging from the data analysis were *online course design*, *online course teaching*, *student assessment*, and *effectiveness of online courses* (Akdemir, 2010). The theme *online course design* emerged from the categories of technical help, course management systems, and student orientation. The theme, *online course teaching,* emerged from the categories of course materials, teaching process, and course assignments. Participant A used a variety of teaching tools. Based on the response from

Participant A it was evident that developing course materials—e-books, e-television, e-exercise, e-tests, and asynchronous advising—requires teamwork. According to Akdemir (2010), this team consisted of different experts—instructional designers, subject matter experts, graphic designers, computer programmers, etc. Participants B and D reported using their course notes, and recommending hard copy books, Internet sources, and a discussion board. It follows that faculty using instructional materials created via teamwork used more teaching tools than faculty who were responsible for creating their instructional materials.

The teaching process in an online mathematics course is not the same as the teaching process in a traditional face-to-face course (Akdemir, 2010); however, the processes should be equivalent (Simonson et al., 1999). In a traditional face-to-face learning environment, instructors deliver content in a step-by-step progressive manner (Akdemir, 2010), whereas in Akdemir's (2010) study, Participant A used e-books to explain course concepts, e-television to teach processes, interactive online exercises for practice, online tests for assessment, and online advising to answer questions when teaching mathematics online. The teaching tools used by Participant A were compatible with the learning management system delivering the course content. Participant D reported delivering online instruction in a different manner. Students in online courses were expected to complete a final project and guided assignments for topics. The final project was presented face-to-face at the end of the semester. Akdemir (2010) did not discuss Participant C's strategy for delivering course content.

The coding for the theme, *student assessment,* was student assessment. Assessment instruments were determined by enrollment. When enrollment was high, standardized tests were preferred. Individual projects, assignments, group projects, discussions, online presentations, and exams were used when course enrollments were manageable.

The theme, *effectiveness of online courses*, was coded by the categories of faculty members' perception and faculty members' perceptions for students. The participants perceived advantages and disadvantages for teaching mathematics courses online. The advantages were having the ability to post course materials at any time, make courses available to students who are at a distance, and monitor student progress effectively.

The disadvantages pertained to faculty workload. Designing and developing online mathematics courses versus traditional mathematics courses requires more time. In addition, providing feedback to online students requires a greater amount of time than providing feedback to face-to-face students.

In addition, Akdemir's (2010) participants perceived advantages and disadvantages for students enrolled in online mathematics courses. The advantages were having the ability to review course content as many times as necessary, as well as review and access course content at any time. The disadvantages were that student success was dependent on the course being well designed, students having basic computer skills, and students being self-regulated learners.

Assessment and feedback. Trenholm, Alcock, and Robinson (2015) explored assessment and feedback practices of undergraduate mathematics instructors who taught fully online courses. Data for this study were taken from Trenholm (2013). The 66 participants consisted of instructors from traditional "brick and mortar" colleges and universities. The instructors reported assessing students' learning using homework

(83%), final exams (73%), tests (65%), quizzes (53%), discussions (39%), midterms (2%), individual projects (20%), group projects (5%), group work (3%), journaling (2%), and portfolios (2%). The instructors also reported which assessments were proctored—discussions (5%), individual projects (8%), tests (29%), final exams (73%), and midterms exams (73%). In addition, the data collected by Trenholm (2013) indicated that instructors weighed summative assessments, such as final exams, midterms, and tests, in a manner comparable to the weightings in their respective face-to-face classes.

To evaluate the data regarding assessment, Trenholm et al. (2015) devised a scoring system. Feedback in terms of only a grade received a score of 0, which was considered poor feedback. Feedback providing the correct answer or full solution received a score of 1. Feedback providing hints or comments received a score of 2, which was considered rich feedback. This type of feedback is credited with enhancing student learning. Based on the feedback scoring system, the average feedback scores for homework, final exams, tests, quizzes, discussions, midterm exams, and individual projects were 1.73, 0.52, 1.23, 1.26, 1.00, 0.94, and 1.85, respectively. Trenholm et al. (2015) found that rich feedback was associated mostly with homework and individual projects. In addition, Trenholm et al. (2015) "found no link between the quality of feedback used and participants' approaches to teaching for conceptual understanding and with a student focus, suggesting this feedback may not be, at least primarily, advancing student learning" (p. 1215). The feedback was used to assist students with maintaining student-instructor, student-student, and student-content engagement throughout the course.

Assessing student learning and providing feedback present challenges for faculty teaching higher education mathematics courses (Akdemir, 2010; Trenholm et al., 2015). Trenholm, Alcock, and Robinson (2016) conducted a follow-up interview study based on Trenholm (2013), where six U.S. instructors of fully online mathematics courses were chosen from the 66 participants in the initial study to participate in an interview. All of the participants had at least 16 years of experience teaching face-to-face and at least one year of experience teaching online. The instructors were asked to base responses on an introductory-level course for which they could compare face-to-face and fully online instructional experiences.

During the interview, the instructors discussed problems and potential advantages associated with using discussion and providing feedback in fully online courses. The instructors found it challenging to incorporate open-ended discussions and collaborative learning discussions in fully online mathematics classes. However, discussions in fully online classes gave students more time to reflect.

Regarding problems and potential advantages associated with providing feedback in fully online courses, instructors' comments were categorized according to process, purpose, and timing. When compared to face-to-face teaching, the instructors found providing feedback was more time consuming, expected 24/7, and used to keep students engaged in the course. The instructors also expressed concern that students may misinterpret feedback from computer-assisted instruction. In spite of challenges, instructors provided more individualized instruction in fully online mathematics courses.

Trenholm et al. (2016) acknowledge the challenges instructors face when incorporating discussions and providing feedback in fully online mathematics courses; however, they do not suggest trying to replicate face-to-mathematics teaching practices.

According to Trenholm et al. (2016), the mathematics education community has developed mathematical instruction that may assist with developing student-centered fully online mathematics courses.

Student perception, satisfaction, and perceived learning. Glass and Sue (2008) explored student preference, satisfaction, and perceived learning in a quarter-long online mathematics course designed for undergraduate business and social science majors. College algebra was a prerequisite for this course, and this course was a requirement for admission to the MBA program.

For the purpose of their study, learning objects are defined as collections of small, reusable, pieces of information (Glass & Sue, 2008). The learning objects for the course being explored were PowerPoint slides, video lectures, web-based tutorial homework, discussions, quizzes, and a textbook (see Table 1).

When the students were surveyed at the beginning of the course to obtain a baseline measure of preferences for learning objects, practice exercises ranked the highest, followed by video lectures, one-on-one online interaction with instructor, and online discussions. The students were surveyed at the end of the course regarding the quality of the learning objects and contribution of the learning objects to learning. For quality, homework had the highest rating, followed by quizzes, PowerPoint slides, lectures, Blackboard discussions, and text, respectively. In terms of contribution to overall learning, homework also had the highest rating, followed by quizzes, PowerPoint slides, lectures, text, and Blackboard discussions, respectively.

Glass and Sue (2008) reported that all assessments in the course, with the

Table 1

Description of Learning Objects

Learning Object	Active/Passive Required/Optional	Description
PowerPoint	Passive Optional	Two weekly sets of PowerPoint slides which were also embedded in the video lectures and were available for printing and review on the course Bb site.
Text	Passive Optional	Students were abler to purchase a hard copy text or view an e-text on the CC/MML course site. Specific examples, “matched problems,” and “look in the book” exercises were referenced in the video lectures. Note that the text is classified as passive because that is generally the manner in which students utilize the text. The authors acknowledge that active utilization of the text is possible and desirable.
Video Lectures	Passive Optional	Two weekly media-enhanced lectures created using Microsoft Acustudio. Lectures included head and shoulder video of the instructor, audio, PowerPoint slides and a white board feature (“examples by hand”).
Homework	Active Required	Two required homework assignments each week. All homework was done on the publisher supported site CC/MML. While doing homework, extensive worked examples (generated by MML) and “hints” are available.
Discussions	Active Required & Optional	Students were required to respond weekly to instructor-provided prompts designed to encourage higher level thinking about the weekly content. Optional discussion boards were available for general and mathematical questions and comments.
Quizzes	Active Required	Required weekly quizzes which were completed on the CC/MML site.

Glass & Sue, 2008, p. 328

exception of the final exam, were completed online and not proctored. The final exam was proctored by the instructor in a face-to-face environment. The assessments were worth 1000 points—homework (240), discussion (60), quizzes (200), midterm (200), and final exam (300).

The course studied in Glass and Sue (2008) was composed of 10 learning modules. Each module contained two lectures and a set of online assignments. Each module was assessible to students at midnight on the first day of the week, and students were given one week to complete the module. At the beginning of the quarter, students were given a document containing a detailed list of assignments and due dates. The course instructor answered questions synchronously during face-to-face and online office hours; the course instructor also answered questions asynchronously via email and discussion board posts.

According to Glass and Sue (2008), based on student preference, satisfaction, and perceived learning, this course provides a best practices model for an online mathematics course composed of "strongly" (p. 337) utilized practice problems with immediate feedback and various types of media delivering course content. On the course evaluation, 44.8% of the students rated this course as outstanding, and 41.4% rated the course as good. Also, 86.7% would recommend this course to other students. Furthermore, 93.1% rated the course as intellectually challenging.

Glass and Sue's (2008) study has implications for establishing teaching presence in higher education online mathematics courses. Having insight into how students view the quality of the learning objects and the contribution of the learning objects to learning in an online mathematics course, equips online mathematics instructors to better develop and select learning objects for assessment, which falls in the category of instructional management (Garrison et al., 2000). Instructors will also be better equipped to establish and maintain discourse, which falls in the category of building understanding (Garrison et al., 2000). In addition, instructors will be better equipped to present content, engage students with questions and answers, assess learning outcomes, and provide constructive feedback, which falls in the category of direct instruction (Garrison et al., 2000).

Course Syllabus

Description and function. A course syllabus is described as "both a document about the course content, goals, and elements and a guide for students to the kind of teaching and learning they can expect" (Stanford University, n.d.) during the course. The syllabus may be the first communication from the instructor to the students, as well as the first learning activity designed to provide information for completing the course successfully and without incident (Gambescia, 2006; Svinicki & McKeachie, 2014). The syllabus also provides the first opportunity for faculty to assist students with being responsible for their learning (O'Brien, Millis, & Cohen, 2008). The syllabus sets the tone for the course (Harnish & Bridges, 2011) and reveals elements of the instructor's personality (Svinicki & McKeachie, 2014). Furthermore, the syllabus has evolved as a contract between instructor and student (Gambescia, 2006; Sulik & Keys, 2014; Svinicki & McKeachie, 2014). O'Brien et al. (2008) suggested that a course syllabus include the following items:

> Table of contents; Instructor information; Student information form; Letter to the students or teaching philosophy statement; Purpose of the course; Course description; Course objectives; Readings; Resources; Course calendar; Course requirements; Policies and expectations: Attendance, late papers, missed tests, class behaviors, and civility; Evaluation; Grading procedures; How to succeed in this course: Tools for study and learning. (p. 40)

An online course syllabus. A syllabus for an online course is essential (Simonson et al., 2012) and includes information not required for a face-to-face course syllabus (West & Shoemaker, 2012). First, online students may interact with other students and the instructor using online communication media; therefore, the online syllabus should discuss net etiquette (West & Shoemaker, 2012). Second, online students may not have required meetings with the instructor; therefore, the course syllabus should provide details on how to communicate with the instructor (West & Shoemaker, 2012). Third, course content will be delivered online; therefore, the syllabus should contain information regarding technologies and technology skills required for the course (West & Shoemaker, 2012). Finally, the online course syllabus should provide an instructional plan to assist students with engaging course content and meeting course deadlines (Sulik & Keys, 2014; West & Shoemaker, 2012).

A learning-centered syllabus. According to O'Brien et al. (2008), "students learn what is required to achieve the course objectives, and they learn what processes will support their academic success" (p. 5) from reading a learning-centered syllabus. In addition to course objectives pertaining to content, this syllabus may contain course objectives regarding processes for achieving the content course objectives (O'Brien et al., 2008). Furthermore, a learning-centered syllabus outlines the instructor's plan for engaging students, as well as a plan for students to engage the instructor, course content, and other students in the course (O'Brien et al., 2008).

Research Questions

The purpose of this phenomenological study is to describe, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses.

The three main research questions and their subquestions were:

1. How do mathematics instructors establish teaching presence in online higher education mathematics courses?
    a. How do mathematics instructors deliver course content in online courses?
    b. How do mathematics instructors ask and answer questions in online courses?
    c. How do mathematics instructors establish dialogue between students in online courses?
    d. How do mathematics instructors assess student learning in online courses?
    e. How do mathematics instructors encourage students to meet deadlines in online courses?
2. How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?
    a. How do mathematics instructors deliver course content in face-to-face courses?
    b. How do mathematics instructors ask and answer questions in face-to-face courses?
    c. How do mathematics instructors establish dialogue between students in face-to-face courses?
    d. How do face-to-face mathematics instructors assess student learning?
    e. How do mathematics instructors encourage students to meet deadlines in face-to-face courses?
3. What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?

Summary

Distance education dates to the early 1880s (Moore & Kearsley, 2012); however, distance education scholarship did not begin until the 1950s. Holmberg in Sweden and Peters in Germany produced the first scholarly writings (Black, 2007). Europeans, Australians, and Canadians, with the exception of the American, Wedemeyer at the University of Wisconsin, have been the primary contributors to distance education theory (Saba, 2003). In 1972, Moore-developed the first American theory that defined distance education in terms of pedagogy (Moore, 2007; Saba, 2003).

Garrison, Anderson, and Archer-developed the CoI framework to fill a gap in distance education theory (Garrison et al., 2010). The core elements of the CoI framework are teaching presence, cognitive presence, and social presence (Garrison et al., 2000). The CoI framework provides order and a methodology for distance education research (Garrison et al., 2010; Kineshanko, 2016). The CoI survey instrument, which has enabled a wide range of empirical studies that could not have been conducted qualitatively, was developed based on the theoretical foundation of the CoI framework (Garrison et al., 2010). In addition, Kineshanko (2016) conducted a thematic analysis of CoI research from 2000 to 2014 and discovered that the CoI framework, terminology, and concepts are continuously being adopted.

In spite of the growth of distance education research, there continues to be a gap in the literature regarding teaching and learning mathematics online. Furthermore, mathematics instructors lack experience teaching and learning mathematics online, as well as pedagogy for designing and teaching online mathematics courses (Appelbaum et al., 2016; Engelbrecht & Harding, 2005; Juan et al., 2012). Glass and Sue (2008) suggest a model for designing an online mathematics course comprised of immediate feedback, and various types of media delivering course content. Note that Glass and Sue (2008) did not emphasize the role of the instructor in facilitating learning and engaging students.

According to Gambescia (2006) and Svinicki and McKeachie (2014), the syllabus may be the first communication from the instructor to the students, as well as the first learning activity designed to provide information for completing the online course successfully and without incident. The syllabus is essential for an online course (Simonson et al., 2012). Information pertaining to assessments as well as other course information should be provided on the course syllabus (O'Brien et al., 2008). Furthermore, West and Shoemaker (2012) explain that a syllabus for an online course contains information not required for a syllabus for a face-to-face course.

Chapter 3: Methodology

Aim of the Study

This phenomenological study described, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. Teaching presence is one of the three core elements of Garrison, Anderson, and Archer's community of inquiry (CoI) framework (Garrison et al., 2000). Teaching presence pertains to course design and facilitation of learning, and indicators of teaching presence can be categorized according to instructional management, building understanding, and direct instruction (Garrison et al., 2000). The CoI survey emerged from a study conducted by Arbaugh et al. (2008), and is available for use under the Creative Commons license (CoI Survey, n.d.). Altering the survey is permissible (CoI Survey, n.d.).

Qualitative Research Approach

Creswell (1998) describes eight criteria for justifying a qualitative research design:

1. The research question often starts with a *how* or a *what* so that initial forays into the topic describe what is going on.
2. The topic needs to be *explored*.
3. There is a need to present a *detailed view* of the topic.
4. Individuals will be studied in their *natural setting*.
5. There is an interest in *writing* in a literary style; the writer brings himself or herself into the study, the personal pronoun "I" is used, or perhaps the writer

engages a storytelling form of narration.

6. There is *sufficient time and resources* to spend on extensive data collection in the field and detailed data analysis of "text" information.
7. *Audiences are receptive* to qualitative research.
8. The researcher's role will be emphasized as an *active learner* who can tell the story from the participants' view rather than as an "expert" who passes judgment on participants. (pp. 17-18)

This study met five of the eight criteria. First, the research questions began with either "how," or "what." Second, the topic, teaching presence in online mathematics courses in higher education, needed to be explored. Third, a detailed view of the topic needed to be discussed. Fourth, the participants were studied in their natural setting. Fifth, the researcher approached this study as an active learner and reported the data from the participants' point of view.

Phenomenology

Phenomenological inquiry was used to investigate the life-world of mathematics instructors when establishing teaching presence in online higher education mathematics classes. The phenomenological movement was founded during the early part of the 20th century by Edmund Husserl (Edmund Husserl, 2017). From this movement grew Husserl's transcendental phenomenology, Maurice Merleau-Ponty and Jean-Paul Sartre's existential phenomenology, and Martin Heidegger's hermeneutic phenomenology (Schwandt, 2007). Husserl (1965) described phenomenology as the "science of science" (p. 23) because (a) phenomenology explores the essence of objects that provide the foundations for other sciences, and (b) the other sciences fail to explore these objects at the same level of detail. Furthermore, Husserl (1981) described phenomenology as the "science of consciousness" (p. 12). Husserl viewed consciousness as a whole that was made of parts such as perceptions, emotions, memories, and sensations (Belousov, 2016) (see Figure 3). The significance of consciousness lies in the idea that one's perceptions and emotions regarding an object, not the object, belong to one's consciousness (Belousov, 2016).

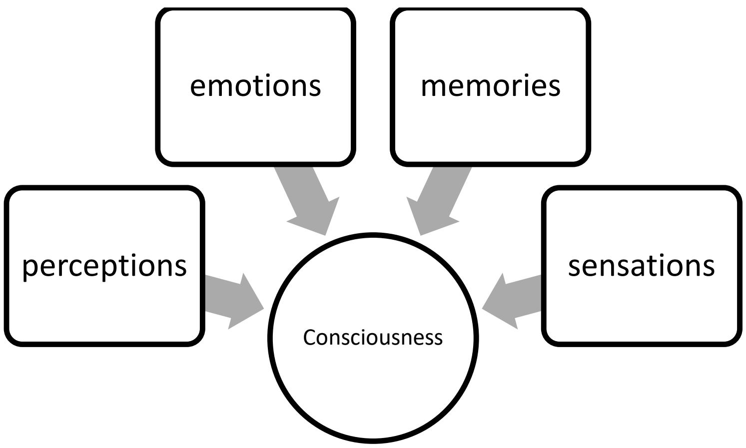

Figure 3. Parts of Consciousness (Belousov, 2016).

Husserl viewed a phenomenon as "the entire lived experience of perceiving with all of its components," "the object which appears in lived experience with all its qualities, moments, and relations," and "the component of my lived experience…that serves as the pivot of my apprehension in its orientation to the object" (Patočka, 1996, p. 62). The phenomenologist gathers data pertaining to everyday conscious experiences, which include perceiving, believing, remembering, deciding, feeling, judging, and evaluating, as well as physiological activities, to determine the essence or structure of phenomena (Merriam, 1998; Schwandt, 2007; Vagle, 2016). The everyday conscious experiences are referred to as the life-world (Schwandt, 2007). Note that phenomenologists do not consider theory, deduction, and assumptions from other disciplines when gathering data

(Phenomenology, 2016).

The essence of consciousness is intentionality (Giorgi, 1989; Phenomenology, 2016). Husserl redefined the term intentional to refer to the meanings associated with acts of the mind toward an object (Moustakas, 1994; Sokolowski, 2000). These acts may include perception, believing, remembering, deciding, feeling, judging, and evaluating, as well as physiological activities directed towards objects (Schwandt, 2007) (see Figure 4).

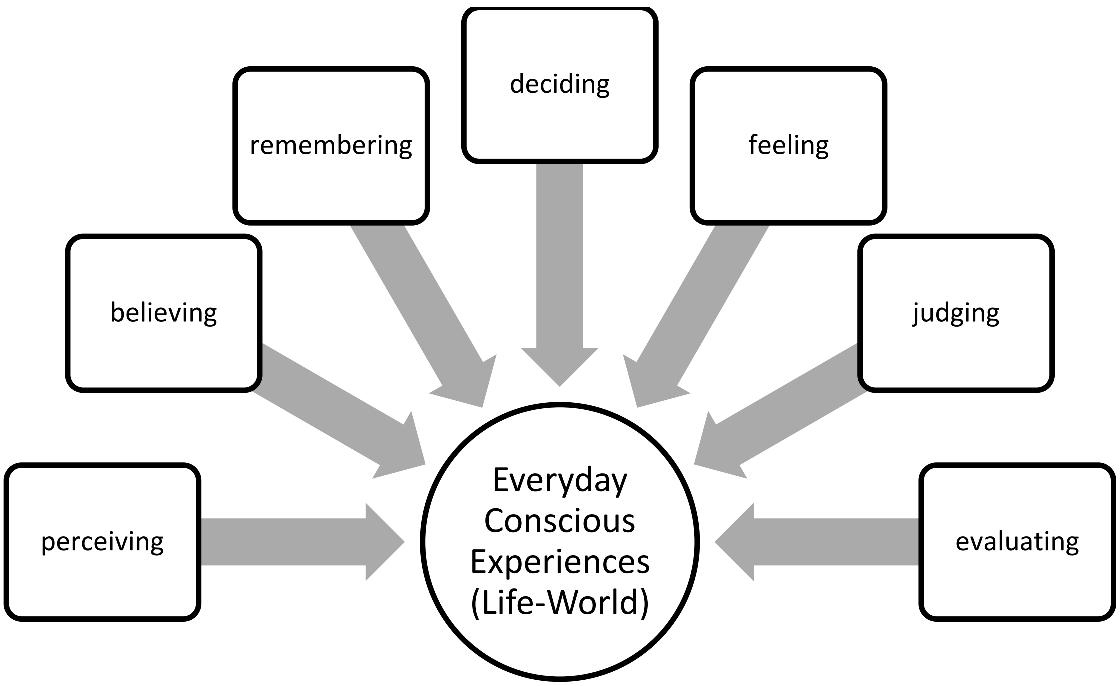

Figure 4. Acts of the Mind Toward an Object (Schwandt, 2007).

Therefore, every act of consciousness and every experience had, when correlated to an object, is intentional (Sokolowski, 2000). Phenomenological analysis is appropriate for this study because the purpose of this study is to gain knowledge regarding how mathematics instructors establish teaching presence in higher education online mathematics courses based on the perceptions, beliefs, memories, decisions, feelings, judgments, or evaluations of these instructors.

The challenges regarding this study were those associated with conducting quantitative research. This study presented challenges because the researcher was required to separate her everyday conscious experiences from those of the participants, as well as decide how and when her experiences would be included in the study (Creswell, 1998).

Participants

Participation in this study was voluntary, and the participants could withdraw from the study at any point in the process. Participants were recruited by email and telephone. Creswell (1998) explains that it is not necessary for the participants to be chosen from the same setting. Therefore, the participants may or may not be on the faculty at the same institution. The participants were from the same university system. Institutional Review Board (IRB) approval from the appropriate universities was required for this study.

Acquiring the appropriate number of participants who had experienced the phenomenon of establishing teaching presence both face-to-face and online was challenging. Polkinghorne (1989) explains that there is a wide range in the number of participants in phenomenological studies. Vagle (2016) suggests the number of participants is driven by the phenomenon being studied and what seems reasonable to the researcher. Creswell (1998) recommends at most 10 participants. Dukes (1984) suggests three to 10 participants. The plan for this study was to include 12 mathematics instructors from a public university system composed of 26 institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges (University System of Georgia, 2018a). Including 12 participants would allow for attrition. However, only 10 instructors consented to participating in this study. Six of the instructors were from research institutions, three from state colleges, and one from a state university. None of the participants were employed by a historically Black university

Participants were to be selected by means of maximal variation sampling, which is a type of purposeful sampling, in order to gather data representative of the diverse universities within the university system. Creswell (2012) defines purposeful sampling as a "qualitative sampling procedure in which researchers intentionally select individuals and sites to learn or understand the central phenomenon" (p. 626) and maximal variation sampling as a "purposeful sampling strategy in which the researcher samples cases or individuals that differ on some characteristic or trait" (p. 623).

Demographics pertaining to gender, age, education level, rank, and years of teaching experience were not included in the criteria for selecting participants. However, these data were included in the interview questions to provide additional information about the characteristics of the participants. Ethnicity was not included because it may affect the anonymity of the participant. The criteria for participation are listed below:

a) The participants must have experienced the phenomenon of establishing teaching presence in higher education face-to-face mathematics courses.
b) The participants must have experienced the phenomenon of establishing teaching presence in higher education online mathematics courses.
c) The participants must have the ability to explain their everyday conscious experiences when establishing teaching presence (Creswell, 1998; Polkinghorne, 1989).

The process for selecting participants yielded participants from three categories of institutions—research universities, state universities, and state colleges. The first participants selected were mathematics instructors from the researcher's institution, which is a research institution. The data collected from these participants provided information for evaluating online mathematics instruction at the researcher's institution. The remaining participants were to be selected from a comprehensive university, state university, state college, historically Black university, and research university, respectively. The participants were to be chosen from each category based on the order in which consent forms were received. This process was to continue until 12 participants were selected. Note that it was possible for a participant to be employed by a state university and historically Black university simultaneously because the historically Black universities are state universities.

Setting

The setting for this study was a public university system consisting of four research universities, four comprehensive universities, nine state universities of which three are historically Black universities, and nine state colleges. All of the institutions are committed to instructional excellence and serving a diverse student body (University System of Georgia, 2018a). However, the institutions differ in geographical influence, academic and professional programs offered, and research expectations of faculty (University System of Georgia, 2018a).

Research universities have statewide influence with a national or international impact (University System of Georgia, 2018a). Academic programs are generally offered at baccalaureate, master's, and doctoral levels; professional programs are generally offered at baccalaureate and post-baccalaureate levels, which include doctoral level programs (University System of Georgia, 2018a). Faculty are expected to produce new knowledge and theories (University System of Georgia, 2018a).

The influence of comprehensive universities is determined by the needs of a specific region of the state. Academic programs are generally offered at baccalaureate and master's levels; professional programs are generally offered at baccalaureate and post-baccalaureate levels, which includes a limited-number of professionally oriented doctoral level programs. Developmental Studies programs are also offered. Faculty engage in research based on specified areas of institutional strengths, as well as regional need (University System of Georgia, 2018a).

The influence of state universities is generally determined by the needs of a specific area of the state (University System of Georgia, 2018a). However, the system's historically Black state universities were established to serve African Americans (University System of Georgia, 2018b). At state universities, academic programs are generally offered at baccalaureate, selected master's and specialist, and selected associate's levels. Developmental studies programs are also offered. In addition, professional programs are generally offered at baccalaureate and post-baccalaureate levels, which includes a limited number of professionally oriented doctoral level programs. Faculty engage in applied research based on specified areas of institutional strengths, as well as area need (University System of Georgia, 2018a).

The influence of state colleges is determined by the needs of a local area. Academic programs are generally offered at the associate's and limited baccalaureate level. Educational programs are generally offered to provide students access to baccalaureate programs. In addition, a limited number of certificate and career programs are offered. Faculty engage in applied scholarship, not necessarily research, based on targeted degree programs (University System of Georgia, 2018a).

Types of Data

Data for this study were collected from face-to-face and online mathematics course syllabi and in-depth semi-structured interviews. Data were collected from both interviews and course syllabi because indicators of teaching presence could be present in the (a) interviews, (b) course syllabi, or (c) interviews and course syllabi. One face-to-face and one online course syllabus were requested from each participant because the course syllabus sets the tone for the class (Harnish & Bridges, 2011), represents an agreement between the instructor and students, reveals elements of the instructor's personality, and is essential for an online course (Svinicki & McKeachie, 2014).

Data were collected from the syllabi based on the measures of teaching presence contained in the Community of Inquiry (CoI) survey (see Appendix F and Appendix G) and a checklist created by the researcher (see Appendix E). The items included in the checklist were based primarily on the common items for a syllabus suggested by O'Brien et al. (2008):

> Table of contents; Instructor information; Student information form; Letter to the students or teaching philosophy statement; Purpose of the course; Course description; Course objectives; Readings; Resources; Course calendar; Course requirements; Policies and expectations: Attendance, late papers, missed tests, class behaviors, and civility; Evaluation; Grading procedures; How to succeed in this course: Tools for study and learning. (p. 40)

Roulston (2010) describes phenomenological interviews as relatively unstructured, with open-end questions. The interviews for this study were semi-structured with open-ended questions and lasted approximately 60 minutes. The focus of the interviews was to gain knowledge of the meaning of lived experiences (Roulston, 2010) of mathematics instructors while establishing teaching presence in online higher education mathematics courses. A list of specific questions were asked of all participants; however, follow-up questions could be different for each participant (Vagle, 2016). The list of questions consisted of five questions pertaining to teaching online courses, five questions pertaining to teaching face-to-face courses, and one question pertaining to both face-to-face and online courses. The interview questions were:

1. How do you deliver course content in online courses?
2. How do you ask and answer questions in online courses?
3. How do you establish dialogue between students in online courses?
4. How do you assess student learning in online courses?
5. How do you encourage students to meet deadlines in online courses?
6. How do you deliver course content in face-to-face courses?
7. How do ask and answer questions in face-to-face courses?
8. How do you establish dialogue between students in face-to-face courses?
9. How do you assess student learning?
10. How do you encourage students to meet deadlines in face-to-face courses?
11. What is the difference between how you establish teaching presence in online courses versus how you establish teaching presence in face-to-face courses?

The researcher engaged the participants in an ice-breaker conversation before the interview began in order to create a relaxed environment for the interview. The researcher announced when the recording began and ended. It was not necessary to ask follow-up questions. The names of institutions were not reported. All data were coded for anonymity. When the interviews were transcribed, participants' names were replaced with pseudonyms. Each recorded interview was stored as a digital video file on the researcher's r drive which requires log-in credentials. Recording the data prevented the loss of data because "everything said is preserved for analysis" (Merriam, 1998, p. 87). However, the researcher took notes for the purpose of isolating statements requiring special emphasis by the researcher or elaboration by the interviewee. Course syllabi were also stored on the researcher's r drive. All data for this study will be deleted from the researcher's storage device 3 years after the conclusion of the study.

Data Collection Tools

Three instruments were used to gather data for this research—a modified CoI survey (see Appendix G), a semi-structured interview (see Appendix D), and a checklist (see Appendix E). The CoI survey (see Appendix F) emerged from a study conducted by Arbaugh et al. (2008). The CoI survey is valid and reliable when measuring teaching presence, cognitive presence, and social presence as described by the CoI framework (Arbaugh et al., 2008). This survey is available for use under the Creative Commons license, and it may be altered (CoI Survey, n.d.). In item 2, "student learning outcomes" replaced "course goals." All statements in the survey were considered in present tense and third person (see Appendix G) because the measures of teaching presence in the survey were used to code the online course syllabi. The measures of teaching presence were used to create a rubric (see Appendix H) that was used for analyzing interview data for online courses and syllabi data for online courses. For example, a measure for design and organization (instructional management) is "The instructor clearly communicates important course topics." The word "clearly" is not well-defined; its meaning is subject to the person completing the survey. If the syllabus for an online course indicates that the instructor communicates course content using video and text, the researcher recorded the instructor as clearly communicating important topics (see Table 2). Also, the researcher recorded an instructor who reports communicating course content using video and text as clearly communicating important topics (see Table 3).

Table 2

Syllabi Criterion for the Instructor Clearly Communicates Important Course Content

Instructor's Teaching Presence	Measure is Met
The syllabus indicates that the instructor communicates course content using video and text.	yes
The syllabus indicates that the instructor communicates course content using either video or text.	almost
The syllabus does not indicate that the instructor delivers course content by using video or text.	no

Table 3

Interview Criterion for the Instructor Clearly Communicates Important Course Content

Instructor's Teaching Presence	Measure is Met
The instructor reports communicating course content using video and text.	yes
The instructor reports communicating course content using either video or text.	almost
The instructor does not report communicating course content by using video or text.	no

The questions for the semi-structured interviews were created by the researcher. The interview questions were based on teaching presence as described by Garrison et al. (2000). The list of questions consisted of five questions pertaining to teaching online courses, five questions pertaining to teaching face-to-face courses, and one question pertaining to both face-to-face and online courses. The researcher piloted the interview questions by interviewing a mathematics instructor who met the criteria for participating in the study, but who would not be a participant in the study. The phenomenon of establishing teaching presence emerged; therefore, the interview questions were not revised.

Data were collected from the syllabi according to the measures of teaching presence outlined in the CoI survey (see Appendix F) and a checklist created by the researcher (see Appendix E). The items included in the checklist were based primarily on the common items for a syllabus suggested by O'Brien et al. (2008):

> Table of contents; Instructor information; Student information form; Letter to the students or teaching philosophy statement; Purpose of the course; Course description; Course objectives; Readings; Resources; Course calendar; Course requirements; Policies and expectations: Attendance, late papers, missed tests, class behaviors, and civility; Evaluation; Grading procedures; How to succeed in this course: Tools for study and learning. (p. 40)

Procedures

This study involved a phenomenological analysis of interview data describing the lived experiences of higher education mathematics instructors establishing teaching presence in online mathematics courses. To gain additional information, the researcher conducted a content analysis of the participants' face-to-face and online course syllabus. Before collecting data, the researcher gained approval from the Institutional Review Board (IRB) at Nova Southeastern University and the researcher's institution of employment.

After receiving IRB approval from both institutions, the researcher emailed mathematics instructors employed by a public university system, requesting their participation in the study (see Appendix A). This email contained a consent form. The researcher did not send a follow-up request one week later even though the number of respondents did not produce the desired number of research participants. The researcher followed up with telephone calls when respondents who met the criteria for participation declined the invitation because they misunderstood the criteria. Due to this misunderstanding, the researcher found it necessary to revise and resend the invitation (see Appendix A).

This study included 10 mathematics instructors from a public university system composed of 26 institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges (University System of Georgia, 2018a). Participation in this study was voluntary, and the participants could withdraw from the study at any point in the process. Participants were to be selected by means of maximal variation sampling, which is a type of purposeful sampling (Creswell, 2012), in order to gather data representative of the diverse universities within the university system. The criteria for participation are listed below:

a) The participants must have experienced the phenomenon of establishing teaching presence in higher education face-to-face mathematics courses.
b) The participants must have experienced the phenomenon of establishing teaching presence in higher education online mathematics courses.
c) The participants must have the ability to explain their everyday conscious experiences when establishing teaching presence (Creswell, 1998; Polkinghorne, 1989).

The process for selecting participants yielded participants from three categories of institutions—research universities, state universities, and state colleges. The first participants selected were mathematics instructors from the researcher's institution, which is a research institution. The remaining participants were selected from a comprehensive university, state university, state college, historically Black university, and research university, respectively. The participants were chosen from each category based on the order in which consent forms were received. This process continued until 10 participants were selected. Note that it was possible for a participant to be employed by a state university and historically Black university simultaneously because the historically Black universities are state universities.

After a participant was selected and the researcher received the participant's consent form, the researcher scheduled a time to interview the participant. The researcher also requested both a face-to-face and online course syllabus for courses taught by the participant.

The interviews for this study were semi-structured with open-ended questions. The focus of the interviews was to gain knowledge of the meaning of lived experiences (Roulston, 2010) of mathematics instructors while establishing teaching presence in online higher education mathematics courses. A list of specific questions (see Appendix D) were asked of all participants; however, follow-up questions could be different for each participant (Vagle, 2016). The list contained five questions pertaining to teaching online courses, five questions pertaining to teaching face-to-face courses, and one question pertaining to both face-to-face and online courses. The interviews for this study lasted approximately 60 minutes.

The interviews were conducted and recorded via web conferencing. The researcher engaged the participant in an ice-breaker conversation before the interview began in order to create a relaxed environment for the interview. The researcher announced when the recording began and ended. It was not necessary to ask follow-up questions. The names of institutions were not reported. All data were coded for anonymity. When the interviews were transcribed, participants' names were replaced with pseudonyms. Each recorded interview was stored as a digital video file on the researcher's r drive which requires log-in credentials. Notes were taken for the purpose of isolating statements requiring special emphasis by the researcher or elaboration by the interviewee.

The researcher did not begin analyzing interview data until all interview data had been collected. The interview data were subject to a phenomenological analysis, which consists of three core processes—epoché, transcendental phenomenological reduction, and imaginative variation (Moustakas, 1994). Epoché required the researcher to bracket or set aside biases and experiences regarding the phenomenon in order to understand the phenomenon from the participants' point of view. During the process of transcendental-phenomenological reduction, the data were reviewed, coded, grouped, reduced, and described. Finally, the imaginative variation process involved finding meaning (Moustakas, 1994). The phenomenon was examined through the participants' experiences, from different angles or perspectives (Merriam, 1998).

Following the phenomenological analysis, the online course syllabi were subjected to a content analysis, with the codes being the measures of teaching presence outlined in the CoI survey (see Appendix F). The content analysis also employed a checklist created by the researcher (see Appendix E) to analyze both online course syllabi and face-to-face course syllabi. The results of both the phenomenological analysis and the content analysis were analyzed based on a rubric (see Appendix H) to determine the degree to which the processes used by mathematics instructors to establish teaching presence in higher education online mathematics courses align with the measures of teaching presence contained in the CoI survey.

Interview data, course syllabi, and coding of all data were stored on the researcher's required storage device. All data will be deleted from the researcher's required research storage device 3 years after the conclusion of the study.

Data Analysis

Phenomenological analysis. Phenomenological analysis was used to organize and analyze the interview data for this study. This analysis consisted of three core processes—epoché, transcendental phenomenological reduction, and imaginative variation (Merriam, 1998; Moustakas, 1994).

Epoché. According to Patton (1990) epoché adds rigor to the analysis. Epoché is not an isolated event, but a continuous process (Merriam, 1998), which required the researcher to bracket or set aside biases and experiences regarding the phenomenon in order to understand the phenomenon from the participants' point of view (Moustakas, 1994). Epoché also enabled the researcher to listen naively to the participants because epoché required the researcher to disregard preconceptions, beliefs, and prior knowledge related to the phenomenon being studied (Moustakas, 1994).

Transcendental-Phenomenological reduction. During the process of transcendental-phenomenological reduction, the data were reviewed, coded, grouped, reduced, and described (Moustakas, 1994). The transcription of the interview is called a textural description. Each textural description was reviewed to isolate or bracket statements relevant to the phenomena. At this point in the study, horizonalization occurred, which means all bracketed statements were viewed with equal value. Next, data from the isolated statements were coded based on meaning. Afterwards, the coded data were clustered into categories or groups based on themes, and repetitive, vague, and irrelevant statements were removed. The remaining statements, which were composed of textural meanings and invariant constituents of the phenomenon, are called horizons. Then, textural descriptions were given to each category or group to describe what happened during the participants' experiences related to the phenomenon. Finally, the textual descriptions for all participants were consolidated to form a composite textual description.

Imaginative variation. The imaginative variation process involved finding meaning (Moustakas, 1994). During this process, the phenomenon was examined through the participants' experiences, from different angles or perspectives (Merriam, 1998). The experiences were described based on the textural descriptions resulting from the transcendental-phenomenological reduction. The experiences were also described based on universal structures, such as the structure of time, space, bodily concerns, materiality, causality, and interpersonal and intrapersonal relationships (Moustakas, 1994). The descriptions, which are called structural experiences (Moustakas, 1994), revealed the underlying and causative factors that contribute to the existence of the experiences (Merriam, 1998). That is, structural experiences respond to the question, "How did the experience of the phenomenon come to be what it is?" (Moustakas, 1994, p. 98). The structural descriptions for all participants were integrated to form a composite structural description (Moustakas, 1994).

Synthesis of descriptions. The final step of the phenomenological analysis involved creating a synthesis of the composite textural and composite structural descriptions (Moustakas, 1994). The synthesis should include "clear, precise, and systematic descriptions of the meaning that constitutes the activity of consciousness" (Polkinghorne, 1989, p. 45). The essence of the phenomenon emerges (Wertz, 1989). The processes by which mathematics instructors establish teaching presence in online mathematics courses emerged. These processes were compared to the measures of teaching presence outlined in the CoI survey (see Appendix F).

Checklist. A checklist was used to review each syllabus for common information. The items included in the checklist are based primarily on the common items for a syllabus suggested by O'Brien et al. (2008):

> O'Brien et al. (2008) suggested that a course syllabus include the following items: Table of contents; Instructor information; Student information form; Letter to the students or teaching philosophy statement; Purpose of the course; Course description; Course objectives; Readings; Resources; Course calendar; Course requirements; Policies and expectations: Attendance, late papers, missed tests, class behaviors, and civility; Evaluation; Grading procedures; How to succeed in this course: Tools for study and learning. (p. 40)

Content analysis. Content analysis was used to study the most recent face-to-face and online course syllabi developed by the participants in this study. Content analysis is a research method by which textual artifacts—which may include books, articles, cartoons, graffiti, newspaper headlines, historical documents, and interview transcripts (Klenke, Wallace, & Martin, 2015)—are explored in order to recognize meanings (Krippendorff, 2013) or make inferences (Weber, 1990). Content analysis reveals cultural information pertaining to the object of the text or the author or creator of the text (Ungvarsky, 2017). While content analysis can be tedious (Ungvarsky, 2017), it is not intrusive (Krippendorff, 2013).

During the reading of each syllabus, textual content was reduced and organized by means of coding (Creswell, 1998). Schwandt (2007) describes coding as "a procedure that disaggregates the data, breaks them down into manageable segments, and identifies or names those segments" (p. 32). The names of these segments are called codes; codes with common characteristics are grouped into categories (Creswell, 2013).

The categories for this content analysis were the categories for the measures of teaching presence contained in the Community of Inquiry (CoI) survey (see Appendix F). The categories are design and organization, facilitation, and direct instruction.

Each syllabus was read three times: first to code for design and organization, second to code for facilitation, and third to code for direct instruction. During each reading, these codes were indicated in the margins of the syllabus as they occur based on words, phrases, sentences, and paragraphs presented in the text relating to measures of teaching presence contained in the Community of Inquiry (CoI) survey (see Appendix F). After the content from each syllabus was coded, the codes were grouped in the categories of design and organization, facilitation, and direct instruction. Afterwards, the categories were examined for alignment with the measures of teaching presence contained in the CoI survey based on a rubric (see Appendix H).

Ethical Considerations

This study was conducted in an ethical manner. Before data could be collected, the Institutional Review Boards from the appropriate institutions granted approval for this study. Afterwards, potential participants received a letter via email requesting participation. An informed consent document was attached to the email. This form described the requirements for participation, rights of participants, procedures for data collection and storage, publishing of results, and the study in a comprehensible manner (Oliver, 2010; Webster, Lewis, & Brown, 2014). According to Oliver (2010), "The principal matters, in an ethical sense, are that as researchers we take all reasonable measures to ensure the peace of mind, and fair treatment of the people we ask to help us with our research" (p. 47).

The researcher also engaged in ethical consideration when reporting the data and findings of this study. The researcher reported and wrote with integrity. The data and findings for this study were not be based on the researcher's personal interest or originated from previously published studies (Creswell, 2012).

Trustworthiness

In general, educational researchers view validity as "the trustworthiness of inferences drawn from data" (Eisenhart & Howe, 1992, p. 644). Furthermore, the degree of validity "depends on the power of its presentation to convince the reader that its findings are accurate" (Polkinghorne, 1989, p. 57). Qualitative researchers have used terms such as validity, reliability, rigor, trustworthiness, credibility, transferability, relevance, and confirmability when evaluating the quality of their studies (Freeman, deMarrais, Preissle, Roulston, & St. Pierre, 2007). The researcher established validity for this study by (a) bracketing or setting aside her biases and experiences regarding the phenomenon (Roulston, 2010), (b) testing the interview questions with a potential participant (Merriam, 1998; Polkinghorne, 1989; Roulston, 2010), (c) describing the processes for collecting and analyzing data (Freeman et al., 2007; Polkinghorne, 1989; Potter & Levine-Donnerstein, 1999; Roulston, 2010), (d) avoiding ambiguous word meanings, category descriptions, and coding rules (Weber, 1990), (e) developing a coding schema consistent with theory (Potter & Levine-Donnerstein, 1999), (f) evaluating the summaries of data from the content analysis based on theory, definitions, and common understandings of words (Potter & Levine-Donnerstein, 1999; Weber, 1990), and (g) staying engaged with the study (Vagle, 2016).

To test the interview questions, the researcher interviewed a mathematics instructor who met the criteria for participation in this study. The interview data were subject to a phenomenological analysis. The interview questions were not revised because the interview data addressed the research questions.

To check for coder reliability, the researcher and a colleague coded the same syllabus. The researcher compared the data for inconsistencies in coding. The researcher made the necessary adjustments for coding the text from the syllabi to avoid inconsistencies.

Limitations

Creswell (2012) defined limitations as "potential weaknesses or problems with the study identified by the researcher" (p. 199); they are present, in varying degrees, in all studies. The present study is limited in at least two respects: (a) the number of participants and (b) the types of institutions represented. The plan for this study was to include 12 mathematics instructors from a public university system composed of 26 institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges (University System of Georgia, 2018a). Including 12 participants would allow for attrition. However, only 10 instructors consented to participation in this study. Six of the instructors were from research institutions, three from state colleges, and one from a state university. Comprehensive universities were not represented, and 60% of the participants were from research institutions. In addition, none of the participants were employed by a historically Black university within the university system. In this case, the data may not reflect the experiences of "key constituencies within the population" (Ritchie et al., 2014, p. 119). As a result, the findings of this study may not be generalizable, which is characteristic of a qualitative study (Ritchie et al., 2014).

In addition, there are two potential problems associated with this study. First, the CoI survey is a data collection tool for this study. Garrison et al. (2010) explain that the CoI framework, which focuses on transactions occurring in asynchronous, text-based group discussions, provides the theoretical foundation for the CoI survey. Therefore, the CoI survey may not be applicable to the interview data and syllabi data collected for this study because these data apply throughout entire mathematics courses, not only asynchronous, text-based group discussions. Second, in the absence of facial cues from students, instructors for online mathematics courses may not know when it is necessary to review course content. According to Dahlke (2008), mathematics content "will fade from memory if it is not used frequently" (p. 524).

Potential Research Bias

The researcher for this study is a mathematics professor who has experience teaching both face-to-face and online undergraduate courses. The process of epoché, which is the first component of phenomenological analysis, required the researcher to set aside biases in order to gather data based on the participants' point of view (Moustakas, 1994). Also, the researcher remained neutral during the interviews and did not ask the participants leading questions (Roulston, 2010).

Summary

This phenomenological study described, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. The 10 participants for this study were selected purposively from five categories within a university system—research institutions, comprehensive institutions, state universities, state colleges, and historically Black universities. Data were gathered from semi-structured interviews and course syllabi. Both sets of data were examined for emerging patterns related to teaching presence.

Interview data were subjected to phenomenological analysis. A phenomenological analysis consists of epoché, transcendental-phenomenological reduction, imaginative variation, and synthesis of descriptions (Merriam, 1998; Moustakas, 1994). Epoché required the researcher to bracket or set aside biases and experiences regarding the phenomenon in order to understand the phenomenon from the participants' point of view (Moustakas, 1994). During the process of transcendental-phenomenological reduction, the data were reviewed, coded, grouped, reduced, and described (Moustakas, 1994). The imaginative variation process involved finding meaning (Moustakas, 1994). Finally, during the synthesis of descriptions, the essence of the phenomenon emerged (Wertz, 1989).

Syllabi were subjected to content analysis. Content analysis is a research method by which textual artifacts—which may include books, articles, cartoons, graffiti, newspaper headlines, historical documents, and interview transcripts (Klenke et al., 2015)—are explored in order to recognize meanings (Krippendorff, 2013) or make inferences (Weber, 1990). In addition, content analysis reveals cultural information pertaining to the object of the text or the author or creator of the text (Ungvarsky, 2017). The categories for this content analysis were the categories for the measures of teaching presence—design and organization, facilitation, and direct instruction—contained in the Community of Inquiry (CoI) survey (see Appendix F).

Chapter 4: Findings

This chapter presents findings from a phenomenological study, which describes, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. Phenomenological analysis was used because it enabled the researcher to examine the lived experiences of mathematics instructors—the perceptions, beliefs, memories, decisions, feelings, judgments, or evaluations of these instructors (Schwadt, 2007)—while establishing teaching presence. Furthermore, a content analysis of course syllabi was implemented to supplement interview data. The topics included in this chapter are (a) participants' demographic data, (b) purpose and research questions, (c) interview and syllabi data, and (d) summary of key findings.

The Participants

This study included mathematics instructors from a public university system composed of 26 institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges (University System of Georgia, 2018a). A request for participation (see Appendix A) and consent form (see Appendix B) were sent to mathematics instructors from each type of institution. The researcher received emails from potential participants declining to participate in the study because they were not currently employed full-time by the public university system. Therefore, the researcher sent a request for participation that clarified the employment status of participants (see Appendix A).

Participants were selected by means of maximal variation sampling, which is a type of purposeful sampling (Creswell, 2012), in order to gather data representative of the diverse universities within the university system. Ten instructors accepted the request for participation. Six of the instructors were from research institutions, three from state colleges, and one from a state university. None of the participants were employed by a historically Black college university within the university system.

The participants were given pseudonyms to protect their identities. Note that the years of teaching mathematics does not include years of teaching as a graduate student. Also, all participants teach or have taught undergraduate mathematics courses online. None of the participants teach or have taught graduate mathematics courses online.

Participant 1, an adjunct professor at a state university, has 14 years of experience teaching mathematics face-to-face and 12 years of experience teaching mathematics online. Participant 2, a lecturer at a research university, has 22 years of experience teaching mathematics face-to-face and 2 years of teaching mathematics online. Participant 3, a retired associate professor, is an adjunct professor at a state college. Participant 3 has 44 years of experience teaching mathematics face-to-face and 15 years of teaching mathematics online. Participant 4, an assistant professor at a research university, has 30 years of experience teaching mathematics face-to-face and 3 years of teaching mathematics online. Participant 5, an associate professor at a research university, has 29 years of experience teaching mathematics face-to-face and 2 years of teaching mathematics online. Participant 6, an assistant professor at a state college, has 38 years of experience teaching mathematics face-to-face and 3 years of teaching mathematics online. Participant 7, an associate professor at a state college, has 13 years of experience teaching mathematics face-to-face and 6 years of teaching mathematics online. Participant 8, an associate professor at a research university, has 15 years of experience teaching mathematics face-to-face and 1 year of teaching mathematics online. Participant 9, an associate professor at a research university, has 16 years of experience teaching mathematics face-to-face and 6 years of teaching mathematics online. Participant 10 is a full professor at a research university. Participant 10 has 28 years of experience teaching mathematics face-to-face and 8 years of teaching mathematics online.

Purpose and Research Questions

The purpose of this phenomenological study is to describe, based on the teaching presence component of the Community of Inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. Indicators of teaching presence can be divided into three categories: (a) instructional management, (b) building understanding, and (c) direct instruction (Garrison et al., 2000).

The three main research questions and their subquestions are:

1. How do mathematics instructors establish teaching presence in online higher education mathematics courses?
    a. How do mathematics instructors deliver course content in online courses?
    b. How do mathematics instructors ask and answer questions in online courses?
    c. How do mathematics instructors establish dialogue between students in online courses?
    d. How do mathematics instructors assess student learning in online courses?

   e. How do mathematics instructors encourage students to meet deadlines in online courses?

2. How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?
   a. How do mathematics instructors deliver course content in face-to-face courses?
   b. How do mathematics instructors ask and answer questions in face-to-face courses?
   c. How do mathematics instructors establish dialogue between students in face-to-face courses?
   d. How do face-to-face mathematics instructors assess student learning?
   e. How do mathematics instructors encourage students to meet deadlines in face-to-face courses?
3. What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?

The research questions are the same as the interview questions.

Presentation of Findings

Data pertaining to how mathematics instructors establish teaching presence in online higher education mathematics courses were collected from semi-structured interviews and course syllabi. The research questions are the same as the interview questions. Data were collected from both interviews and course syllabi because indicators of teaching presence could be present in the (a) interviews, (b) course syllabi, or

(c) interviews and course syllabi. The interviews were subject to a phenomenological analysis and the syllabi were subject to a content analysis.

Results for Research Question 1

Research Question 1 asked, "How do mathematics instructors establish teaching presence in online higher education mathematics courses?" This question was answered by the interview responses to Subquestions 1a–1e (see Appendix D), the results from the Checklist of Common Items on Syllabi (see Appendix E), the results from the Rubric for Analyzing Interview Data for Online Courses and Syllabi Data for Online Courses (see Appendix H), and the modified CoI Community of Inquiry Survey (see Appendix G).

Results of research Subquestion 1a. Research Question 1a asked, **"**How do mathematics instructors deliver course content in online courses?" All participants reported delivering course content using video and print-based instruction. A theme, *instructor delivers content*, which is an indicator of the teaching presence category, direct instruction, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 1a.

Participant 1 reported using both instructor-made and online videos, graded discussions, and a textbook for delivering content in online courses;

> The students will read some of the materials in the textbook on data collection and strategies for data collection. They will watch a video. If I can't find a video that's appropriate, I will create a video using a screencast. Then I will have a discussion on them sharing some sample data that they've collected as a group…. It's very challenging, but I find that discussions are helpful and should be part of an online math course, for sharing, for looking at each other's work…

Participant 2 uses instructor- and publisher-made PowerPoint presentations and PowerPoints with voice-over. Participant 4 reported delivering course content through a combination of written materials and self-made videos. Participant 5 reported using instructor-made video lectures and print-based notes, as well as web conferencing office hours. Participant 5 said,

> I post lectures online in Desire2Learn which is the main platform that I use for teaching, as well as conduct daily online office hours…. I'll post additional notes, plus solutions to problems, plus solutions to exams.

Participant 3 reported using content created and posted by eCore. According to Participant 3, ecore uses online textbooks. Participant 3 explained "I don't have to develop any of the content"; the syllabus for the online course is set by the educational specialist at eCore, "so I don't really deliver any content." Participant 3 further explained that the educational specialists take pages from the textbook and insert videos, and that the videos seems to be beneficial to the students; "A lot of the students report to me that they get a lot of benefits out of the videos." Participant 3 said, "With the eCore program, everything is already programmed for you." Similarly, Participant 6 said, "My online classes are predominantly a shell that the institution has given us, and we follow the protocol. We can interject our own examples and explanations and videos." Participant 6 reported creating videos for specific questions. Participant 6 explained, "I will add note material that I think will make matters easier for them…. The basic material that they want the students to do is already loaded up. The classes use MyMathLab."

Participant 10 reported delivering course content through lecture notes, instructor-made videos, and online videos. Participant 10 stated that the lecture notes are posted in

Desire2Learn. “I have uploaded all my class notes in pdf format…. Students can either download or maybe even print them…. My class notes are self-explanatory. I have introduced each concept with motivation and several examples.” Participant 10 explained that the complete solutions are provided for some of the examples, and the other examples are for students to practice. Participant 10 also reported providing solutions for the practice problems. Participant 10 stated,

> I give them a chance to do the problems first by themselves, and if they cannot get the answers, they can look at my solutions and verify them. So I provide several examples, and highlight all the important things that they have to remember. I have provided lots of highlights in my notes, and they find it useful.

Furthermore, Participant 10 reported developing and posting videos to explain difficult concepts, as well as providing students with links for online videos.

Participant 7 reported delivering course content “mainly via assessment software which provides the training videos and an interactive ebook, online assessments with immediate feedback, and an online project.” Participant 8 reported delivering course content by creating video lectures and posting the lectures in Desire2Learn. Participant 8 also reported delivering content directly off the Web, such as interactive statistical tutorials, and online homework.

Participant 9 reported delivering course content by using the textbook for the course, directing students to multimedia files within MyMathLab, providing face-face-face office hours, helping with homework, and providing print-based instruction, such as problems. Some of courses taught by Participant 9 use MyMathLab, and some courses use WebAssign. In addition, Participant 9 stated, “I may…create some more materials…like problems…. They will be additional examples that I think are interesting and that may not be well enough enforced in the book or in MyMathLab." Participant 9 provides answers for the additional examples.

Results of research Subquestion 1b. Research Question 1b asked, "How do mathematics instructors ask and answer questions in online courses?" Based on participants' responses, all participants receive and answer questions in their online courses by email. In the case where several students ask the same question, participants reported posting the answer on a discussion board for the entire class to view. Some participants also ask and answer questions via both face-to-face and online office hours, text messages, phone calls, announcements, video, online assignments, and the "Ask My Instructor" features of the online homework software. A theme, *instructor engages students with questions and answers*, which is an indicator of the teaching presence category, direct instruction, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 1b.

Participant 1 responded,

> A lot of students use email, which is fine. Some will text me. It depends on the comfort level they have.…One of the keys I found out is responsiveness, so I try to practice responsiveness within a few hours, 6 or 7 hours, try to answer the students or get back to them and acknowledge their email within the same day.

Participant 2 reported mainly using email, using the discussion board, and hosting face-to-face office hours. Similarly, Participant 3 reported, "There's a dedicated email within the eCore system…. We can also text them or call them privately on cell phones. Most of the time, I communicate with students by email." In addition, Participant 3 said, "I communicate a lot with them through the announcements, as well as through the email platform." However, Participant 3 reported answering students' content related questions usually by email. Furthermore, Participant 3 interacted with students on the course's discussion board. Participant 3 said,

> There's also a discussion board within each course, and there's a place to ask questions about the content within the discussion board…. This last semester, I was teaching College Algebra, and there were specific discussion questions that students had to answer.

Participant 3's, students were also required to interact with each other on the discussion board. Participant 3 said, "I would go in, read them." Whenever students had questions or posted incorrect mathematics, Participant 3 would "jump in and explain" the concept. Regarding texting, when Participant 3 was asked whether a personal cell phone was used for texting students, Participant 3 responded,

> Yes…. If it's anything to do with grades, I have to refer them to the email platform because we are not allowed to text confidential… information…. If it's a question that deals with content…, I usually refer them, look at my email. I'll send you a more detailed email…. Texting is for emergency situations, specifically if a student misses a deadline, they miss a quiz or a test, they say, "I was sick in the hospital, whatever, can you reopen something?"

Participant 4 responded, "I have primarily done so using the Ask My Instructor features in the software, with email, with some face-to-face office visits, and very rarely by web conferencing." Participant 5 reported using email, discussions boards, and web conferencing software. Participant 5 said,

> People will log in and ask particular questions like, "What to study for the test?" I'll also have students email me with problems that they can't do in the homework, and they ask me to provide solutions for them. I'll write up the solutions, scan them, and email them, or I'll also post them on Desire2Learn for everybody to be able to see.

Participant 6 asked and answered questions in online courses "by email, by video. Also, I ask and answer questions within the discussion forums." Participant 7 responded, "I do not ask questions. I only answer questions." Participant 7 reported answering questions through email and the discussion board. Participant 8 reported,

> One way is through message boards in Desire2Learn. There is a message board set up for each chapter in each course, and also, students can ask questions via the student portal in WebAssign…via email also…. Usually, if a student asks a question via email, I'll respond via email. If more than one student asks the same question, I will usually then take the question, post it in one of the Desire2Learn message boards, and refer the student to the Desire2Learn message board.

Participant 10 reported having students complete quizzes, homework assignments, and tests in MyMathLab. According to Participant 10, all quiz and homework questions are publisher-made. However, Participant 10 said, "For all the exams, I insert instructor-graded questions, and those questions are developed by me. I have to grade them manually." Furthermore, Participant 10 reported receiving questions from students via email and the discussion board. Participant 10 explained that all students in the class can see both questions and answers posted on the discussion board.

Results of research Subquestion 1c. Research Question 1c asked, "How do mathematics instructors establish dialogue between students in online courses?" The strategies used for establishing dialogue between students in online courses included graded discussions, optional discussions, face-to-face test reviews, face-to-face problem sessions, and optional study groups. All of the participants reported giving students an opportunity to post on a discussion board. A theme, *instructor and students engage in discourse for meaning*, which is an indicator of teaching presence category, building understanding, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 1c.

For establishing dialogue between online students, Participant 1 reported, "Through discussions, I require them to reply to other." According to Participant 1, students' replies are graded. In addition, Participant 1 said, "There's a lot of monitoring…. Students can go off track, and it happens a lot in math." As a result, Participant 1 reported monitoring discussions every day to make sure students were not off track "because if they're off track, the students that need to reply to them are going to be off track." Participant 1 explained that answers will be incorrect. Furthermore, when responding to Subquestion 1a, Participant 1 said,

> The discussions are graded…at least 20% of the grade. It's very challenging, but I find that discussions are helpful and should be a part of an online math course, for sharing, for looking at each other's work, having a comfortable environment where they can share ideas and they feel comfortable looking at each other's work.

Participant 2 reported establishing dialogue between online students through discussions, which are not graded. According to Participant 3, students are required to participant in discussions about certain topics. Participant 3 further explained,

> When they post something on the discussion board, they are required to communicate with at least two other people in the class. I follow the conversations. We log in every day. I look at the discussion every day. I see some pretty good feedback to and fro between the students. So they kind of take it upon themselves to establish that dialogue.

Then Participant 3 explained, “I jump in every once in a while to encourage students or correct misconceptions.”

To establish dialogue between online students, Participant 4 reported experimenting some with the discussion board; however, Participant 4 provides opportunities for students to interact face-to-face. Participant 4 holds optional face-to-face test reviews. Participant 4 explained that the test reviews “tend to be somewhat collaborative, such as working on a worksheet.” When asked how dialogue is established between Participant 5’s online students, Participant 5 said, “Either through the forums in Desire2Learn, or I have had them come in for problem sessions in person. They can talk to each other about any problems they are having with the course material.” According to Participant 5, the forums are optional discussions.

Participant 6 responded, “Between the students, they interact inside of the forums. They have two forums they do most every week. One is skilled-based, and one is more critical-thinking based. They interact with each there, along with interacting with me.” Furthermore, Participant 6 said, “The forums are graded. The skills have an accuracy component.” According to Participant 6, the critical-thinking component is not graded for accuracy as strongly.

Participant 7 establishes dialogue between online students "via the discussion board mainly." The discussions are not graded. According to Participant 8, establishing dialogue between online students is sometimes challenging, Participant 8 said,

> I do require each student to, at the beginning of the course, introduce themselves virtually to the rest of the class using the Desire2Learn message board, just providing some very basic information, who they are, why there're taking the course.

Furthermore, Participant 8 said, "I do try to encourage students to form study groups outside of the course."

Participant 9 reported establishing dialogue between online students by using discussion forums when teaching at other institutions. Students would discuss five or six problems on the discussion board. The discussions were graded for both accuracy and participation. Similarly, Participant 10 also reported establishing dialogue between students via the discussion board. Participant 10 said, "They can post questions." According to Participant 10, students are permitted to ask questions about course concepts, but not questions pertaining to homework assignments, and to answer questions posted on the discussion board. Participant 10 explained that the discussions, in addition to completing assignments on time, count as 5% of the overall course grade.

Results of research Subquestion 1d. Research Question 1d asked, "How do mathematics instructors assess student learning in online courses?" Participants reported assessing student learning in online courses by discussions, projects, online homework, quizzes, tests, midterm exams, and final exams. Nine of the participants reported assigning online homework; Participant 6 and Participant 10 mentioned using online homework when responding to Subquestion 1e, "How do mathematics instructors encourage students to meet deadlines in online courses?" Some of the participants administered proctored tests, midterm exams, and/or final exams. A theme, *instructor assesses learning*, which is an indicator of the teaching presence category, direct instruction, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 1d. In addition, a theme, *instructor uses assessments with automatic feedback*, which is an indicator of the teaching presence category, instructional management (design & organization), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 1d.

Participant 1 responded, "I require students to submit their own handwritten work, in most cases. In some cases, when I have them use Excel, because it's appropriate for statistics, I do have specific grading criteria" Participant 1 also reported using MyMathLab for students to practice. Furthermore, Participant 1 explained that by incorporating MyMathLab assignments, students receive immediate feedback.

Participant 2 assesses student learning in online courses through chapter tests, quizzes, and homework, all of which are administered online. Participant 2 also reported having a face-to-face final exam. Participant 3 assesses student learning in online courses through quizzes, test, online homework, discussions, a proctored midterm exam, and a proctored final exam. The quizzes, tests, and homework are graded automatically. Participant 3 said, "I don't really do any grading outside of the discussions. For the math courses, they have to do at least one proctored exam." According to Participant 3, students may have their exams proctored face-to-face at their campuses or virtually by private companies.

Participant 4 described assessing student learning in online course “the same way” that learning is assessed in Participant 4’s face-to-face courses. Participant 4 said, “I have proctored tests as well as online assignments through the homework system.” Participant 4’s students may take tests during proctored sessions offered by Participant 4, take tests at the campus testing center, or take tests at other universities’ testing centers. Participant 5 assesses learning via online homework, proctored tests, and a proctored final exam. Participant 5 reported proctoring the tests and final exam; however, some of the students opt to test at the campus testing center, or approved, off-campus testing centers.

Participant 6 reported assessing student learning through graded assignments—discussions, homework, quizzes, a midterm exam, and a final exam—none which are proctored, which is a “drawback.” Participant 7 responded, “By homework, quizzes, and a project, midterm exam, and a final exam. The midterm is not proctored because I want them to have some experience first. The final exam is mostly the proctored one.” Participant 7 also explained that the project is an individual project, not a group project.

Participant 8’s students take three proctored exams and a comprehensive final exam. They also have graded WebAssign homework and three small computer projects. The projects are submitted online and demonstrate that students “have some facility with some course technology” and can actually do some applied statistics. Furthermore, “Students are instructed they can work with other students, but each student ultimately has to submit their own work, one project per student.”

Participants 9’s usual method of assessing student learning in online courses is tests:

There is a midterm or final. If it is a lower level, like college algebra or below, there will be chapter tests, one for each chapter, and of course, a comprehensive final, normally a weekly quiz and discussion forums, at least one every week.

According to Participant 9, the midterm, chapter tests, and quizzes are administered in MyMathlab and are not proctored. Participant 9 also reported assigning weekly homework assignments.

When asked how do you assess learning in online courses, Participant 10 responded, "I assess it by the homework assignments and the exams. I administer five exams in a semester plus the final exam."

Results of research Subquestion 1e. Research Question 1e asked, "How do mathematics instructors encourage students to meet deadlines in online courses?" Participants encouraged students to meet deadlines in online courses using different strategies. The most common strategies were sending weekly emails and posting weekly announcements. Other strategies included posting class statistics for tests, providing a late policy, providing detailed calendar containing assignments and due dates, sending reminders when due dates are approaching, and using the Remind App. One participant mentioned alerting students that online learning differs from face-to-face learning. Two themes, (a) *instructor establishes due dates and the flow of the course*, and (b) *instructor monitors student participation*, which are indicators of the teaching presence category, instructional management (design & organization), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 1e.

To encourage students to meet deadlines in online courses, Participant 1 reported using the features of the learning management system to send frequent announcements to students' emails. Participant 2 replied, "There is a pretty detailed calendar on their syllabus. It's a recommended system, how to take the course, but then there're actual deadlines for the tests and quizzes." Participant 2 reported sending out reminders about the tests and quizzes to help students stay on track. In addition, Participant 2 said, "Since my classes were relatively small, I could easily see if someone was not keeping up, and I could send them an email to make sure they were okay, not having trouble."

Participant 3 reported sending an email containing the agenda for the week and posting the agenda on the announcement page for the course. Most students reported liking the agenda on course evaluations. Participant 3's students know exactly "what's due each day of the week." Participant 3 also reported posting an additional announcement whenever something important is due. In addition, Participant 3 reported, if students are falling behind, "contacting the appropriate person at eCore, and they get in touch with the students who are having difficulty." Furthermore, Participant 3 reported texting or calling students who have fallen behind or having difficulty with the course.

Participant 4 replied,

> Well my course is pretty organized. Every single week they have a list of the week's activities that they should be doing. In addition to that, I send out a weekly newsletter reminding them and maybe letting them know problems I may be noticing. For instance, if people are behind on homework, I'll let them know that I've noticed that…. The newsletter is general, but I will prod extreme cases. I'm not worried if people are an assignment behind."

Participant 5 encourages students to meet deadlines in online courses "just by being very vigilant of how they are doing on a daily basis and being sure to contact them on an individual basis" when students "are not doing the work that they should be doing." Participant 5 also said,

> I send them a weekly bullet list of things that are coming up for the week that they need to be apprised of—any exams that are coming up, any homework assignments that are do. I do this on a weekly basis, sometimes a biweekly basis.

Participant 6 gives students all deadlines for the course. Students also have a news and announcement area on their course page, which they are encouraged to read daily. In addition, Participant 6 said that at the beginning of the week, I always "tell them when things are due that week." Furthermore, Participant 6 said, "They have items that are due on Wednesdays, so I will go in on Wednesday and type, 'Don't forget your initial post in the skills forum is due today.'" Participant 6 reported doing the same type of reminder for the initial post in the critical-thinking forum. It was necessary for Participant 6 to clarify the due dates and time:

> The time is 11:55. They have a deadline on Wednesday, Friday, and Sunday at 11:55…. Sometimes, if I see they haven't done something towards the end of the week, like their MyMathLab homework or quiz, I'll send them a little email, "Please don't forget to do this."

Participant 6 said that sending constant reminders is the best that can be done.

Participant 7 said, "I keep resending them messages." Participant 7 reported sending a reminder via Desire2Learn on the day an assignment is due. Participant 7 also asks students to sign on a mobile app called Remind, and on the due date for an assignment, sends a reminder directly to the students' cellphones. "The due date is typically Sunday night," so on Wednesday morning, Participant 7 sends an announcement on D2L, “You need to work on your assignments. Start early.” Participant 7 also reported sending a weekly announcement with due dates for the week.

Participant 8 reported reminding students about due dates “through email or occasionally through posting announcements on Desire2Learn.” Participant 8 said,

> Usually, at least three times a week, kind of mimicking what the course structure would be if they were taking a face-to-face course, I usually send out email reminders just letting the students know approximately what they should be doing each week of the semester. When there are due dates for homework or projects coming up, I usually try to remind students what those due dates are.

Participant 9 reported sending a weekly announcement at the beginning of the week, on Sunday, outlining assignments and deadlines for the week. Participant 9 said that the announcements are repetitive because most weeks are the same.

In addition, Participant 9 said,

> Normally, I would send some sort of message at the beginning of the class, trying to explain that this is a different type of course and they need to always be sort of on top of whatever they are doing. I also have a fairly clear late policy that I post at the beginning of the class which pretty much says, “You have the right to ask for an extension once without me asking what’s the reason, but if you need more than one, then you’ll need a serious reason for that, and it needs to be documentable.”

Participant 9 added, “Also, if I see a student that hasn’t done anything in a week or so, I may send a message saying, ‘Hey, you’re still around? What’s going on?’”

Participant 10 encourages students to meet deadlines in online courses “through constant reminders." Participant 10 said, "I send them email reminders all the time. That is the hardest part of teaching online courses, getting them to complete their homework assignments on time…. So I send them lots of email reminders." Participant 10 uses the search by criteria feature in MyMathLab to "see who hasn't started doing assignments." Afterwards, Participant 10 said, "I raise that issue with them, and they go ahead and complete the assignment on time." When asked whether or not weekly announcements are sent, Participant 10 replied, "I would say yes because I have nine homework assignments, five exams and then one final exam that means every week something or the other is due." Furthermore, Participant 10 said,

> I look at the performance of students in the completed assignments, and then I give them feedback. I give them information about how the rest of the class performed…as a sort of encouragement for them. So I tell them what the class average is and what the range is—minimum to maximum, the lowest to the highest—what the standard deviation is, what quartile they belong. Most of my students know exactly where they fit in the class, and that sort of encourages them to study more. I also look over the problems they missed the most, and I provide them my written solutions for those problems.

Results From the Checklist of Common Items on Online Course Syllabi

The results from the checklist are presented in Table 4. The items included in the checklist are based primarily on the common items for a syllabus suggested by O'Brien et al. (2008). All participants included the name of the course, instructor's name and contact information, grading procedures, study plan, and course materials (books, technology, etc.) on online syllabi.

Table 4

Common Items on Online Course Syllabi

Item	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
1. Table of contents										
2. Name of the course	x	x	x	x	x	x	x	x	x	x
3. Quarter or semester offered	x	x	x	x	x		x	x		x
4. Instructor's name and contact information	x	x	x	x	x	x	x	x	x	x
5. Course description	x		x		x	x	x			
6. Student learning outcomes	x	x	x		x	x	x			x
7. Policies and expectations	x	x	x		x	x	x	x	x	x
8. Communicating instructions	x	x	x	x	x	x		x	x	x
9. Attendance/Participation	x	x	x		x	x	x	x	x	x
10. Grading procedures	x	x	x	x	x	x	x	x	x	x
11. Study plan	x	x	x	x	x	x	x	x	x	x
12. Course materials (books, technology, etc.)	x	x	x	x	x	x	x	x	x	x
13. Academic honesty	x	x	x			x	x	x		x
14. Americans with Disabilities Act	x	x	x		x	x	x	x	x	x
15. Campus resources	x	x	x	x		x	x	x	x	x
16. Technical support	x	x	x		x	x		x		x

Notes. The letter "x" indicates that the item is included on the participant's online course syllabus. Each participant is represented by the letter "P" and the number from the participant's pseudonym.

Results From the Rubric for Analyzing Interview and Syllabi Data

Interview data for online courses and syllabi for online courses were analyzed according to the Rubric for Analyzing Interview Data for Online Courses and Syllabi

Data for Online Courses (see Appendix H). The results of the rubric were used to complete the CoI survey (see Appendix G) for each participant. The measures of teaching presence are indicated in italics and numbered according to the CoI survey (see Appendix G). All participants met measures 1 and 3 from the category of Design and Organization (Instructional Management), measure 7 from Facilitation (Building Understanding), and measure 12 from Direct Instruction. For facilitation (building understanding), nine participants met measure 8 and none of the participants met measure 11. The CoI survey results are presented in Tables 5–7.

Table 5

Design & Organization (Instructional Management)

Measure of Teaching Presence in CoI Survey	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
1.The instructor clearly communicates important course topics.	x	x	x	x	x	x	x	x	x	x
2. The instructor clearly communicates student learning outcomes.	x	x	x		x	x	x	x		x
3. The instructor provides clear instructions on how to participate in course learning activities.	x	x	x	x	x	x	x	x	x	x
4. The instructor clearly communicates important due dates/time frames for learning activities.	x		x	x	x		x		x	

Notes. The letter "x" indicates that the participant met the measure of teaching presence from the Community of Inquiry survey.

Summary for Research Question 1

Research Question 1 asked, "How do mathematics instructors establish teaching presence in online higher education mathematics courses?" Table 8 contains the themes related to teaching presence as described by the CoI framework that emerged from responses to Subquestions 1a–1e (see Appendix D). Table 4 indicates

Table 6

Facilitation (Building Understanding)

Measure of Teaching Presence in CoI Survey	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
5. The instructor is helpful in identifying areas of agreement and disagreement on course topics that helps students learn.	x	x	x		x	x		x		x
6. The instructor is helpful in guiding the class understanding course topics in a way that helps students clarify their thinking.	x	x	x		x	x		x		x
7. The instructor helps to keep course participants engaged and participating in productive dialogue.	x	x	x	x	x	x	x	x	x	x
8. The instructor helps keep the course participants on task in a way that helps students learn.	x	x	x	x	x	x		x	x	x
9. The instructor encourages course participants to explore new concepts.	x	x				x		x		x
10. Instructor actions reinforce the development of a sense of community among.	x		x					x		

Notes. The letter "x" indicates that the participant met the measure of teaching presence from the Community of Inquiry survey.

Table 7

Direct Instruction

Measure of Teaching Presence in CoI Survey	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
11. The instructor helps to focus discussion on issues in a way that helped students learn.										
12. The instructor provides feedback that helps students understand their strengths and weaknesses relative to the course's goals and objectives.	x	x	x	x	x	x	x	x	x	x
13. The instructor provides feedback in a timely fashion.			x		x	x				x

Notes. The letter "x" indicates that the participant met the measure of teaching presence from the Community of Inquiry survey.

Table 8

Emerging Themes & Teaching Presence Categories From the CoI Framework for Establishing Teaching Presence in Online Higher Education Mathematics Courses

Theme	Category
Instructor uses assessments with automatic feedback	Instructional Management (Design & Organization)
Instructor establishes due dates and flow of the course	Instructional Management (Design & Organization)
Instructor monitors student participation	Instructional Management (Design & Organization)
Instructor and students engage in discourse for meaning	(Building Understanding) Facilitation
Instructor delivers course content	Direct Instruction
Instructor engages students with questions and answers	Direct Instruction
Instructor assesses learning	Direct Instruction

common items that are found on online course syllabi (see Appendix E). Table 9 contains the measures of teaching presence met by at least 90% of participants based on the Rubric for Analyzing Interview Data for Online Courses and Syllabi Data for Online Courses (see Appendix H).

Table 9

Measures of Teaching Presence Met by at Least 90% of Participants Based on the Rubric for Analyzing Interview Data for Online Courses and Syllabi Data for Online Courses

Measure of Teaching Presence in CoI Survey	Category
1. The instructor clearly communicates important course topics.	Instructional Management (Design & Organization)
3. The instructor provides clear instructions on how to participate in course learning activities.	Instructional Management (Design & Organization)
7. The instructor helps to keep course participants engaged and participating in productive dialogue.	Facilitation
8. The instructor helps keep the course participants on task in a way that helps students learn.	Facilitation
12. The instructor provides feedback that helps students understand their strengths and weaknesses relative to the course’s goals and objectives.	Direct Instruction

Results for Research Question 2

Research Question 2 asked, “How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?” Note that this question may not seem relevant based on the purpose of this study; however, this question is worth considering because it provides additional information about the participants establishing teaching presence. This question was answered by the interview responses to Subquestions 2a–2e and the results from the Checklist of Common Items on Syllabi (see Appendix E),

Results of research Subquestion 2a. Research Question 2a asked, **“**How do mathematics instructors deliver course content in face-to-face courses?” Eight of the ten participants reported delivering course content in face-to-face courses by lecturing. Participants also reported requiring students to complete tasks before attending class, having students participate in collaborative learning activities during class, having students work problems in class, and having students participate in review sessions. A theme, *instructor delivers course content*, which is an indicator of the teaching presence category, direct instruction, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2a. In addition, a second theme, *instructor requires student preparation*, which is an indicator of teaching presence category, instructional management (design & organization), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2a.

When asked about delivering content in online courses, Participant 1 said,

> I think I did a lot more of backwards design than I remember. It’s just that the full focus there is on lecture and demonstrating rather than the short videos that I do

> online. I just remember doing a lot more of the prepping for the lectures and demonstrations. I have students pair up a lot. They have specific assignments to do as a pair in class.

According to Participant 1, the assignments were due in MyMathLab, and incorporating technology, such as MyMathLab, made the course web enhanced. Participant 2 reported, "The students have lecture notes and outlines. We use those in class through overhead in the classroom."

Participant 3 was more of a facilitator than a lecturer. Participant 3 responded,

> The last couple of semesters I taught, we were using MyMathLab. They had a textbook…. Usually, what I did was…put together something called a reading guide. It was like a basic outline of the material to be covered in one particular section. These were given to the students ahead of time, and they were to read the material, complete the reading guide with examples or concepts from the textbook…. If they didn't understand the content from the reading guide, I would go over a few ideas, work a few examples. Basically, I was acting as a facilitator…I would guide them.

Participant 4 reported lecturing face-to-face once a week in the hybrid courses. For face-to-face courses, Participant 4 said,

> content delivery would be through lecturing, whereas hybrid would also have supplemental videos…. If I've already developed a set of videos for an online course, like I have in a few of my courses, I'll offer those to my face-to-face students. They will frequently view them…. If I have someone who is absent, I let them know to watch the video.

Furthermore, Participant 4 said, "I do not lecture the whole period. They always have a period of activity at the end where they do a worksheet, and they're allowed to work together."

Participant 5 replied,

> Just the traditional lecture style. I go in and lecture…. I've given them some problems that they need to be prepared to ask questions about. I'll start the lecture by asking if they have any problems that they need to see worked…. Before each exam, I will devote an entire class period to nothing but review. I usually post some questions for them to have looked at before each exam to help them focus their study, and then I'll answer questions about those. I'll post solutions online for them to look over….

Participant 6 said, "First, I actually expect the students to have at least looked through PowerPoints. I have also done videos, and I have made those available." According to Participant 6, students don't always view the PowerPoints and videos. In addition, Participant 6 said,

> I go into class, and I will work an example. Then, I will let the students work a similar example, and we check it…. I usually have several days that they can come in and ask questions about their homework.

Participant 6 reported helping students "get through the difficult problems before the material is tested."

Participant 7 reported lecturing, using PowerPoint presentations, and working problems on the board in face-to-face courses. In addition, Participant 7 asks questions during lectures to see how well students understand the concepts.

According to Participant 8, 90%-95% of Participant 8's face-to-face course involves lecturing. Participant 8 also reported using video tutorials that were developed for Participant 8's online course. Participant 8 tells students, "Here's sort of a 10-minute mini lecture. View that outside of the course…." Participant 8 flips the face-to-face course when appropriate.

Participant 9 responded, "It's usually lecture style. Similarly, Participant 10 reported delivering content in face-to-face courses via lecture and instructor-made web notes. Participant 10 said, "The students print my class notes … and I do problems from them. I only have problems stated there. I haven't solved them." Participant 10 reported solving these problems on the board and asking students questions. Participant 10 stated that the class is interactive. When comparing the web notes for Participant 10's face-to-face course and online course, Participant 10 said, "Online notes have a different set of problems and those problems are explained step-by-step like I would teach in a classroom."

Results of research Subquestion 2b. Research Question 2b asked, "How do mathematics instructors ask and answer questions in face-to-face courses?" All of the participants reported asking and answering questions verbally during face-to-face classes. Participants also answered questions via email. In addition, participants reported using a discussion board and face-to-face office hours, as well as team tests and team quizzes. A third theme, *instructor engages students with questions and answers*, which is an indicator of teaching presence category, direct instruction, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2b.

Participant 1 asks and answers questions in online courses "by students raising their hands or while walking around to the groups." In regard to students asking questions by email, Participant 1 said. "Not so much, they had the option to. There were open forums. Very few would email me, but they wouldn't use the discussions." Like Participant 1, Participant 2 answers questions during class. In addition, Participant 2 answers questions during face-to-face office hours and via email. As for using discussion boards to answer questions, Participant 2 said, "I don't use the discussion boards in face-to-face as much. The students can use them with each other, but I don't really pay attention...."

When asked about asking and answering questions in face-to-face courses, Participant 3 stated,

> Basically, it's kind of a Socratic method. I have students who ask questions, and I try to answer the them, or I get students to help each other answer questions. If they have questions about certain concepts or an example they don't understand, I'll explain it in class.

Before Participant 3 began using a student-centered approach, "half of the class time would be taken up answering questions from homework assignments." Participant 3 further explained that the amount of time spent on homework questions was not conducive to learning. Participant 3 said,

> They could figure out how to work the problems but with my direction, not their direction. So later on, I more or less turned it to kind of a peer review….

Furthermore, Participant 3 explained that math education students were given team tests, where part of the test would be completed as a team, and the other part would be completed individually. Participant 3 said, "I strongly recommended the students work together as much as possible."

For asking and answering questions in face-to-face courses, Participant 4 responded,

> I let them know that they can stop me at any time, in a polite manner, and ask a question. Because a lot of classes don't ask questions…, I never go very long before I say, "Now, do you get that?" or "Is there something I need to clarify?" I probably remind them to ask questions more than they actually ask questions.

In addition, Participant 4 said that face-to-face students also ask questions via email and the "Ask My Instructor" feature within the software used for the course. Participant 4 answers students' questions via email. Participant 4 said, "I usually do a pretty good job of that because they are usually happy. If I can't get it across to them, then I say, 'We better meet.'"

Participant 5 asks and answers questions in face-to-face courses "usually on an interactive basis." Participant 5 said, "I'll just put a problem up on the board or a question up on the board and ask if anybody knows the answer." Participant 5 also reported receiving questions by email "quite often" and answering questions by email. "Sometimes, if it's an extended answer, I will write it up, scan it, and email it to them." Participant 5 also answers questions in class.

Participant 6 reported asking questions and receiving answers verbally, and using both written quizzes and MyMathLab quizzes for asking questions. Participant 6 also reported receiving and answering questions by email. "Usually, it's concerning a homework problem that they're having difficulty with…. If I feel that I need to build on it for the class, I will build upon that email."

Participant 7 reported asking and answering questions in class and by email. "If it's an individual question, I respond by email. If it's several asking a similar question, I will address it in class as well."

When asked about asking and answering questions in face-to-face courses, Participant 8 said,

> Usually during the course of the lecture, students have the opportunity to ask questions at certain designated points to make sure they have understood various examples. Usually at least one day a week, at the beginning of class, it'll just be kind of open session for students who want to ask questions…. Occasionally students will ask questions via email or through WebAssign…. If it's like a one-time question, I would usually just email the students. If a number of students ask the same question, sometimes I'll post a comment in the announcements in Desire2Learn, or…I may say something about it at the beginning of the next class period.

Participant 9 reported answering questions in class, setting aside "15-20 minutes, sometimes even more, to answer homework questions." Participant 9 said, "I assign homework that's not graded from one class to the other, and especially like calculus courses, and at the beginning of the next class, I'll answer whatever homework questions." Participant 9 also explained that students are encouraged to ask questions during the lecture. "As I teach, if there's anything that they don't understand or they want to ask, they can interrupt."

Participant 10 reported asking questions in class for any student to answer. "I don't call out a single student. I just ask a question, and if anyone knows, they can raise their hand and answer it. That's how I illicit responses from my students."

Participant 10 also reported receiving and answering questions via email. "I remain awake until 12 midnight, so I always answer questions immediately. All my assignments are due at midnight, so I know I will be getting questions in the last minute."

Results of research Subquestion 2c. Research Question 2c asked, "How do mathematics instructors establish dialogue between students in face-to-face courses?" Participant 8 replied that students "naturally seek each other out." Eight of the 10 participants reported establishing dialogue between students in face-to-face courses by means of collaborative learning activities or encouraging students to work together on problems during class. A fourth theme, *instructor and students engage in discourse for meaning*, which is an indicator of teaching presence category, building understanding (facilitation), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2c. In addition, a fifth theme, *students seek to reach consensus and understanding*, which is an indicator of the teaching presence category, building understanding (facilitation), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2c.

Participant 1 reported having students complete group work, where each group had no more than three students, to establish dialogue between students in face-to-face courses. Whenever a group had more than three students, there would always be a student not participating in the group. Participant 1 said, "I wanted them to be active and to always have something definite that they needed to turn in for at least a couple of points."

Participant 2 reported allocating time during class for students to work together. "They kind of have the option of working alone or working with people beside them."

Participant 2 also instructed students on how to retrieve each other's email from the university's course management system for the purpose of setting up times to study together or do homework.

According to Participant 3, establishing dialogue between students was "pretty easy once they decided they had to work together" to solve problems. Whenever a quiz was given, at least two students would be grouped together. Participant 3 said that the students "always" talked to each other when "trying to solve" the problems on the quiz. Furthermore, when Participant 3 started using MyMathLab, Participant 3 said,

> Students would ask each other questions if they didn't understand the concepts. Actually, each student was kind of responsible for helping anybody else in the class who didn't understand the material. I didn't have any trouble establishing any dialogue between the students.

However, Participant 3 explained that it was problematic establishing dialogue between the students and instructor.

Participant 4 responded, "It's definitely at the end. I want them to be attentive, and quite frankly, quiet when I'm lecturing, but I let them know at the end, 'You're fine talking to each other.'" Participant 5 responded, "I encourage them to work together if they can. That's one of the reasons I give them problems to work on before each test." Participant 5 expects students to get together and talk to each other about the problems during class and outside of class. Participant 5 said,

> Sometimes it works. Sometimes it doesn't. It depends on the class really. Sometimes you get a class that's really inquisitive, and they will ask a lot of questions. Sometimes you'll get a class that doesn't really do much of anything,

but I do my best.

To establish dialogue between students in face-to-face courses, Participant 6 said, "A lot of times, I will say, 'You work the problem. Check it with your neighbor. See if you have the same answer. If you don't have the same answer, discuss it to see where you differ.'" Furthermore, Participant 6 said, "I find that a lot of our students are very willing to help each other. I even see that going on before class begins or after class ends, or in the hallway that kind of thing."

Participant 7 responded, "I will divide them into groups and then they can do the group work, group discussion. Then they present it as a group, my questions." Participant 7 reported not grading the discussions but giving students extra credit on tests for leading discussions and presenting at the board. Participant 8 stated, "I don't do a whole lot to really stimulate that because it seems to be a fairly natural process where students will naturally seek each other out."

Participant 9 responded,

> I give, every semester, about six or seven cooperative quizzes. The idea is partially to get them to talk to each other, to feel good about themselves…, and also, so they'll do a little bit of work without the stress of the grade.

The cooperative quizzes are "due the next day in class, so they have enough time and resources to do well."

Participant 10 does not establish dialogue between students in face-to-face courses. Participant 10 said,

> Dialogue, I don't know. I don't think I have done anything like that. They can talk to themselves. They can form a group and try to solve the problems, the

> homework problems. I don't have any issue with them talking to each other and learning the material. I ask them to form a group, a study group type of thing, and study the materials.

Participant 10 further explained that the study group is expected to meet outside class, rather during class sessions.

Results of research Subquestion 2d. Research Question 2d asked, "How do face-to-face mathematics instructors assess student learning?" Participants reported assessing student learning in face-to-face courses using attendance, presentations, projects, exams/tests, quizzes, and homework/practice assignments. A sixth theme, *instructor assesses learning*, which is an indicator of teaching presence category, direct instruction, as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2d. A seventh theme, *instructor uses assessments with automatic feedback*, which is an indicator of teaching presence category, instructional management (design & organization), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2d.

Participant 1 responded that students are required to complete an assessment task after completing MyMathLab practice assignments. In reference to the assessment task, Participant 1 said, "Most of the time, they would begin it, but very few would turn it in during class. They would turn in the assessment task online, after class, before the next session." According to Participant 1, the MyMathLab assignments do not count toward a student's overall grade.

Participant 2 administers chapter tests, weekly quizzes, and a proctored final exam, all of which are face-to-face assessments. Participant 2 also requires students to complete online homework. Both online and face-to-face students complete the same homework assignments.

Participant 3 reported using homework, quizzes, tests, and a final exam. Participant 3 said that the homework was mostly graded online by MyMathLab, and the quizzes were graded in class. Participant 3 reported giving a short 10-minute quiz, on which students work together, at the beginning of class. Participant 3 added that once a quiz was completed, students exchanged quizzes. Participant 3 said, “We graded it right there in class, so they got the feedback right away.” In addition, Participant 3’s students had three or four paper-and-pencil exams each semester. “I would grade those. Of course, the final exam was graded by me…. Usually, I gave each exam in two different parts. There was a multiple choice part and a free response part.”

Participant 4 administers proctored tests and assigns online homework for assessing student learning in face-to-face courses, and Participant 5 uses performance on exams and homework assignments, as well as attendance. Participant 6 mainly uses online quizzes, in-class quizzes, online test, and an occasional presentation. Participant 7 uses homework, quizzes, proctored unit exams, and a proctored final exam. Participant 8 replied, “The assessment is identical to what it is in the online course—exams, small computer projects, and online homework.”

For assessing student learning in face-to-face courses, Participant 9 said, “It depends on the course, most of the time, tests and quizzes.” For high level classes, Participant 9 requires students to submit one homework assignment every 2 weeks, at the maximum. Participant 9 also gives a final exam in upper level courses. “I usually split that into a take-home part and an in-class part…. There will be things that are really hard to test in 1 or 2 hours. The more computational or longer problems will be on the take-home part." The take-home part is not collaborative. Participant 9 stated, "I don't necessarily encourage them to do it all together, but I don't specifically forbid it. I kind of insist that they write their own…." If students work together, there should be "at least minor differences between" solutions.

Participant 10 gives face-to-face students four exams and a final exam. The students are also required to complete homework assignments.

Results of research Subquestion 2e. Research Question 2e asked, "How do mathematics instructors encourage students to meet deadlines in face-to-face courses?" Participants reported encouraging students to meet deadlines in face-to-face courses by giving verbal reminders, sending email reminders, posting announcements, providing a semester calendar, and assigning a grade of zero for current assignments. An eighth theme, *instructor establishes due dates and flow of the course,* which is an indicator of teaching presence category, instructional management (design & organization), as described by the CoI framework (Garrison et al., 2000), emerged from the responses to Subquestion 2a.

Participant 1 responded, "They would usually be required to have completed the MyMathLab practice and to have submitted the assessment before class started the next week." Students received a grade of zero until the MyMathLab practice assessment was submitted. Participant 1 explained, "That prompted them to turn in their assessment and finish." Participant 1 also gave students verbal reminders at the end of class. In addition, Participant 1 posted announcements and sent emails, "probably not as often as the online, less frequently, maybe once a week."

Participant 2 responded,

> At the beginning of the semester, I remind them a lot about their homework and when it's due. Then I kind of ease up, and they're kind of on their own with things that are due and with the tests. All the reminders are in class. If someone hasn't been coming to class, I will go and look at their homework to see…if they've completely dropped out, or they are doing work outside of class.

Participant 2 added, "Otherwise, I don't monitor their homework as much face-to-face as I would for an online class."

Participant 3 provided a calendar for the semester. Sometimes, Participant 3 would be a little lenient with students who had outside college related activities. Participant 3 said, "My philosophy was, as long as they learn the material some time during the semester, that was fine. I wasn't that strict on deadlines."

Participant 4 responded, "That's easier than online since you're seeing them." Furthermore, at each class meeting, Participant 4 says to students, "Now look, this is where you should be. If you're up-to-date, you should have finished this."

Participant 5 gives students a course calendar and face-to-face reminders, as well as email reminders. Participant 5 said,

> I give them a calendar…. In the online course, I try to map out each day what they should be doing, but in the face-to-face, the only I dates I put on the calendar are the quiz and exam dates because each class is different. It's very difficult for me to gauge what section I'm going to be on and what day. All I do is give them a list of the sections…, and it's up to them to know what section we are on on what particular day.

Participant 5 also said, "Just continually remind them of what's coming up and that they need to be ready to take an exam, and sometimes it works, and sometimes it doesn't."

Participant 6 does not send students weekly announcements, but Participant 6 gives students a semester calendar and verbal reminders. Participant 6 said,

> I give them a calendar at the beginning of the semester. Which of course, things change a little bit. As long as they attend class daily, I am constantly reminding them of deadlines and what's due and when we are going to test….

Participant 7 encourages students to meet deadlines in face-to-face courses by reminding them verbally at the end of class. Participant 7 also has students sign up for the Remind mobile app. Every Sunday at 9:00 a.m., Participant 7 sends a reminder with the date the homework is due and the message, "Please complete it on time." Participant 7 also sends a weekly reminder via Desire2Learn.

Participant 8 stated,

> Most of the time, it is just a matter of prompting them, reminding them at the beginning of the class period that a due date is coming up or an exam is coming up. Occasionally, I will use Desire2Learn to send out mass announcements via email if there is a particularly important deadline coming up….

Participant 9 reported reminding face-to-face students about deadlines in class. Participant 9 is strict with deadlines in lower level classes; however, in upper-level classes, Participant 9 is "pretty lenient about deadlines." Participant 9 said, "Usually if they show up and say, 'I need a couple more days or so.' I'm fine."

Participant 10 responded, "In face-to-face classes, since I meet them regularly, I always remind them about the deadlines, and I also use emails to remind them." According to participant 10, having face-to-face classes meet deadlines is not "much" of a problem. "It is the online class that's a little bit harder."

Summary for Research Question 2

Research Question 2 asked, "How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?" Table 10 contains the themes related to teaching presence as described by the CoI framework that emerged from responses to Subquestions 2a–2e (see Appendix D).

Table 10

Emerging Themes & Teaching Presence Categories From the CoI Framework for Establishing Teaching Presence in Face-to-Face Higher Education Mathematics Courses

Theme	Category
Instructor uses assessments with automatics feedback	Instructional Management (Design & Organization)
Instructor establishes due dates and flow of the course	Instructional Management (Design & Organization)
Instructor requires student preparation	Instructional Management (Design & Organization)
Group shares meaning	Building Understanding (Facilitation)
Instructor delivers content	Direct Instruction
Instructor engages students with questions and answers	Direct Instruction
Instructor assesses learning	Direct Instruction

Results From the Checklist of Common Items on Face-to-Face Course Syllabi

The results from the checklist are presented in Table 11. The items included in the checklist are based primarily on the common items for a syllabus suggested by O'Brien et al. (2008). All participants included the name of the course, instructor's name and contact information, grading procedures, study plan, and course materials (books, technology, etc.).

Table 11

Common Items on Face-to-Face Course Syllabi

Item	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
1. Table of contents										
2. Name of the course	x	x	x	x	x	x	x	x	x	x
3. Quarter or Semester offered	x	x	x	x		x	x	x	x	x
4. Instructor's name and contact Information	x	x	x	x	x	x	x	x	x	x
5. Course description	x	x	x		x	x	x		x	x
6. Student learning outcomes	x	x	x			x	x	x		x
7. Policies and expectations	x	x	x		x	x	x	x		x
8. Communicating instructions	x							x		x
9. Attendance/Participation	x	x	x		x	x	x	x	x	x
10. Grading procedures	x	x	x	x	x	x	x	x	x	x
11. Study plan	x		x	x	x			x		x
12. Course materials (books, technology, etc.)	x	x	x	x	x	x	x	x	x	x
13. Academic honesty	x	x	x			x	x	x		x
14. American Disability Act	x	x	x			x	x	x		
15. Campus Resources	x	x	x	x		x	x	x		x
16. Technical Support	x									

Notes. The letter "x" indicates that the item is included on the participant's face-to-face course syllabus. Each participant is represented by the letter "P" and the number from the participant's pseudonym.

Results for Research Question 3

Research Question 3 asked, “What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?” The differences reported by participants when establishing teaching presence in online courses versus face-to-face courses include creating course content, delivering course content, organizing course content, communicating with students, keeping students on track, interacting with students, and receiving feedback from students. Four themes emerged from the responses to Question 3—frequent and precise communication in online course, online course set in stone, online course less interactive, and online course materials (see Table 12).

The theme, frequent and precise communication in online course, from the CoI teaching presence category, instructional management (design & organization) emerged from responses from Participants 1, 2, 4, 5, 7, and 10. Participant 1 said, “I would frequently have announcements and a copy in emails for the online students.”

Participant 2 said, I guess with the online, there’s more emailing or posting announcements and reminders than I would normally do in the classroom face-to-face.”

Table 12

Emerging Themes & Teaching Presence Categories From the CoI Framework for Differences in Establishing Teaching Presence in Online Classes Versus Establishing Teaching Presence in Face-to-Face Classes

Theme	Category
Frequent and precise communication	Instructional Management (Design & Organization)
Online course set in stone	Instructional Management (Design & Organization)
Online course less interactive	Building Understanding (Facilitation)
Online course materials	Direct Instruction

Participant 4 said,

> So, in my online course, I try to have everything spelled out but very concisely. For instance, like I told you, any given week of the online course, they can read that week, and they can say, "I should be reading these pages in the book, should be watching this video, doing this homework." Whereas, of course, in a face-to-face class, you're there. You can say these things. Whereas online, you have to put it down on paper, so you have to be careful.… Online, you can't have ambiguous instructions.

Participant 5 responded, "What I'm finding with the online classes is that it takes a lot more prompting for them to actually do work on a daily basis." According to Participant 7, "For the online course, because you don't see students, mainly, you have to provide additional instruction in writing instead of verbal instruction." Furthermore, Participant 10 said, "In online classes, we don't meet every day or every week, so the only way I can establish contact with them is through sending them email reminders and show them I am concerned about their progress"

The theme, online course set in stone, from the CoI teaching presence category, instructional management (design & organization) emerged from responses from Participants 3, 5, and 9. Participant 3 stated that the online course is "pretty much set in stone"; it's set up by the educational specialist at eCore. Participant 5 said, "Now, in the online classes, basically you have the set of outcomes, but then you basically just have to cover each section almost as if it were out of a textbook almost because it is not as interactive." Furthermore, Participant 9 responded,

> I just say read this chapter, watch these videos, do this homework, and based on this, you should be able to do well on the weekly quiz or the midterm.… That's

pretty sort of set in stone. In class, you can sort of change things a little bit.

The theme, online course less interactive, from the CoI teaching presence category, building understanding (facilitation) emerged from responses from Participants 3, 4, 5, 7, and 9. According to Participant 3, "it's a little more difficult" to establish presence when teaching online. Participant 3 said, "You are not physically there with the students, to see them. That's why I try to use various methods to keep in touch with them, the announcement page, …email." Participant 4 said, "Whereas, of course, in a face-to-face class, you're there. You can say these things." Participant 5 said, "Now, in the online classes, basically you have the set of outcomes, but then you basically just have to cover each section almost as if it were out of a textbook almost because it is not as interactive." According to Participant 7, for a face-to-face class, "you can see students' feedback, so you'll know" the effectiveness of your instruction. Similarly, Participant 9 said that it is easier to detect when face-to-face students, unlike online students, do not understand instruction. Participant 9 said,

> It's easier for me to get a feeling for what they understand or not if I see how they react to my teaching…. Within class, based on the questions they have, if you feel there is something you need to say, you can do it right then.

Finally, the theme, online course materials, from the CoI teaching presence category, direct instruction emerged from responses from Participants 2, 4, 8, and 10.

Participant 2 responded,

> It's all the same material, exactly the same. In the face-to-face classes, they have course notes and outlines that we go over during class, and they are not the PowerPoints, but there're a lot of similarities. The PowerPoints that the online

students get are mostly manufactured, from the publisher. Some of them are mine. Participant 2 added that there is a "little" difference in the delivery. "One's PowerPoint. One's just outlines, but it's the same material." According to Participant 4, "In the online course, they do need to sense that they are not being taught by a computer." Professor 4 met this need by making videos. Participant 8 said,

> Rather than having…a 50-minute lecture for the online course, I would try to take that 50 minutes of content and chop it up into smaller pieces so that a student doesn't necessarily have to sit in front of their computer screen for 50 minutes to absorb the content. That 50-minute lecture might be broken up into five 10-minute mini tutorials.

Furthermore, Participant 10 noted that the most difficult part of designing an online course is the preparation of course materials, which "have to be very crisp and clean and self-explanatory." Participant 10 also said that the course materials "must highlight important things" because students "don't have much time to learn the whole thing in great detail. Some of them study to the test, so you need to be aware of that and provide them the details so that they will succeed."

Responses to Question 1 and Question 2 also contribute to the results for research Question 3. The themes, "instructor monitors student participation," and "instructor and students engage in discourse for meaning," emerged as two of the themes for research Question 1; however, these themes did not emerge as themes for research Question 2.

In addition, Table 13, presents results for research Question 3. More online course syllabi contained the items, policies and expectations, communicating instructions, study plan, American Disability Act, campus resources, and technical support, than face-to-face

Table 13

Summary and Comparison of Checklist Items for Online and Face-to-Face Course Syllabi

Item from Checklist	Online Course Syllabi Percent of Item from the Checklist	Face-to-Face Course Syllabi Percent of Item from the Checklist
1. Table of contents	0%	0%
2. Name of the course	100%	100%
3. Quarter or Semester offered	80%	90%
4. Instructor's name and contact Information	100%	100%
5. Course description	50%	80%
6. Student learning outcomes	70%	70%
7. Policies and expectations	90%	80%
8. Communicating instructions	90%	30%
9. Attendance/Participation	90%	90%
10. Grading procedures	100%	100%
11. **Study plan**	100%	60%
12. Course materials (books, technology, etc.)	100%	100%
13. Academic honesty	70%	70%
14. **American Disability Act**	90%	60%
15. **Campus Resources**	90%	80%
16. **Technical Support**	70%	10%

Note. The items in bold are contained on more online course syllabi than face-to-face course syllabi.

course syllabi.

Summary

This chapter presents findings from a phenomenological study which describes, based on the CoI framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. Phenomenological analysis was used because it enabled the researcher to examine the lived experiences of mathematics instructors—the perceptions, beliefs, memories, decisions, feelings, judgments, or evaluations of these instructors (Schwandt, 2007)—while establishing teaching presence. Furthermore, a content analysis of course syllabi was implemented to supplement interview data.

Research Question 1 asked, "How do mathematics instructors establish teaching presence in online higher education mathematics courses?" Themes relating to categories of the teaching presence component in the CoI framework emerged from the responses to the interview Subquestions 1a–1e (see Table 8). Research Question 2 asked, "How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?" Themes also emerged from responses to Subquestions 2a–2e (see Table 10). Research Question 3 asked, "What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?" Themes emerged from responses to this question (see Table 12).

The themes, *instructor monitors student participation* and *instructor and students engage in discourse for meaning*, emerged as two of the themes for Question 1. However, these themes did not emerge as themes for Question 2. Also, more online course syllabi contained the items, (a) policies and expectations, (b) communicating instructions, (c) study plan, (d) American Disability Act, (e) campus resources, and (f) technical support, than face-to-face course syllabi (see Table 13).

In addition, data for online courses and syllabi for online courses were analyzed according to the Rubric for Analyzing Interview Data for Online Courses and Syllabi Data for Online Courses (see Appendix H). The results of the rubric were used to complete the CoI survey (see Appendix G) for each participant. All participants met measures 1 and 3 from the category of Design and Organization (Instructional Management), measure 7 from Facilitation (Building Understanding), and measure 12 from Direct Instruction. For facilitation (building understanding), nine participants met measure 8 and none of the participants met measure 11. The CoI survey results are presented in Tables 5–7.

Chapter 5: Conclusion

This phenomenological study described, based on the teaching presence component of the community of inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. The core elements of the CoI framework are teaching presence, social presence, and cognitive presence (Garrison et al., 2000). Teaching presence pertains to course design and facilitation of learning (Garrison et al., 2000). According to Arbaugh (2008), teaching presence influences student satisfaction, perceived learning, and sense of community. Shea et al. (2010) suggested researchers consider entire courses, not only threaded discussions or survey data, when evaluating teaching presence.

Indicators of teaching presence can be divided into three categories: instructional management, building understanding, and direct instruction. Instructional management includes selecting curriculum, designing methods and assessment, establishing due dates and the flow of the course, and navigating the learning environment. Building understanding refers to transferring valid knowledge through discourse. The process of building understanding enables the community to develop an effective group consciousness. During this process, the group shares meaning, identifies areas of agreement and disagreement, and seeks to reach consensus and understanding. Direct instruction refers to the teacher presenting content, engaging students with questions and answers, assessing learning outcomes, and providing constructive feedback.

Phenomenological analysis was used because it enables the researcher to examine the lived experiences of mathematics instructors—the perceptions, beliefs, memories, decisions, feelings, judgments, or evaluations of these instructors (Schwandt, 2007)—while establishing teaching presence. Furthermore, a content analysis of course syllabi was implemented to supplement interview data. This chapter will include (a) a summary of findings, (b) an interpretation of findings, (c) implications of findings, and (d) limitations of the findings from this study. This chapter will also include a discussion on future directions of research.

Summary of Findings

Data for this phenomenological study were gathered from 10 participants employed by the same university system. Six of the instructors were from research institutions, three from state colleges, and one from a state university. None of the participants were employed by a historically Black university. The criteria for participation are listed below:

a) The participants must have experienced the phenomenon of establishing teaching presence in higher education face-to-face mathematics courses.
b) The participants must have experienced the phenomenon of establishing teaching presence in higher education online mathematics courses.
c) The participants must have the ability to explain their everyday conscious experiences when establishing teaching presence (Creswell, 1998; Polkinghorne, 1989).

Participants were selected by means of maximal variation sampling, which is a type of purposeful sampling, in order to gather data representative of the diverse universities within the university system.

Three instruments were used to gather data for this research—a modified CoI survey (see Appendix G), a semi-structured interview (see Appendix D), and a checklist (see Appendix E). Interview data were subjected to a phenomenological analysis, and syllabi data were subjected to a content analysis. Both sets of data were coded according to indicators of teaching presence, which pertains to course design and facilitation of learning (Garrison et al., 2000). Indicators of teaching presence can be divided into three categories: instructional management, building understanding, and direct instruction (Garrison et al., 2000).

Research Question 1 asked, “How do mathematics instructors establish teaching presence in online higher education mathematics courses?” To answer Question 1, participants provided responses to Subquestions 1a–1e (see Appendix D). All participants reported delivering course content in online courses using video and print-based instruction and receiving and answering questions in online courses by email. When several students ask the same question, participants reported posting the answer on a discussion board for the entire class to view. Some participants also ask and answer questions via both face-to-face and online office hours, text messages, phone calls, announcements, video, online assignments, and the Ask My Instructor features of the online homework software.

The strategies used for establishing dialogue between students in online courses included graded discussions, optional discussions, face-to-face test reviews, face-to-face problem sessions, and optional study groups. All of the participants reported giving students an opportunity to post on a discussion board. Participants reported assessing student learning in online courses by discussions, projects, online homework, quizzes, tests, midterm exams, and final exams. Nine of the participants reported assigning online homework with automatic feedback. Some of the participants administered proctored tests, midterm exams, and/or final exams.

Participants encouraged students to meet deadlines in online courses using different strategies. The most common strategies were sending weekly emails and posting weekly announcements. Other strategies included posting class statistics for tests, providing a late policy, providing detailed calendar containing assignments and due dates, sending reminders when due dates are approaching, and using the Remind App. One participant mentioned alerting students that online learning differs from face-to-face learning.

In addition to describing strategies and practices for establishing teaching presence in online higher education online mathematics courses, seven themes emerged from responses to Subquestions 1a–1e during the transcendental-phenomenological reduction process. The themes (a) *instructor uses assessments with automatic feedback,* (b) *instructor establishes due dates and flow of the course*, and (c) *instructor monitors student participation* emerged. These themes are from the CoI framework category Instructional Management (Design & Organization). The theme *instructor and students engage in discourse for meaning* also emerged. This theme is from the CoI framework category Building Understanding (Facilitation). Furthermore, the themes (a) *instructor delivers course content,* (b) *instructor engages students with questions and answers,* and *instructor assesses learning* emerged during responses to Subquestions 1a–1e. These themes are from the CoI framework category Direct Instruction.

To gain additional information regarding mathematics instructors establishing teaching presence in online mathematics courses, data were collected from online course syllabi based on a checklist created by the researcher (see Appendix E). The items included in the checklist are based primarily on the common items for a syllabus suggested by O'Brien et al. (2008):

> Table of contents; Instructor information; Student information form; Letter to the students or teaching philosophy statement; Purpose of the course; Course description; Course objectives; Readings; Resources; Course calendar; Course requirements; Policies and expectations: Attendance, late papers, missed tests, class behaviors, and civility; Evaluation; Grading procedures; How to succeed in this course: Tools for study and learning. (p. 40)

The results from the checklist are presented in Table 4. All participants included the name of the course, instructor's name and contact information, grading procedures, study plan, and course materials (books, technology, etc.).

Research Question 2 asked, "How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?" To answer Question 2, participants provided responses to Subquestions 2a–2e (see Appendix D). Eight of the ten participants reported delivering course content in face-to-face courses by lecturing. Participants also reported requiring students to complete tasks before attending class, having students participate in collaborative learning activities during class, having students work problems in class, and having students participate in review sessions. All of the participants reported asking and answering questions verbally during face-to-face classes. Participants also answered questions via email. In addition, participants reported using a discussion board and face-to-face office hours, as well as team tests and team quizzes for asking and answering questions.

Eight of the 10 participants reported establishing dialogue between students in face-to-face courses by means of collaborative learning activities or encouraging students to work together on problems during class. Participants reported assessing student learning in face-to-face courses using attendance, presentations, projects, exams/tests, quizzes, and homework/practice assignments. Participants reported encouraging students to meet deadlines in face-to-face courses by giving verbal reminders, sending email reminders, posting announcements, providing a semester calendar, and assigning a grade of zero for current assignments.

In addition to describing strategies and practices for establishing teaching presence in online higher education online mathematics courses, seven themes emerged from responses to Subquestions 2a–2e during the transcendental-phenomenological reduction process. The themes (a) *instructor uses assessments with automatic feedback,* (b) *instructor establishes due dates and flow of the course*, and (c) i*nstructor requires student preparation* emerged. These themes are from the CoI framework category Instructional Management (Design & Organization). The theme *group shares meaning* also emerged. This theme is from the CoI framework category Building Understanding (Facilitation). Furthermore, the themes (a) *instructor delivers course content,* (b) *instructor engages students with questions and answers*, and *instructor assesses learning* emerged during responses to Subquestions 2a–2e. These themes are from the CoI framework category Direct Instruction.

To gain additional information pertaining to mathematics instructors establishing teaching presence in online mathematics courses, data were collected from face-to-face course syllabi based on a checklist created by the researcher (see Appendix E). The results from the checklist are presented in Table 11. All participants included the name of the course, instructor's name and contact information, grading procedures, and course materials (books, technology, etc.).

Research Question 3 asked, "What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?" The differences reported by participants when establishing teaching presence in online courses versus face-to-face courses include creating course content, delivering course content, organizing course content, communicating with students, keeping students on track, interacting with students, and receiving feedback from students. Four themes emerged from responses to Question 3 during the transcendental-phenomenological reduction process: (a) *frequent and precise communication in online course* from the CoI category of Instructional Management (Design & Organization); (b) *online course set in stone* from the CoI category of Instructional Management (Design & Organization); (c) *online course less interactive* from the CoI category of Building Understanding (Facilitation); and (d) *online course materials* from the CoI category of Direct Instruction.

Data collected for Question 1 and Question 2 provide additional information for Question 3. The themes, *instructor monitors student participation* and *instructor and students engage in discourse for meaning*, emerged as two of the themes for Question 1; however, these themes did not emerge as themes for Question 2. Also, the themes, *instructor requires student preparation* and *group shares meaning,* emerged as two of the themes for Question 2; however, these themes did not emerge as themes for Question 1.

Also, responses to subquestions for Question 1 and Question 2 revealed different strategies and practices for establishing teaching presence in online higher education online and face-to-face mathematics courses. Collaborative learning activities and synchronous lectures are used by face-to-face mathematics instructors participating in this study, but not the online mathematics instructors. The online mathematics instructors participating in this study did not report requiring collaborative learning activities, and they present course content asynchronously via videos and print-based instruction. The face-to-face mathematics instructors reported primarily asking and answering questions verbally in class, whereas, the online instructors reported primarily answering students' questions by email and asking questions via assessments. In addition, the online instructors reported the need to monitor students constantly for participation in the course because students are not required to be present in a physical classroom.

In addition, a checklist (see Appendix E) based primarily on the common items for a syllabus suggested by O'Brien et al. (2008) was applied to both online and face-to-face syllabi submitted by the participants for this study. More face-to-face course syllabi contained the items, quarter or semester offered and course description, than online course syllabi. More online course syllabi contained the items, (a) policies and expectations, (b) communicating instructions, (c) study plan, (d) Americans with Disabilities Act, (e) campus resources, and (f) technical support, than face-to-face course syllabi.

Furthermore, interview data for online courses and syllabi for online courses were analyzed according to the Rubric for Analyzing Interview Data for Online Courses and Syllabi Data for Online Courses (see Appendix H). The results of the rubric were used to complete the CoI survey (see Appendix G) for each participant. All participants met (a) measure 1, The instructor clearly communicates important course topics from the CoI category of Design and Organization (Instructional Management); (b) measure 3, The instructor provides clear instructions on how to participate in course learning activities from the CoI category of Design and Organization (Instructional Management); (c) measure 7, The instructor helps to keep course participants engaged and participating in productive dialogue from the CoI category of Facilitation (Building Understanding); and measure 12, The instructor provides feedback that helps students understand their strengths and weaknesses relative to the course's goals and objectives from the CoI category of Direct Instruction. For the CoI category of Facilitation (Building Understanding), nine participants met measure 8, The instructor helps keep the course participants on task in a way that helps students learn. None of the participants met measure 11, The instructor helps to focus discussion on relevant issues in a way that helped students learn from the CoI category of Facilitation (Building Understanding)

Interpretation of Findings

The themes that emerged from the interview responses for both establishing teaching presence in online classes, and differences in establishing teaching presence in online classes versus face-to-face classes are indicators of the categories comprising the teaching presence component of the CoI framework. Five themes emerged for the category of instructional management (design & organization): (a) *instructor uses* *assessments with automatic feedback*; (b) *instructor establishes due dates and flow of the course*; (c) *instructor monitors student participation*; (d) *frequent and precise communication*; and (e) *online course set in stone*. Two themes emerged for the category of building understanding (facilitation): (a) *group shares meaning* and (b) *online course less interactive*. Four themes emerged for the category of direct instruction: (a) *instructor delivers course content*; (b) *instructor engages students with questions and answers*; (c) *instructor assesses learning*; and (d) *online course materials*.

The themes emerging from this phenomenological study are consistent with contemporary teaching practices described by Gleason (2006a, 2006b, & 2006c), Akdemir (2010), Trenholm et al., 2015, and Glass and Sue (2008). Gleason designed an online mathematics course in a manner in which he believed would enable students to gain mathematical knowledge and develop mathematical thinking (Gleason, 2006a, 2006b). His course included two hours of synchronous interaction per week via web conferencing that featured both instructor-student and student-student interaction; this action reflects the theme, *group shares meaning*. Gleason graded homework and provided feedback, reflecting the theme, *instructor assesses learning*. Content was delivered by PowerPoint slides containing definitions, theorems, and problems, which reflects the themes, *instructor delivers course content* and *online course materials.* Instead of a final exam, the students were required to submit a group project, which reflects the theme, *group shares meaning*. Also, Gleason (2006c) stated that in the absence of facial cues, online instructors must determine how to assess student understanding when students interact with course content, which reflects the themes, *online course less interactive* and *instructor assesses learning*.

Akdemir (2010) provided additional insight into the experiences of instructors teaching mathematics courses online in his exploration of “current practices of teaching mathematics online” (p. 50). The themes emerging from Akdemir (2010) were *online course design*, *online course teaching*, *student assessment*, and *effectiveness of online courses*. Categories determining themes from Akdemir (2010) support themes that emerged from this phenomenological study exploring the lived experiences of mathematics instructors while establishing teaching presence in online mathematics courses. The theme *online course design* from Akdemir (2010) emerged from the categories of technical help, course management systems, and student orientation. The theme *online course teaching* emerged from the categories of course materials, teaching process, and course assignments. Note, the categories for *online course teaching* from Akdemir (2010) correspond to the themes *online course materials* and *instructor delivers course content* from this phenomenological study on the lived experiences of online mathematics instructors while establishing teaching presence in online mathematics courses. In addition, the theme *student assessment* from Akdemir (2010) corresponds to the theme *instructor assesses learning* from this phenomenological study.

Furthermore, the theme *effectiveness of online courses* in Akdemir (2010) was coded by the categories of faculty members’ perceptions and faculty members’ perceptions for students. The participants in Akdemir (2010) perceived advantages and disadvantages for teaching mathematics courses online. One perceived disadvantage was that providing feedback to online students requires more time than providing feedback to face-to-face students, which was addressed by this phenomenological study. The theme *instructor uses assessments with automatic feedback* emerged from responses Question 1 and Question 2 from this phenomenological study on establishing teaching presence.

Similarly, the themes *instructor uses assessments with automatic feedback* and *instructor assesses learning*, are reflected in a study, which explored assessment and feedback practices of undergraduate mathematics instructors who taught fully online courses, conducted by Trenholm et al. (2015). Data for that study were taken from Trenholm (2013). The 2015 study had 66 participants. The instructors reported assessing students' learning using homework (83%), final exams (73%), tests (65%), quizzes (53%), discussions (39%), midterms (2%), individual projects (20%), group projects (5%), group work (3%), journaling (2%), and portfolios (2%). The instructors also reported which assessments were proctored. According to Trenholm et al. (2015), feedback was used to assist students with maintaining student-instructor, student-student, and student-content engagement throughout the course. Furthermore, Trenholm et al. (2016) reported that instructors found providing feedback was more time consuming, expected 24/7, and used to keep students engaged in the course.

The last study to consider is a study conducted by Glass and Sue (2008), which explored student preference, satisfaction, and perceived learning in a quarter-long online mathematics course designed for undergraduate business and social science majors. College algebra was a prerequisite for this course, and this course was a requirement for admission to the MBA program.

Glass and Sue (2008) defined learning objects as collections of small, reusable, pieces of information. The learning objects for the course being explored were PowerPoint slides, video lectures, web-based tutorial homework, discussions, quizzes, and a textbook (see Table 1), which encompasses the themes: (a) *instructor uses* *assessments with automatic feedback*, (b) *group shares meaning*, (c) *instructor delivers course content*, (d) *instructor engages students with questions and answers*, and (e) *online course materials,* in no respective order, from this phenomenological study on the lived experiences of mathematics instructors while establishing teaching presence in online mathematics courses.

The course studied in Glass and Sue (2008) was composed of 10 learning modules. Each module contained two lectures, which reflects the theme *instructor delivers course content*, and a set of online assignments, which reflects the theme *online course materials* from this phenomenological study. Each module was made available to students at midnight on the first day of the week, and students were given one week to complete the module, which reflects the theme *instructor establishes due dates and flow of the course*. At the beginning of the quarter, students were given a document containing a detailed list of assignments and due dates, which also reflects the theme *instructor establishes due dates and flow of the course*. The course instructor answered questions synchronously during face-to-face and online office hours, which reflects the theme *instructor engages students with questions and answers*; the course instructor also answered questions asynchronously via email and discussion board posts, which also reflects the theme *instructor engages students with questions and answers*.

Best practices most often refer to "a set of documented strategies, procedures, or methods employed by highly successful organizations to effectively achieve results in particular circumstances" (Orellana & Hudgins, p. ix, 2009). The course explored in Glass and Sue (2008), based on student preference, satisfaction, and perceived learning, provides a best practices model for an online mathematics course composed of "strongly"

(p. 337) utilized practice problems with immediate feedback and various types of media delivering course content, which reflects the theme *instructor delivers course content*. Immediate feedback from Glass and Sue (2008) supports the theme *instructor uses assessments with automatic feedback* from this phenomenological study. Also, the discussion of various types of media delivering course content in Glass and Sue (2008) supports the theme *instructor delivers course content* from this phenomenological study.

Glass and Sue's (2008) study has implications for establishing teaching presence in higher education online mathematics courses. Having insight into how students view the quality of the learning objects and the contribution of the learning objects to learning in an online mathematics course, equips online mathematics instructors to better develop and select learning objects for assessment, which falls in the category of instructional management (Garrison et al., 2000). Instructors will also be better equipped to establish and maintain discourse, which falls in the category of building understanding (Garrison et al., 2000). In addition, instructors will be better equipped to present content, engage students with questions and answers, assess learning outcomes, and provide constructive feedback, which falls in the category of direct instruction (Garrison et al., 2000).

There were three themes—*instructor monitors student participation*, *frequent and precise communication*, and *online course set in stone*—from this phenomenological study that were not directly reflected by Gleason (2006a, 2006b, & 2006c), Akdemir (2010), Trenholm et al., 2015, and Glass and Sue (2008). The participants from the phenomenological study mentioned using a course management system for monitoring students' participation in the course, posting announcements, sending emails, and posting course materials. Note that the category course management systems was an indicator for the theme *online course design* from Akdemir (2010).

Furthermore, this study supports Simonson et al. (2012), West and Shoemaker (2012), and Sulik and Keys (2014). A syllabus for an online course is essential (Simonson et al., 2012) and includes information not required for a face-to-face course syllabus (West & Shoemaker, 2012). More online course syllabi for this phenomenological study contained the items, policies and expectations, communicating instructions, study plan, Americans with Disabilities Act, campus resources, and technical support, than face-to-face course syllabi for this study (Table 13). Also, according to West and Shoemaker (2012), an online course syllabus should provide details on how to communicate with the instructor and information regarding technologies and technology skills required for the course (West & Shoemaker, 2012). Online syllabi for this phenomenological study contain information for technical support. In addition, the online course syllabus should provide an instructional plan to assist students with engaging course content and meeting course deadlines (Sulik & Keys, 2014; West & Shoemaker, 2012). Furthermore, a learning-centered syllabus outlines a plan for students to engage the instructor, course content, and other students in the course (O'Brien et al., 2008). The online syllabi for this phenomenological study contained policies and expectations, communicating instructions, and a study plan.

Implications of Findings

This phenomenological study on the lived experiences of mathematics instructors while establishing teaching presence in online mathematics courses begins to fill the gap in the literature for best practices and strategies for teaching mathematics online, as well as the application of the CoI theoretical framework to an entire course. This study has implications for mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators. First, this study informs mathematics instructors, both junior and senior faculty, of the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. The responses from the participants to the interview questions provide insight on how the participants deliver course content, ask and answer questions, establish dialogue between students, assess student learning in online courses, and encourage students to meet deadlines in online courses. The participants also provide insight into designing and facilitating higher education online mathematics courses that are equivalent (Simonson et al., 1999) to the same courses offered in a face-to-face format in terms of achieving learning outcomes. When a course is designed effectively, instruction will be effective (Simonson & Schlosser, 2009).

Based on findings from this study, mathematics instructors teaching higher education online mathematics courses should: (a) deliver content using video and print-based instruction; (b) receive and answer questions by email; (c) post answers to commonly asked questions on a discussion board for the entire class to view; (d) give students an opportunity to post on a discussion board; (e) assign online homework with automatic feedback; (f) send weekly emails and post weekly announcements; (g) monitor student participation constantly and contact students who are not participating in the course; (h) create unambiguous course materials; and (i) create a course that is structured from beginning to end. Other strategies and practices for mathematics instructors to establish teaching presence in online mathematics courses include: (a) asking and answering questions during face-to-face and online office hours, text messages, phone calls, announcements, video, online assignments, and the Ask My Instructor features of the online homework software; (b) establishing dialogue between students in online courses by offering or encouraging graded discussions, optional discussions, face-to-face test reviews, face-to-face problem sessions, and optional study groups; (c) assessing student learning in online courses by discussions, projects, online homework, quizzes, tests, midterm exams, and final exams; and (d) encouraging students to meet deadlines by posting class statistics for tests, (e) providing a late policy, (f) providing a detailed calendar containing assignments and due dates, (g) sending reminders when due dates are approaching, and (h) using the Remind App. Mathematics instructors should also review assessment data to determine when it is necessary to review course content.

Furthermore, the course syllabus sets the tone for the class (Harnish & Bridges, 2011), represents an agreement between the instructor and students, reveals elements of the instructor's personality, and is essential for an online course (Svinicki & McKeachie, 2014). Based on findings from the content analysis for this study, online mathematics course syllabi should include the items, (a) table of contents, (b) name of the course, (c) quarter or semester offered, (d) instructor's name and contact information, course description, (e) student learning outcomes, policies and expectations, (f) communicating instructions, (g) attendance/participation, (h) grading procedures, (i) study plan, (j) course materials (books, technology, etc.), (k) academic honesty, (l) Americans with Disabilities Act, (m) campus resources, and (n) technical support. These items formed the checklist created by the researcher for the content analysis, and are based on suggestions from O'Brien et al. (2008, p. 40)

Second, this study informs mathematics instructors and mathematics educators, who validate and distribute best practices, strategies, and standards for teaching mathematics (MAA, 2018; NCTM, 2018). Currently, pedagogy informing strategies, best practices, and standards for online mathematics courses is in a stage of infancy (Engelbrecht & Harding, 2005; Juan et al., 2012), and many math teachers have not participated in teaching or learning mathematics in an online environment (Appelbaum et al., 2016). This study begins to fill the gap on strategies and best practices for teaching mathematics online.

Third, this phenomenological study on the lived experiences of mathematics instructors while establishing teaching presence in online mathematics courses informs mathematics educators who teach preservice teachers how to teach mathematics in order to achieve learning outcomes. Mathematics educators can use the findings from this study to provide an online learning experience in mathematics education courses that their students can emulate when teaching mathematics online.

Fourth, instructional designers are trained in best practices and standards for teaching online (Pennsylvania State University, 2018); however, this study informs instructional designers of the process by which mathematics instructors establish teaching presence in online mathematics courses and provides instructional designers with a theoretical framework for establishing and evaluating teaching presence in online mathematics courses. Based on findings from this study, instructional designers may use the CoI survey to evaluate teaching presence throughout entire online mathematics courses. The CoI survey (see Appendix F), which emerged from a study conducted by Arbaugh et al. (2008), is valid and reliable when measuring teaching presence, cognitive presence, and social presence as described by the CoI framework (Arbaugh et al., 2008).

Therefore, instructional designers will be better equipped to fulfill their primary responsibility of designing instruction (Morrison et al., 2013). Hirumi (2009) stated that when the effectiveness, efficiency, and attractiveness of online learning materials is inadequate, “educators may have to spend exorbitant amounts of time explaining requirements, clarifying expectations, correcting errors, troubleshooting, and otherwise filling in gaps in design” (p. 40).

Fifth, this study informs higher education policy makers and higher education administrators. The participants’ responses provide insight about the training, technologies, and infrastructure needed in order for higher education mathematics instructors to establish teaching presence in higher education online mathematics courses. Therefore, this study provides a basis for higher education policy makers and higher education administrators to make informed decisions regarding online education policy and funding (Simonson et al., 1999). Simonson and Schlosser (2009) posit, “Distance education programs require a careful planning process that includes systematic design and implementation” (p. 3).

Finally, this study begins to fill the gap in the literature on the application of the CoI theoretical framework to an entire mathematics course. The CoI framework focuses on transactions occurring in asynchronous, text-based group discussions (Garrison et al., 2010) and is essential for a worthwhile higher education experience (Garrison et al., 2000). The core elements of the CoI framework are teaching presence, social presence, and cognitive presence (Garrison et al., 2000). Teaching presence pertains to course design and facilitation of learning (Garrison et al., 2000) and is necessary for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010).

The themes that emerged from this study are indicators of instructional management, building understanding, and direct instruction, which are categories of teaching presence.

Limitations of Findings

Creswell (2012) defined limitations as "potential weaknesses or problems with the study identified by the researcher" (p. 199); they are present, in varying degrees, in all studies. The present study is limited in at least two respects: (a) the number of participants and (b) the types of institutions represented. The plan for this study was to include 12 mathematics instructors from a public university system composed of 26 institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges (University System of Georgia, 2018a). Including 12 participants would allow for attrition. However, only 10 instructors consented to participation in this study. Six of the instructors were from research institutions, three from state colleges, and one from a state university. Comprehensive universities were not represented, and 60% of the participants were from research institutions. In addition, none of the participants were at any time employed by a historically Black university within the university system. In this case, the data may not reflect the experiences of "key constituencies within the population" (Ritchie et al., 2014, p. 119). As a result, the findings of this study may not be generalizable, which is characteristic of a qualitative study (Ritchie et al., 2014).

In addition, there are two potential problems associated with this study. First, the CoI survey is a data collection tool for this study. Garrison et al. (2010) explain that the CoI framework, which focuses on transactions occurring in asynchronous, text-based group discussions, provides the theoretical foundation for the CoI survey. Therefore, the

CoI survey may not be applicable to the interview and syllabi data collected for this study because these data apply throughout entire mathematics courses, not only asynchronous, text-based group discussions. Second, in the absence of facial cues from students, instructors for online mathematics courses may not know when it is necessary to review course content. According to Dahlke (2008), mathematics content "will fade from memory if it is not used frequently" (p. 524).

Recommendations for Future Research

This phenomenological study describes the lived experiences of mathematics instructors while establishing teaching presence in online mathematics courses. Teaching presence pertains to course design and facilitation of learning (Garrison et al., 2000) and is essential for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010). According to Garrison et al. (2000), teaching presence is essential for a worthwhile higher education experience (Garrison et al., 2000). A recommendation for future research is to replicate this study with a different research design. Vagle (2016) suggests the number of participants is driven by the phenomenon being studied and what seems reasonable to the researcher.

Future research could also use the CoI survey instrument (see Appendix F) to describe teaching presence in online mathematics courses. Garrison et al. (2010) explain that the CoI framework provides the theoretical foundation for the survey. In addition, the CoI framework focuses on transactions occurring in asynchronous, text-based group discussions (Garrison et al., 2010). Therefore, future research could explore interactions—instructor-student interactions, student-student interactions, and student-content interactions, occurring throughout entire online mathematics courses.

Furthermore, future research could explore how, in the absence of facial cues, instructors for online mathematics classes know when it is necessary to review course content. This topic surfaced during the interview process. Participant 7 said that one of the differences between establishing teaching presence in online courses versus face-to-face courses is that for a face-to-face class, "you can see students' feedback, so you'll know" the effectiveness of your instruction. In addition, Participant 7 said,

> For the online class, since you are not able to see their faces, I cannot judge how well they understand the material or instruction. The only thing I can tell is from the grade after they submit their assignment, so it's kind of delayed…. Normally online, it's a week later…unless they ask questions.

Summary

This phenomenological study described, based on the teaching presence component of the community of inquiry (CoI) theoretical framework, the lived experiences of mathematics instructors while establishing teaching presence in online higher education mathematics courses. A mathematics instructor searching the literature for information on teaching and designing online mathematics courses will find a wealth of information pertaining to best practices, strategies, and standards for online education; however, information specific to designing and teaching online mathematics courses is scarce (Engelbrecht & Harding, 2005; Juan et al., 2012). This scarcity includes information on teaching presence, which is necessary for achieving learning outcomes (Garrison & Akyol, 2013) and student satisfaction (Bush et al., 2010). This study begins to fill a gap in the literature for teaching and designing online mathematics courses. The three main research questions and their subquestions are:

1. How do mathematics instructors establish teaching presence in online higher education mathematics courses?
    a. How do mathematics instructors deliver course content in online courses?
    b. How do mathematics instructors ask and answer questions in online courses?
    c. How do mathematics instructors establish dialogue between students in online courses?
    d. How do mathematics instructors assess student learning in online courses?
    e. How do mathematics instructors encourage students to meet deadlines in online courses?
2. How do mathematics instructors establish teaching presence in face-to-face higher education mathematics courses?
    a. How do mathematics instructors deliver course content in face-to-face courses?
    b. How do mathematics instructors ask and answer questions in face-to-face courses?
    c. How do mathematics instructors establish dialogue between students in face-to-face courses?
    d. How do face-to-face mathematics instructors assess student learning?
    e. How do mathematics instructors encourage students to meet deadlines in face-to-face courses?
3. What is the difference between how mathematics instructors establish teaching presence in online courses versus face-to-face courses?

Participants for this study were from a public university system composed of 26 institutions—four research institutions, four comprehensive universities, nine state universities, and nine state colleges (University System of Georgia, 2018a). Data for this study were collected from face-to-face and online mathematics course syllabi and in-depth semi-structured interviews. The interview data were subject to a phenomenological analysis and syllabi data were subject to a content analysis. In addition, interview data for online courses and syllabi data for online courses were evaluated for the measures of teaching presence contained in the CoI survey (see Appendix G).

This study has implications for mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators. Findings for this study include practices and strategies for teaching mathematics online. This study also presents information that should be included on course syllabi for online mathematics courses. Furthermore, this study presents themes that emerged from the research questions. These themes are indicators of the categories, instructional management, building understanding, and direct instruction, from the teaching presence component of the community of inquiry (CoI) theoretical framework.

Based on this study, there are four recommendations for future researcher. First, a recommendation for future research is to replicate this study with a different research design. Second, future research could also use the CoI survey instrument (see Appendix F) to describe teaching presence in online mathematics courses. Third, future research could explore interactions—instructor-student interactions, student-student interactions, and student-content interactions, occurring throughout entire online mathematics courses.

Finally, future research could explore how, in the absence of facial cues, instructors for online mathematics classes know when it is necessary to review course content.

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Appendix A

Request for Participation

Dear Colleagues:

I am a doctoral student in the Instructional Technology and Distance Education Program at Nova Southeastern University (NSU) and a mathematics professor at [researcher's place of employment]. My dissertation focuses on establishing teaching presence in higher education online mathematics courses.

I am requesting your participation in this study. I understand the depth of your professional obligations; therefore, I will only ask for a modest commitment of your time. The results of this study will fill a gap in the literature and inform mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators regarding establishing teaching presence in online mathematics courses. Furthermore, the results could suggest best practices and standards for designing and facilitating online mathematics courses.

Participants in this study will be from [name of university system]. The instructors must have had experience teaching both online and face-to-face mathematics courses. The instructors must also have the ability to explain these experiences. The Internal Review Boards at both NSU and [researcher's place of employment] have approved this study.

Two types of data will be collected—interview and course syllabi. The semi-structured interviews will be recorded and last approximately 60 minutes. The course syllabi will include a syllabus from one of your past or current online courses and a course syllabus from one of your past or current face-to-face courses. Your identity will be kept confidential. In addition, you will have an opportunity to review the report related to your interview for discrepancies.

If you are willing to participate in this study, we will schedule your interview after I receive your signed consent.

Thank you for your consideration. If you have any questions, please contact me.

Sincerely,

Deltrye Eagle Holt
Doctoral Student
Nova Southeastern University
Instructional Technology & Distance Education

Dear Colleague:

I am a mathematics professor at [researcher's place of employment] and a doctoral student in the Instructional Technology and Distance Education Program at Nova Southeastern University (NSU). My dissertation focuses on establishing teaching presence in higher education online mathematics courses.

I am requesting your participation in this study. I understand the depth of your professional obligations; therefore, I will only ask for a modest commitment of your time. The results of this study will fill a gap in the literature and inform mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators regarding establishing teaching presence in online mathematics courses. Furthermore, the results could suggest best practices and standards for designing and facilitating online mathematics courses.

Participants in this study—full-time, part-time, and retired mathematics instructors from the [name of university system]—must have experience teaching both online and face-to-face mathematics courses. The instructors must also have the ability to explain these experiences. The Institutional Review Boards at both [researcher's place of employment] and NSU have approved this study.

Two types of data will be collected—interview and course syllabi. The semi-structured interviews will be recorded and last approximately 60 minutes. The course syllabi will include a syllabus from one of your past or current online courses and a course syllabus from one of your past or current face-to-face courses. Your identity will be kept confidential. In addition, you will have an opportunity to review the report related to your interview for discrepancies.

If you are willing to participate in this study, we will schedule your interview after I receive your signed consent.

Thank you for your consideration. If you have any questions, please contact me.

Sincerely,
Deltrye Eagle Holt
Doctoral Student
Nova Southeastern University
Instructional Technology & Distance Education

Appendix B

Consent Form

Participant's Name:______________________

Researcher's Place of Employment
Research informed Consent Document

Establishing Teaching Presence in Higher Education Online Mathematics Courses: A Phenomenological Study

Principal Investigator:	**Principal Investigator telephone number:**
Deltrye Eagle Holt	

You are being asked to take part in this research study about establishing teaching presence in higher education online mathematics courses because you can provide a firsthand account of your experience teaching mathematics courses online. The information you provide will fill a gap in the literature and inform mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators regarding establishing teaching presence in online mathematics courses.

The purpose of this document is to:

- Explain your rights and responsibilities
- Explain the purpose of the study
- Describe what will happen if you decide to take part in this study
- Explain the potential risks and benefits of taking part in the study

Participation in research studies is voluntary. Please read this consent form carefully and take your time making your decision. As the study staff discusses this consent form with you, please ask them to explain any words or information that you do not clearly understand.

Why is this study being done?
The purpose of this study is to fill a gap in the literature by documenting the real life experiences of higher education mathematics instructors/professors that lead to establishing teaching presence in online courses. Teaching presence pertains to course design and facilitation of learning and is essential for achieving learning outcomes and student satisfaction.

Participant's Name:______________________

How long will I be in this study?
Your active participation in this study is expected to take approximately 60 minutes. You can choose not to be in the study or stop participating at any time without penalty or loss of any rights or benefits you are entitled to. Participating in this study will not affect your status as an employee. Please talk to the study staff first before you stop participating in the study.

What will happen to me in the study?
If you participate in this study, you will engage in a 60-minute, semi-structured, recorded interview via a web conference. The interview will occur at a mutual agreed upon time. There are 22 interview questions—11 demographic questions, five questions regarding teaching mathematics online, five questions regarding teaching mathematics face-to-face, and one question comparing establishing teaching presence in online and face-to-face online mathematics courses. You may be asked additional questions for clarification during the interview. If further clarification is needed, you may be asked follow-up questions via email or telephone.

You will also be requested to email two course syllabi to the researcher before your interview. You will be asked to send a face-to-face course syllabus and an online course syllabus.

I give my consent to be recorded during my participation in this research study. These recordings will only be used for analyses, research documentation and classroom instruction.

I have a right to revoke my consent to be recorded in writing at any time to *Deltrye Holt, [researcher's address].* I may request cessation during the recording process. My recordings will be maintained in a protected and secure manner as part of my confidential research record.

____ (***Participant Initials)*** **I will allow photographs, recordings, or other images taken of me.**

____ (***Participant Initials)*** **I do not want photographs, videotaped images, or other images taken of me.**

What are the risks of being in this study?
This research study involves minimal risk to you. The procedures you will follow have no more risk of harm than you would have in everyday life. Furthermore, the researcher will take precautions to protect your identity; however, confidentiality cannot be guaranteed.

Participant's Name:______________________

Will I benefit from this study?
This study is not designed to benefit you directly. The study results may benefit others in the future.

Who will see my study information?
Your records may be reviewed in order to meet federal or state regulations. Reviewers may include the [researcher's place of employment] Institutional Review Board (the committee who oversees safety of volunteers in research studies), the Nova Southeastern University Institutional Review Board, institutional officials, and outside agencies.

How will you keep my study information confidential?
Study records that identify you will be kept confidential except as required by law. You will not be identified in study records or publications disclosed outside [researcher's place of employment].

Information we learn about you in this research study will be handled in a confidential manner, within the limits of the law and will be limited to people who have a need to review this information. The names of institutions will not be reported. All data will be coded for anonymity. When the interviews are transcribed, participants' names will be replaced with pseudonyms. This data will be available to the researcher, the [researcher's place of employment] Institutional Review Board and other representatives of this institution, the Nova Southeastern University Institutional Review Board, and any regulatory and granting agencies (if applicable). If the researcher publishes the results of the study in a scientific journal or book, the researcher will not identify you. All confidential data will be kept securely. Each recorded interview will be stored as a digital video file on [researcher's place of employment] r drive. Each recorded interview will be deleted after the interview is transcribed. Course syllabi and coding of all data will also be stored on [researcher's place of employment] r drive. Researcher's notes and consent forms will be stored in a locked file cabinet in the researcher's campus office. All personally identifiable data will be deleted from [researcher's place of employment] r drive 3 years after the conclusion of the study. The researcher's notes and consent forms will be shredded 3 years after the conclusion of the study.

What are my costs (what will it cost me) for taking part in the study?
It will not cost you anything to take part in the study other than basic expenses like transportation.

Will I be paid for participation in this study?
You will not be paid for taking part in this study.

Participant's Name:_____________________

Who can answer my questions about this study?
You can ask questions about this study at any time. Please contact the study staff listed on page 1 of this document if you have questions about:

- Study procedures
- Reporting a problem
- Leaving the study before it is finished
- Expressing a concern about the study
- Any other questions you may have about the study

Who can I contact to discuss my rights, problems, concerns, questions, or complaints I have as a study participant?
Contact the [researcher's place of employment] Review Board at (706) 721-1483.

STATEMENT OF CONSENT

I have read this form and the information in it was explained to me. My taking part in the study is voluntary. All of my questions were answered. I will receive a copy of this form for my records. I agree to take part in this study. **I am not giving up my legal rights by signing this form.**

____
Participant's Name (print)

_________________________________ ___________________
Participant's Signature Date /Time (00:00)

INVESTIGATOR STATEMENT
I acknowledge that I have discussed the above study with this participant and answered all of his/her questions. They have voluntarily agreed to participate. I have documented this action in the participant's research chart source documents. A copy of this signed document will be placed in the participant's research chart, as applicable. A copy of this document will be given to the participant or the participant's legally authorized representative.

____
Printed name of Investigator obtaining consent

_______________________________________ ___________________
Signature of Investigator obtaining consent Date /Time (00:00)

Appendix C

Follow-Up Request for Participation

Dear Colleagues,

I sent you an email (see below) on (date) requesting your participation in a study on establishing teaching presence in higher education online mathematics courses. I know you are very busy; I am asking for approximately 1.5 hours of your time. Please reply to this email if you are willing to participate in this study.

Thank you for your consideration.

Deltrye Eagle Holt
***
Dear Colleagues:

I am a doctoral student in the Instructional Technology and Distance Education Program at Nova Southeastern University (NSU) and a mathematics professor at [researcher's place of employment]. My dissertation focuses on establishing teaching presence in higher education online mathematics courses.

I am requesting your participation in this study. I understand the depth of your professional obligations; therefore, I will only ask for a modest commitment of your time. The results of this study will fill a gap in the literature and inform mathematics instructors, mathematics educators, instructional designers, higher education policy makers, and higher education administrators regarding establishing teaching presence in online mathematics courses. Furthermore, the results could suggest best practices and standards for designing and facilitating online mathematics courses.

Participants in this study will be from the [name of university system]. The instructors must have had experience teaching both online and face-to-face mathematics courses. The instructors must also have the ability to explain these experiences. The Internal Review Boards at both NSU and [researcher's place of employment] have approved this study.

Two types of data will be collected—interview and course syllabi. The semi-structured interviews will be recorded and last approximately 60 minutes. The course syllabi will include a syllabus from one of your past or current online courses and a course syllabus from one of your past or current face-to-face courses. Your identity will be kept confidential. In addition, you will have an opportunity to review the report related to your interview for discrepancies.

If you are willing to participate in this study, we will schedule your interview after I receive your signed consent.

Thank you for your consideration. If you have any questions, please contact me.

Sincerely,

Deltrye Eagle Holt
Doctoral Student
Nova Southeastern University
Instructional Technology & Distance Education

Appendix D

Interview Questions

Appendix D: Establishing Teaching Presence in Higher Education Mathematics Courses Interview Questions

Script

Before I begin the interview, I would like to thank you for participating in this study. This interview is divided into 2 parts—demographic questions and teaching questions. The teaching questions will pertain to both online and face-to-face courses. Do you have any questions or concerns? I will start recording after I introduce the topic.

Part 1: Demographic Information

In this study, you will be identified by a pseudonym. I will ask you 6 demographic questions.

Pseudonym

1. What is your gender?

2. What is your age range? 20-29, 30-39, 40-49, 50-59, 60-69, 70+

3. What degrees have you earned? Please include the program.

4. What is your rank? Adjunct Instructor, Adjunct Professor, Lecturer, Instructor, Assistant Professor, Associate Professor, Professor

5. What is your total number of years teaching?

6. What is your total number of years teaching online?

7. How many years have you taught at this institution?

8. How many years have you taught face-to-face courses at this institution?

9. Do you teach undergraduate or graduate courses face-to-face at this institution?

10. How many years have you taught online courses at this institution?

11. Do you teach undergraduate or graduate courses online at this institution?

Part II: Experience Narrative

Please provide a detailed response for each question based on your experience teaching online.

12. How do you deliver course content in online courses?

13. How do you ask and answer questions in online courses?

14. How do you establish dialogue between students in online courses?

15. How do you assess student learning in online courses?

16. How do you encourage students to meet deadlines in online courses?

Please provide a detailed response for each question based on your experience teaching face-to-face.

17. How do you deliver course content in face-to-face courses?

18. How do ask and answer questions in face-to-face courses?

19. How do you establish dialogue between students in face-to-face courses?

20. How do you assess student learning?

21. How do you encourage students to meet deadlines in face-to-face courses?

During this interview, the questions that I asked about your online and face-to-face courses pertain to the concept of teaching presence.

22. What is the difference between how you establish teaching presence in online courses versus how you establish teaching presence in face-to-face courses?

Appendix E

Common Information Checklist for Course Syllabi

Appendix E: Common Information Checklist for Course Syllabi

Common Information based on suggestions from O'Brien et al. (2008, p. 40)

1. Table of contents
2. Name of the course
3. Quarter or Semester offered
4. Instructor's name and contact Information
5. Course description
6. Student learning outcomes
7. Policies and expectations
8. Communicating instructions
9. Attendance/Participation
10. Grading procedures
11. Study plan
12. Course materials (books, technology, etc.)
13. Academic honesty
14. American Disability Act
15. Campus Resources
16. Technical Support

Appendix F

Community of Inquiry Survey

Appendix F: Community of Inquiry Survey Instrument (draft v14)

Teaching Presence

Design & Organization

1. The instructor clearly communicated important course topics.

2. The instructor clearly communicated important course goals.

3. The instructor provided clear instructions on how to participate in course learning activities.

4. The instructor clearly communicated important due dates/time frames for learning activities.

Facilitation

5. The instructor was helpful in identifying areas of agreement and disagreement on course topics that helped me to learn.

6. The instructor was helpful in guiding the class towards understanding course topics in a way that helped me clarify my thinking.

7. The instructor helped to keep course participants engaged and participating in productive dialogue.

8. The instructor helped keep the course participants on task in a way that helped me to learn.

9. The instructor encouraged course participants to explore new concepts in this course.

10. Instructor actions reinforced the development of a sense of community among course participants.

Direct Instruction

11. The instructor helped to focus discussion on relevant issues in a way that helped me to learn.

12. The instructor provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.

13. The instructor provided feedback in a timely fashion.

Social Presence

Affective expression

14. Getting to know other course participants gave me a sense of belonging in the course.

15. I was able to form distinct impressions of some course participants.

16. Online or web-based communication is an excellent medium for social interaction.

Open communication

17. I felt comfortable conversing through the online medium.

18. I felt comfortable participating in the course discussions.

19. I felt comfortable interacting with other course participants.

Group cohesion

20. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.

21. I felt that my point of view was acknowledged by other course participants.

22. Online discussions help me to develop a sense of collaboration.

Cognitive Presence

Triggering event

23. Problems posed increased my interest in course issues.

24. Course activities piqued my curiosity.

25. I felt motivated to explore content related questions.

Exploration

26. I utilized a variety of information sources to explore problems posed in this course.

27. Brainstorming and finding relevant information helped me resolve content related questions.

28. Online discussions were valuable in helping me appreciate different perspectives.

Integration

29. Combining new information helped me answer questions raised in course activities.

30. Learning activities helped me construct explanations/solutions.

31. Reflection on course content and discussions helped me understand fundamental concepts in this class.

Resolution

32. I can describe ways to test and apply the knowledge created in this course.

33. I have developed solutions to course problems that can be applied in practice.

34. I can apply the knowledge created in this course to my work or other non-class related activities.

<u>5 point Likert-type scale</u>

1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

Appendix G

Modified Community of Inquiry Survey

Appendix G: Modified Community of Inquiry Survey Instrument (draft v14)

Teaching Presence

Design & Organization

1. The instructor clearly communicates important course topics.

2. The instructor clearly communicates student learning outcomes.

3. The instructor provides clear instructions on how to participate in course learning activities.

4. The instructor clearly communicates important due dates/time frames for learning activities.

Facilitation

5. The instructor is helpful in identifying areas of agreement and disagreement on course topics that helps students learn.

6. The instructor is helpful in guiding the class towards understanding course topics in a way that helps students clarify their thinking.

7. The instructor helps to keep course participants engaged and participating in productive dialogue.

8. The instructor helps keep the course participants on task in a way that helps students learn.

9. The instructor encourages course participants to explore new concepts.

10. Instructor actions reinforce the development of a sense of community among course participants.

Direct Instruction

11. The instructor helps to focus discussion on relevant issues in a way that helped students learn.

12. The instructor provides feedback that helps students understand their strengths and weaknesses relative to the course's goals and objectives.

13. The instructor provides feedback in a timely fashion.

Social Presence

Affective expression

14. Getting to know other course participants gave me a sense of belonging in the course.

15. I was able to form distinct impressions of some course participants.

16. Online or web-based communication is an excellent medium for social interaction.

Open communication

17. I felt comfortable conversing through the online medium.

18. I felt comfortable participating in the course discussions.

19. I felt comfortable interacting with other course participants.

Group cohesion

20. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.

21. I felt that my point of view was acknowledged by other course participants.

22. Online discussions help me to develop a sense of collaboration.

Cognitive Presence

Triggering event

23. Problems posed increased my interest in course issues.

24. Course activities piqued my curiosity.

25. I felt motivated to explore content related questions.

Exploration

26. I utilized a variety of information sources to explore problems posed in this course.

27. Brainstorming and finding relevant information helped me resolve content related questions.

28. Online discussions were valuable in helping me appreciate different perspectives.

Integration

29. Combining new information helped me answer questions raised in course activities.

30. Learning activities helped me construct explanations/solutions.

31. Reflection on course content and discussions helped me understand fundamental concepts in this class.

Resolution

32. I can describe ways to test and apply the knowledge created in this course.

33. I have developed solutions to course problems that can be applied in practice.

34. I can apply the knowledge created in this course to my work or other non-class related activities.

5 point Likert-type scale

1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree

Appendix H

Rubric for Analyzing Interview Data for Online Courses and Syllabi Data for Online Courses

Design & Organization

Teaching Presence Measure for Design & Organization: 1. The instructor clearly communicates important course content.	
Instructor's Teaching Presence	**Measure is Met**
The syllabus indicates that the instructor communicates course content using video and text.	yes
The syllabus indicates that the instructor communicates course content using either video or text.	almost
The syllabus does not indicate that the instructor delivers course content by using video or text.	no

Teaching Presence Measure for Design & Organization: 1. The instructor clearly communicates important course content.	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports communicating course content using video and text.	yes
The instructor reports communicating course content using either video or text.	almost
The instructor does not report communicating course content by using video or text.	no

Teaching Presence Measure for Design & Organization: 2. The instructor clearly communicates student learning outcomes.	
Instructor's Teaching Presence	**Measure is Met**
The syllabus contains a list of student learning outcomes (or goals) for the course.	yes
The syllabus does not contain a list of student learning outcomes (or goals) for the course.	no

Teaching Presence Measure for Design & Organization: 2. The instructor clearly communicates student learning outcomes.	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports using student learning outcomes (or course goals) for designing the course.	yes
The instructor does not report using student learning outcomes (or course goals) for designing the course.	no

Teaching Presence Measure for Design & Organization: ***3. The instructor provides clear instructions on how to participate in course learning activities.***	
Instructor's Teaching Presence	**Measure is Met**
The syllabus contains instructions for participating in course learning activities.	yes
The syllabus does not contain instructions for participating in course learning activities.	no

Teaching Presence Measure for Design & Organization: ***3. The instructor provides clear instructions on how to participate in course learning activities.***	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports instructing students on how to participate in course learning activities.	yes
The instructor does not report instructing students on how to participate in course learning activities.	no

Teaching Presence Measure for Design & Organization: ***4. The instructor clearly communicates important due dates/time frames for learning activities.***	
Instructor's Teaching Presence	**Measure is Met**
The syllabus indicates the minimum amount of time students are expected to commit to the course per week and contains due dates.	yes
The syllabus indicates either the minimum amount of time students are expected to commit to the course per week or contains due dates.	almost
The syllabus indicates neither the minimum amount of time students are expected to commit to the course per week nor contains due dates.	no

Teaching Presence Measure for Design & Organization: 4. The instructor clearly communicates important due dates/time frames for learning activities.	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports communicating the minimum amount of time students are expected to commit to the course per week and making students aware of due dates for assessments.	yes
The instructor reports either communicating the minimum amount of time students are expected to commit to the course per week or making students aware of due dates for assessmen	almost
The instructor does not report communicating the minimum amount of time students are expected to commit to the course per week and making students aware of due for assessments.	no

Facilitation

Teaching Presence Measure for Facilitation: 5. The instructor is helpful in identifying areas of agreement and disagreement on course topics that help students learn.	
Instructor's Teaching Presence	**Measure is Met**
The syllabus indicates that online discussions are available for students to engage in discourse on topics related to course content or learning mathematics, and the instructor serves as a mediator when necessary.	yes
The syllabus indicates that online discussions are available for students to engage in discourse on topics related to course content or learning mathematics, and the instructor does not serves as a mediator.	almost
The syllabus does not indicate that online discussions are available for students to engage in discourse on topics related to course content or learning mathematics.	no

Teaching Presence Measure for Facilitation: 5. The instructor is helpful in identifying areas of agreement and disagreement on course topics that help students learn.	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports providing online discussions for students to engage in discourse on topics related to course content or learning mathematics, where the instructor serves as a mediator when necessary.	yes
The instructor reports providing online discussions for students to engage in discourse on topics related to course content or learning mathematics, where the instructor does not serve as a mediator.	almost
The instructor does not report providing opportunities for students to engage in discourse on topics related to course content or learning mathematics.	no

Teaching Presence Measure for Facilitation: 6. The instructor is helpful in guiding the class towards understanding course topics in a way that help students clarify their thinking.	
Instructor's Teaching Presence	**Measure is Met**
The syllabus indicates that multiple attempts are allowed for at least one type of assessment.	yes
The syllabus does not indicate that multiple attempts are allowed for at least one type of assessment.	no

Teaching Presence Measure for Facilitation: 6. The instructor is helpful in guiding the class towards understanding course topics in a way that help students clarify their thinking.	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports providing multiple attempts for at least one type of assessment.	yes
The instructor does not report providing multiple attempts for at least one type of assessment.	no

Teaching Presence Measure for Facilitation: ***7. The instructor helps to keep course participants engaged and participating in productive dialogue.***	
Instructor's Teaching Presence	**Measure is Met**
The syllabus explains how students should ask the instructor questions.	yes
The syllabus does not explain how students should ask the instructor questions.	no

Teaching Presence Measure for Facilitation: ***7. The instructor helps to keep course participants engaged and participating in productive dialogue.***	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports receiving questions from students.	yes
The instructor does not report receiving questions from students.	no
Teaching Presence Measure for Facilitation: ***8. The instructor helps keep the course participants on task in a way that helps students learn.***	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The syllabus explains the consequences for not participating in the course.	yes
The syllabus does not explain the consequences for not participating in the course.	no

Teaching Presence Measure for Facilitation: ***8. The instructor helps keep the course participants on task in a way that helps students learn.***	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The instructor reports reminding students of due dates and contacting students who do not meet due dates.	yes
The instructor reports either reminding students of due dates or contacting students who do not meet due dates.	almost
The instructor does not report reminding students of due dates or contacting students who do not meet due dates.	no

Teaching Presence Measure for Facilitation: 9. The instructor encourages course participants to explore new concepts.	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The syllabus indicates that students will connect course concepts to real world phenomena.	yes
The syllabus does not indicate that students will connect course concepts to real world phenomena.	no

Teaching Presence Measure for Facilitation: 9. The instructor encourages course participants to explore new concepts.	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The instructor reports that students will connect course concepts to real world phenomena.	yes
The instructor does not report that students will connect course concepts to real world phenomena.	no

Teaching Presence Measure for Facilitation: 10. Instructor actions reinforces the development of a sense of community among course participants.	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The syllabus indicates that students are required to post meaningful replies to their classmates' posts on the discussion board.	yes
The syllabus indicates that students are required to post replies to their classmates' posts on the discussion board.	almost
The syllabus does not indicate that students are required to post replies to their classmates' posts on a discussion board.	no

Teaching Presence Measure for Facilitation: 10. Instructor actions reinforces the development of a sense of community among course participants.	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The instructor reports requiring students to post meaningful replies to their classmates' posts on a discussion board.	yes
The instructor reports requiring students to post replies to their classmates' posts on a discussion board.	almost
The instructor does not report requiring students to post replies their classmates' posts on a discussion board.	no

Direct Instruction

Teaching Presence Measure for Direct Instruction: *11. The instructor helps to focus discussion on relevant issues in a way that helped students learn.*	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The syllabus indicates that students will have an opportunity to correct posts on the discussion board.	yes
The syllabus does not indicate that students will have an opportunity to correct posts on the discussion board.	no

Teaching Presence Measure for Direct Instruction: *11. The instructor helps to focus discussion on relevant issues in a way that helped students learn.*	
Instructor's Teaching Presence	**Degree to Which Measure is Met**
The instructor reports giving students an opportunity to correct posts on the discussion board.	yes
The instructor does not report giving students an opportunity to correct posts on the discussion board.	no

Teaching Presence Measure for Direct Instruction: *12. The instructor provides feedback that helped students understand their strengths and weaknesses relative to the course's goals and objectives.*	
Instructor's Teaching Presence	**Measure is Met**
The syllabus indicates that the instructor will respond to students' questions.	yes
The syllabus does not indicate that the instructor will respond to students' questions.	no

Teaching Presence Measure for Direct Instruction: *12. The instructor provides feedback that helped students understand their strengths and weaknesses relative to the course's goals and objectives.*	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports responding to students' questions.	yes
The instructor does not report responding to students' questions.	no

Teaching Presence Measure for Direct Instruction: 13. The instructor provides feedback in a timely fashion.	
Instructor's Teaching Presence	**Measure is Met**
The syllabus indicates the instructor's timeline for providing feedback on assessments.	yes
The syllabus does not indicate the instructor's timeline for providing feedback on assessments.	no

Teaching Presence Measure for Direct Instruction: 13. The instructor provides feedback in a timely fashion.	
Instructor's Teaching Presence	**Measure is Met**
The instructor reports providing feedback on assessments within a specified amount of time.	yes
The instructor does not report providing feedback on assessments within a specified amount of time.	no

Social Presence

Affective expression

14. Getting to know other course participants gave me a sense of belonging in the course.

15. I was able to form distinct impressions of some course participants.

16. Online or web-based communication is an excellent medium for social interaction.

Open communication

17. I felt comfortable conversing through the online medium.

18. I felt comfortable participating in the course discussions.

19. I felt comfortable interacting with other course participants.

Group cohesion

20. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.

21. I felt that my point of view was acknowledged by other course participants.

22. Online discussions help me to develop a sense of collaboration.

Cognitive Presence

Triggering event

23. Problems posed increased my interest in course issues.

24. Course activities piqued my curiosity.

25. I felt motivated to explore content related questions.

Exploration

26. I utilized a variety of information sources to explore problems posed in this course.

27. Brainstorming and finding relevant information helped me resolve content related questions.

28. Online discussions were valuable in helping me appreciate different perspectives.

Integration

29. Combining new information helped me answer questions raised in course activities.

30. Learning activities helped me construct explanations/solutions.

31. Reflection on course content and discussions helped me understand fundamental concepts in this class.

Resolution

32. I can describe ways to test and apply the knowledge created in this course.

33. I have developed solutions to course problems that can be applied in practice.

34. I can apply the knowledge created in this course to my work or other non-class related activities.

5 point Likert-type scale

1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree