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THE IMPACT OF THE TEACHER ON ONLINE SECONDARY STUDENTS' BELIEFS ABOUT MATHEMATICS

BY

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Dedication

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Abstract

Mathematics is the only universal language. Despite its concrete foundations, it is often associated with strong negative emotions. From an early age, children are taught how to count, measure, add, subtract, multiply, and divide in real-life contexts. With mathematics being integral to communication and foundational knowledge, why do some children develop math anxiety and math aversion? This mixed-methods study examines the mathematics self-confidence and likeability of 85 high school students within a Provincial Online Learning School in British Columbia, Canada. The Community of Inquiry (CoI) teaching presence instrument was utilized in conducting an online survey. The study's results indicate that there is a perceived relationship between teacher impact and students' beliefs about mathematics. Therefore, with the rise in the adoption of K-12 blended and online education in Canada, emphasis must be placed on incorporating a strong teaching presence into the design and delivery of online learning. This will ensure young learners are equipped and empowered for the world they will face. Recommendations are made to support mathematical knowledge development through optimal course design and best practices for teachers.

Keywords: Community of Inquiry (CoI), teaching presence, teacher presence, constructivism, blended learning, online learning, distance education

No content generated by AI technologies has been used in this assessment.

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Chapter One: Introduction

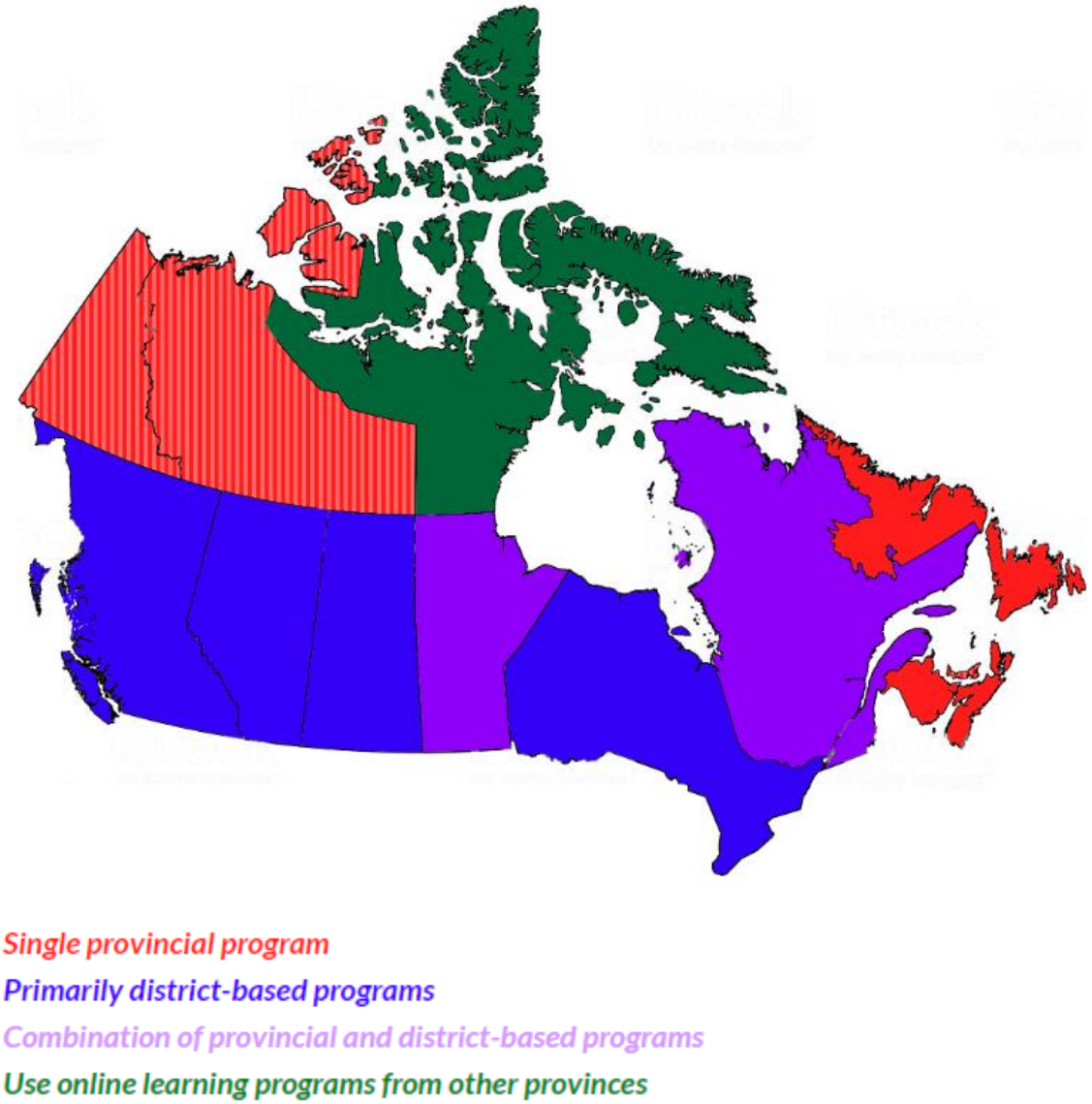
The adoption of blended and online education at the K-12 level is growing at a tremendous rate; however, the research to reinforce the importance of intentional course design, execution, and support of K-12 blended and online learning has not kept pace. According to Garrison (2017), online learning is a "form of distance education that had its focus on content delivery and autonomous approaches to learning" (p. 3). Blended learning includes any instructional units that combine face-to-face (or Livestream) synchronous activities and online asynchronous activities (Roblyer & Hughes, 2019). Simonson et al. (2019) claim that to be qualified as a blended or hybrid course, 30%-79% of the course's content is delivered online. Blended and online learning is a dynamic remodeling of education that increases learning opportunities for all students, especially students who are geographically separated.

Canada has been at the forefront of establishing K-12 online educational opportunities for learners with the first Canadian virtual school beginning in 1994-95. Currently, every Canadian province and territory has some configuration of online learning. Figure 1 shows the K-12 distance and online learning programming types across Canada. Education in Canada is a provincial, not federal, jurisdiction. Many of the jurisdictions have either primarily district-based programs or provincial programs (Barbour, 2023). The primary model used in Atlantic Canada is the use of a single provincial program whereas the Yukon and Northwest Territories are developing their own online educational programs. However, all three territories in Northern Canada implement programs from the southern provinces of Ontario, Alberta, and British Columbia (BC). In September 2022, a change to the online educational structure in BC

was implemented by the BC Ministry of Education and Child Care (MoECC). Eighteen school districts and 16 independent school authorities signed agreements to become Provincial Online Learning Schools (POLS) (Home: Online learning BC, 2023). BC students now have two options for online education: a choice to attend a local public or independent school that offers online learning or attend a POLS which can enroll students from anywhere in the province.

Figure 1

K-12 distance and online learning programming across Canada



Note. This figure was produced by Barbour (2023) and illustrates the types of K-12 distance and online learning programming across Canada. Copyright 2023 State of the Nation, para. 1.

In 2021-22, the total K-12 population in Canada of distance and online learning activity was approximately 400,000 learners out of a total of 5.3 million K-12 students.

This accounts for approximately 7.6% of the overall K-12 population. Figure 2 shows the summary of K-12 distance and/or online learning activity by jurisdiction for 2021-22.

Figure 2

2021-22 Summary of K-12 distance and/or online learning activity by jurisdiction

	# of K-12 students	# enrolled in distance/online learning	Percent involvement
NL	63,536	936	1.5%
NS	129,121	2,761	2.1%
PE	20,131	~260	1.3%
NB	98,906	5,134	5.2%
QC	1,003,322	~55,000	5.5%
ON	2,056,055	~139,000	6.8%
MB	204,149	~8,000	3.9%
SK	186,084	19,142	10.3%
AB	733,599	~92,000	12.5%
BC	~667,000	73,744	11.1%
YT	5,456	~250	4.6%
NT	8,700	120	1.4%
NU	10,902	–	–
Federal	109,001	~3,500	3.2%
Total	*5,295,962*	*399,847*	*7.6%*

Note: ~ symbol means that approximations were provided by one or more sources

Note. This figure was produced by Barbour (2023) and illustrates the summary of K-12 distance and/or online learning activity by jurisdiction for 2021-22. Copyright 2023 State of the Nation, para. 4.

The data in the above figure shows that most western provinces in Canada (BC, Alberta, and Saskatchewan) have an above-national average of students participating in distance and online learning. Conversely, students in Atlantic Canada (Prince Edward Island, Nova Scotia, and Newfoundland and Labrador) and Northern Canada (Yukon,

Northwest Territories, and Nunavut) have a somewhat lower percentage of students engaged in distance and online learning. “While Ontario has the highest number of students engaged in K-12 distance and online learning, it is slightly below the national average in terms of the proportion of K-12 students participating in distance and online learning” (Barbour, 2023, para. 11).

Barbour (2023) asserts that after a period of relative stability in the number of students enrolled in K-12 distance and online learning, the 2021-22 school year saw the highest percentage of students engaged in K-12 distance and online learning. He suggests this increase is likely due to the pandemic and parents’ concerns about the health and well-being of their children and families.

The arrival of blended and online learning as an alternative to traditional in-class learning has not diminished the anxiety and aversion related to some subjects, including mathematics (Tan, 2021). According to a survey published in Citizens Journal in 2021, 48% of participants selected mathematics as the hardest subject to learn online, followed by chemistry at 28%, followed by physics and biology which tied for 25%. There are some specific reasons, such as the complexity required in calculations, and the frequent lack of explanation by educators (Williams, 2023), though these are not well researched (Kosko et al., 2014).

Statement of the Problem

Trends and Issues in K-12 Online and Blended Learning

K-12 online and blended learning increased in adoption around the globe during the Covid-19 pandemic. The necessary transition away from face-to-face instruction

revealed to administration and educators the value of an online, or hybrid, model of education within which students can combine positive attributes of campus-based and online learning. “Moving instruction online can enable the flexibility of teaching and learning anywhere, anytime, but the speed with which this move to online instruction is expected to happen is unprecedented and staggering” (Hodges et al., 2020, p. 1). Recognition of the benefits of online or blended learning and the need to empower educators for the specific skills required to teach in these environments (Archibald et al., 2020; Graham et al., 2019) was birthed from this season. Going forward, there should always be a future for distance and online education because learners will continue to require access to courses and programs without the requirement to attend a brick-and-mortar institution (Bates, 2013).

Shifting education from brick-and-mortar to online settings has not solved the riddle of viewing some subjects, including mathematics, through a negative lens (Tan, 2021). However, there are possibilities already in practice that could help with mathematics aversion. To maintain and improve student engagement, commitment, and interaction in online or blended learning programs, schools need to support students in making the change to learning at a distance (Shaaban, 2021; Simpson-Spence, 2021). Garrison, Anderson, and Archer’s (2000) Community of Inquiry (CoI) framework explains the components of the online learning experience and how these components interact with one another to provide an optimal learning experience for students. Their framework has received widespread support as a beneficial model for understanding the online learning experience (Castellanos-Reyes, 2020; Harrell & Wendt, 2019; Majeski et al., 2018; Stenbom, 2018; Vourloumis, 2021; Zhang et al., 2016).

The three highly dynamic and interdependent elements of the CoI framework are social, cognitive, and teaching presence. Social presence is "the ability of participants to identify with a group, communicate openly in a trusting environment, and develop personal and affective relationships progressively by way of projecting their individual personalities" (Garrison, 2017, p. 25). Social presence in an online mathematics environment is especially important to cultivate because of the limited face-to-face or synchronous activity in online learning. Cognitive presence "is reflective of the purposeful nature of collaborative knowledge construction inherent in constructivist educational experiences" (Arbaugh et al., 2008, p. 134). Cognitive presence is closely connected to critical thinking and is realized when learners "contrive and validate meaning through the stages of practical inquiry leading to a resolution of a dilemma, reflection, discourse, analysis, and synthesis" (Harrel & Wendt, 2019, p. 262). In an online mathematics context cognitive presence is achieved when learners master concepts resulting in better outcomes. Finally, teaching presence is "the instructor's visibility that influences students' participation, teamwork, and commitment. It is to facilitate student learning through course design and implementation" (Wang & Liu, 2019, p. 371). Teaching presence emerges in an online mathematics classroom as the teacher draws the student into discovering solutions to mathematical problems.

The intersection of social presence and cognitive presence facilitates student discourse, and the intersection of social presence and teaching presence helps set the climate of the educational learning environment. The intersection of cognitive presence and teaching presence promotes student regulation of learning (Garrison, 2017). The heart of the educational experience lies at the intersection of all three presences; however,

it is a focused and attentive teaching presence that establishes and maintains a community of inquiry (Garrison et al., 2010b).

The Impact of Teaching Presence

Emphasis must be placed on strengthening teaching presence in the K-12 context. The importance and impact of teaching presence on students' well-being and education are vital to student success. Teaching presence is responsible for incorporating instructional strategies based on sound pedagogy and theory. Schunk (2020) explains that cognitive modeling "incorporates modeled explanation and demonstration with verbalization of the model's thoughts and reasons for performing given actions" (p. 135). Students are not the experts in their fields and therefore do not have "the background knowledge and scaffolds to...engage in these 'expert' skills in a way that contributes positively to their development" (Krahenbuhl, 2016, p. 101). Students need their teachers to teach and model because factual knowledge is a necessary precondition for students to acquire these skills (Krahenbul, 2016). This is especially relevant in online mathematics sessions where new complex problems requiring modeling are taught in an environment which typically has less weekly interaction with the teacher.

Instructors who provide goal progress feedback and encourage their learners to self-evaluate their achievements against their personal goals lead their pupils to gain "greater personal satisfaction with their learning progress and further efforts to improve their performance" (Zimmerman, 2002, p. 69). Teachers who spark a desire to learn for the sake of learning pique their students' curiosity because "it is the process of self-determination that is intrinsically motivating rather than the underlying need of the

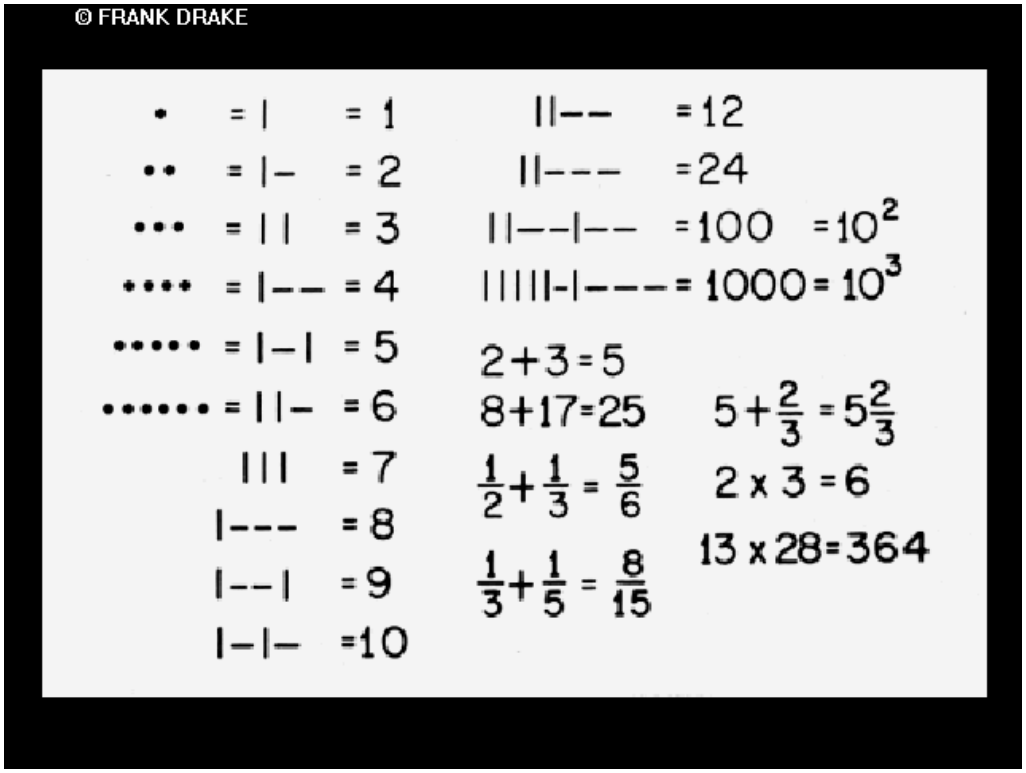
demonstrated behavior" (Schunk, 2020, p. 403). Raising students' understanding of the relationship between working diligently and increasing competence is a needed educational practice. Cultivating these disciplines in an online mathematics classroom is paramount because mastery in both content and competencies is needed in a scaffolding subject. Educational environments and instructional practices which support these habits should lead learners to a greater experience of motivation, self-determination, and intrinsic interest. It is the presence of a teacher that fosters these values in an educational community. Further research is required to authenticate the adaptation of the Community of Inquiry framework to the K-12 online learning environment.

Teaching Presence Specific to Online and Blended Mathematics Classrooms

Mathematical concepts began developing near the beginning of man's existence. China's mathematical system was first recorded in the 11th century BCE. Egypt's pyramids were built using the Egyptian royal cubit measurement. Later, the Romans gave us Roman Numerals and our current, now universally recognized system, has its roots in India (Eves, 1992). This shared history of mathematical development and its central role in societal and economic growth prompted NASA to include elements of mathematics on the Golden Record in their Voyager spacecrafts. Figure 3 displays the image included to explain our number system in a way that even aliens would be able to decipher if discovered (Lewin, 2017).

Figure 3

An image on the Golden Record building up a binary and base 10 number system



Note. This image is credited to Frank Drake (1977) and illustrates building up a binary and base 10 number system. Copyright 2017 SPACE.com, para 13.

From an early age, children are taught how to count, measure, add, subtract, multiply, and divide in real-life contexts. With mathematics being integral to communication and foundational knowledge, why is there math anxiety in children? If mathematics is essential for the human condition to survive, at what point does the subject become something to be afraid of? Why is the subject of mathematics often associated with strong emotion? Barroso et al. (2021) express that math anxiety is experienced by many people throughout development. As such, studying the emotions associated with mathematics and its link to mathematics achievement may help to

improve “math experiences; academic outcomes; and science, technology, engineering, and mathematics career participation” (p. 134). Answering the above questions goes beyond the scope of this research; however, this study explored the impact of the teacher on students’ attitudes and emotions toward the subject of mathematics and on students’ perceptions about their beliefs about their own abilities in mathematics.

Mathematics is a sequential subject wherein each course builds upon the previous course in knowledge and skills. A gap at any point in any topic can be detrimental to the success of future studies; attaining mastery is the prerequisite required in a scaffolding subject (Mesghina et al., 2023). Therefore, mathematics is a subject that requires a strong teacher presence (Elbers, 2003; Lan & Al-Tech, 2019; Sivalingam, 2020). The articles highlight the need to apply the CoI model to the development of mathematical literacy in online or blended mathematics classrooms. Recommendations are shared to support mathematical knowledge development through optimal course design and best practices for teachers. Professional development and education for pre-service and in-service teachers on implementing a Mathematics Community of Inquiry in a K-12 blended context are critical to ensure young learners are equipped and empowered for the world they will face. Further research is needed to determine how to best implement a Community of Inquiry in K-12 blended and online mathematics contexts.

Purpose of the Study

The purpose of this mixed methods study was to explore online secondary students’ perception of teaching presence and their beliefs about their own abilities in and the likability of mathematics.

Research Questions

The research questions ask: *"What are students' perceptions of a relationship between teaching presence and their beliefs about their own abilities in mathematics?"* and *"What are students' perceptions of a relationship between teaching presence and the likability of mathematics?"*

Significance of the Study

Students often have a positive view of mathematics during primary grades and develop growing negative views in the high school years (Stodolsky, 1985). As with subjects such as music and art, success in mathematics is thought to be based on talent and is 'commonly perceived in a rather dichotomous way: either one has or does not have the ability to do math" (p. 131). Students who hear their parent's comment "It's understandable that you are not good in math because I was not good in math" (M. Hann, personal communication, July 27, 2023) form an early mindset that their talents in math are predetermined and cannot change. Stodolsky (1985) asserts there is a strong association between the instructional conditions learners frequently experience in the elementary grades and their later beliefs, attitudes, and assumptions surrounding mathematics learning.

Math concepts have traditionally been taught with the expectation that learners have little or no prior understanding of the concepts and procedures. Grasping mathematics is comparable to learning a new language (Bahrami, 2022, para 2). Additionally, unlike other subjects which utilize two-way dialogue and small group participation for collaborative learning, mathematical instruction flows from the expert to the novice in a one-way direction with less emphasis on peer collaboration. As the

subject material becomes more complicated and challenging, Stodolsky (1985) posits that it is culturally acceptable to excuse our misunderstandings of the problem by "declaring yourself 'not good at math'" (p. 131). As the likability of the subject diminished, mathematics "was seen as correspondingly more difficult" (p. 131).

Positive attitudes towards mathematics and high course grades are highly correlated (Fullerton & Umphrey, 2016), therefore, a strong teaching presence is critical for bolstering confidence in students, especially in learners who have an aversion to mathematics. The findings presented on teaching presence have been conducted in post-secondary institutions and in K-12 settings; however, the impact of teaching presence in both online and blended K-12 educational settings is less researched (Harrell & Wendt, 2019; Pulham & Graham, 2018). The ongoing increase of students engaged in K-12 online learning underscores the need for appropriate professional development for educators who migrate into this new platform of teaching. Their preparedness is critical to its successful adoption (Graham et al., 2019).

Results from this research promoted insight into whether the three elements of teaching presence (design and organization, facilitation, and direct instruction) influence course design, communication with learners, and students' perceptions of their beliefs about their own abilities in blended or online secondary mathematics learning. The results showed students' perceptions of a relationship between teaching presence and the likability of mathematics. Further research is required on the impact of teaching presence on K-12 students in general, and specifically in secondary online mathematics students. In addition, the relationship between emotion and cognition in online learning should be examined further (Cleveland-Innes & Campbell, 2012).

Limitations and Delimitations

Limitations

Mauch and Park (2003) note that a limitation is "a factor that may or will affect the study but is not under the control of the researcher" (p. 114). This study was limited by the possibility that the parents and/or guardians of the population of students who are eligible to participate may not have allowed their children to access the survey. Participation in the study was voluntary, and therefore the collection of data was dependent upon the willingness of the individuals to participate in the study. The data gathered from a convenience sample of students who were willing to complete the survey may not be generalizable to include those students who did not wish to participate. Moreover, the freedom to expand in the qualitative long answer questions may have allowed individuals to provide unguided responses that may not have aligned with the nature of the question. In addition, the language of the questions may have been confusing to some of the students, and therefore, may have hindered the accuracy of their answers.

Delimitations

Delimitations are elements of the study that are under the control of the researcher (Mauch & Park, 2003). Participants of the study were limited to students who were in Grades 9-12 enrolled in a small Provincial Online Learning School in BC. All students included in the study have been or are currently enrolled in one or more blended or online secondary mathematics courses. The sharing of their online educational experience in the survey is not limited to their academic institution, therefore, their views may have

included their blended or online experience from other academic organizations. The study period was planned to be administered during a less busy period in the school year to gather optimal participation.

Chapter Two: Literature Review

A vital study to pursue is the examination of teaching presence in Garrison, Anderson, and Archer's (2000) Community of Inquiry (CoI) framework and the role emotion plays in learning (Cleveland-Innes & Campbell, 2012) through the lens of students' perceptions of success in blended or online secondary mathematics environments. With the rise in blended and online learning post-pandemic (Hodges et al., 2020), institutions must provide adequate training to their faculty in the unique skills required for successfully adopting this form of education (Archibald et al., 2020; Graham et al., 2019). Special preparation is required for instructors to ensure an optimal learning experience for their students through intentional course design, the recognition of emotions in learning, and interaction with their learners. This includes the knowledge and skills needed to reduce the transactional distance by humanizing the online educational experience for learners (Boling et al. 2012; Roblyer & Hughes, 2019).

Applying the CoI Framework to Online or Blended Mathematics Environments

Mathematics is the only universal language that can be communicated regardless of one's mother tongue. Civilizations have progressed in relation to their mathematical discoveries. As such, humankind has depended on the understanding of numbers to make sense of the world and one's surroundings (Bellos, 2014). "Indeed, mathematics has become a guide to the world in which we live, the world which we shape and change, and of which we are a part" (Sardar et al., 2011, p. 5). Pickover (2009) asserts that "successfully completing a mathematics class in high school results in better performance at college *whatever major* the student chooses to pursue" (p. 10). Therefore, having a

working knowledge of mathematics is essential to experience success in the everydayness of life. Moreover, considering mathematics' significance at an "individual, educational, and social development level, improving math abilities, while also reducing cognitive and emotional risk factors of math difficulties, is of great importance in today's numerate society" (Passolunghi et al., 2020, p. 1).

Teaching mathematics to K-12 learners in an online environment can be more challenging than in a face-to-face setting due to the lack of teacher presence and reliance on sufficient technology. Anabousy and Tabach's (2022) study involving middle school mathematics teachers suggested that participating in professional development to create a community of inquiry promoted their knowledge related to technology integration. Humanizing the online mathematics educational experience for young learners through *teacher* presence (support from the instructor) and *teaching* presence (the intentionality of the course's design to build community between teacher and student and between students and students) is of paramount importance. Creating a strong teacher and teaching presence can be realized through the intentionality of the educator to foster a positive perspective on the curriculum and teacher, develop instructional supports, and apply mathematical learning to real-life contexts (Goos, 2004).

Emotional Presence

Cleveland-Innes and Campbell (2012) posit that to "engage in education innovation with no reference to emotion and continue to assume learners are little more than dispassionate thinkers, would be to miss a fundamental influence on education" (p. 270). Online mathematics learning is a complex social environment wherein emotion,

including anxiety, is often present (Barroso et al., 2021; Mesghina et al., 2023; Passolunghi et al., 2020; Tornare et al., 2015). Therefore, studying emotional presence in online mathematics learning environments may help to alleviate negative emotions associated with mathematics, including mathematics anxiety.

The relationship between emotional presence and mathematical cognitive processes was the central theme of research by Cleveland-Innes et al. in 2012 and 2014. How successfully the learner connects emotionally to the teacher, to one another, and to the content can ascertain the extent of realized critical higher-order thinking, which is essential for mastery of mathematical content and competencies. Emotional Presence is "the outward expression of emotion, affect and feeling, by individuals and among individuals in a community of inquiry, as they relate to and interact with the learning technology, course content, students and instructor" (Cleveland-Innes & Wilton, 2018, p. 14).

Stenbom et al. (2016) examined emotional presence in the one-to-one online math coaching setting through the Relationship of Inquiry framework. This framework "contains the same elements as those in the Community of Inquiry (cognitive, teaching, and social presence) with modified definitions reflecting the one-to-one learning setting" (p. 44). The coaches who participated in this study found that emotions, such as anxiety about an upcoming mathematics test, were common in their conversations with their students. The results of their study support that emotions are an essential component of learning. As such, understanding emotional presence has the capacity to strengthen frameworks for evaluating online learning.

Majeski et al.'s (2018) study noted that a teacher's understanding of emotions in learning may help their learners build resilience to the stretching and difficult emotions they encounter in their schooling. Moreover, students' adaptability to their emotions may potentially "open communication, empathy, group cohesion (social presence), and greater engagement with course materials and assignments" (Majeski et al., 2018, p. 57).

Examining six emotions: joy, pride, contentment, worry, shame, and hopelessness after solving a math problem in students aged 10-12 years was the focus of Tornare et al.'s study in 2015. The authors concluded that the more students believed the math task was difficult, the less they experienced contentment and joy, and the more they felt hopeless after resolving the problem. Conversely, the more the students perceived their performance as good, the less they experienced hopelessness and shame, and the more they experienced pride after completing the task. Results from their study suggest that educators should provide opportunities for students to "express and talk about their metacognitive experiences and associated emotional experiences as this may contribute to improve self-regulation in learning" (p. 94).

Cleveland-Innes and Campbell (2012) assert that "positive emotions lead to positive outcomes and negative emotions to negative outcomes" (p. 273). Therefore, the educator's emotional perception and emotional understanding may foster a sense of trust and safety in their pupils, creating a positive learning community.

Instructional Supports

One of the roles of mathematics teachers is to motivate their learners to engage in a subject often feared or associated with negativity. Sivalingam (2020) asserts that "online course design, delivery methods, faculty involvement, and student support has [sic] an important role that could make it easier for students to be motivated and be better learners" (p. 145). Barana et al. (2021) developed four open online mathematics courses for lower secondary school students and educators prior to the emergency remote teaching during the Covid-19 pandemic. They posit that adding colour, images, and videos to the resources and simplifying the language appropriate to younger learners can improve their engagement. Providing archived online lectures to in-class math students (Cascaval et al., 2008), synchronous one-to-one online tutoring (Cleveland-Innes et al., 2014), or instructional videos to students on challenging concepts or how-tos (Lan & Ah-Teck, 2019) strengthens comprehension and skill development.

Passolunghi et al.'s (2020) study provides evidence that the implementation of specific and short-term mathematics tutoring programs positively impacts primary school children's ability to accurately calculate, improves their general mathematics abilities, and decreases their levels of mathematics anxiety. They recommend instructional supports such as a game-like approach to numerical problems to help "desensitize children to fears related to number manipulation, while also enhancing self-efficacy and control" (p. 9) in mathematics anxiety.

Mesghina et al.'s (2023) study discovered that mathematics anxiety decreased students' situational interest during learning and increased mind wandering during

testing. Their research concluded that instructional supports such as providing worked examples and multiple ways to arrive at a solution were shown to decrease students' mathematics anxiety and the "feelings of tension or apprehension one feels when thinking about or working on math" (p. 2).

Engaging with these instructional supports can reduce anxiety and promote a positive shift in mindset for learners.

Connection to Real-Life Problems

Intentional design by the course instructor to tether mathematics to contextualized situations can improve student motivation and learning. "Cognitive scientists have discovered that learners retain material better and are able to generalise it to a broader range of contexts…when they learn how to use that knowledge in real-world and practical settings" (Lan & Ah-Teck, 2019, p. 7). Passolunghi et al. (2020) claim that incorporating an online mathematics anxiety training program during live math lessons and in math testing may "facilitate children's acquisition of emotional techniques and their application to real-life situations" (p. 8). Connecting emotionally through field experiences aid a student's "skills and knowledge to be transferred from the structured school environment to real-world decision making because they provide an *emotional rudder* to guide judgment and action" (Immordino-Yang & Damasio, 2007, p. 3). It is the manifestation of an emotional rudder, equipped through real-life applications and experiences, that guides learners to make best choices for daily living.

What is Community?

Fostering a sense of community has become a critical research area in distance education because the way students perceive community directly correlates to their overall satisfaction with online learning (Simonson et al., 2019). Goos (2004) asserts that "*all* classrooms are communities of practice" (p. 259). In the context of distance education, Fiock (2020) describes a *community* as a group of physically separated members connected emotionally and cognitively, who share a sense of belonging and commitment to group goals, support, satisfaction, and cooperation. Blayone et al. (2017) state that fully online environments with minimal teacher participation can successfully create communities that both construct a variety of valuable learning outcomes, as well as "deepen the democratic functioning of learners and their social contexts" (p. 1). In contrast, Borup et al. (2014) argue that teachers are the "binding element" of online communities, with students likely to fail without a strong teaching presence (p. 793). Exploring the impact of teaching presence on social connections within community engagement helps to support a school's goals and vision. Educators who foster community among their members aid in the overall wellness and contributions of the group.

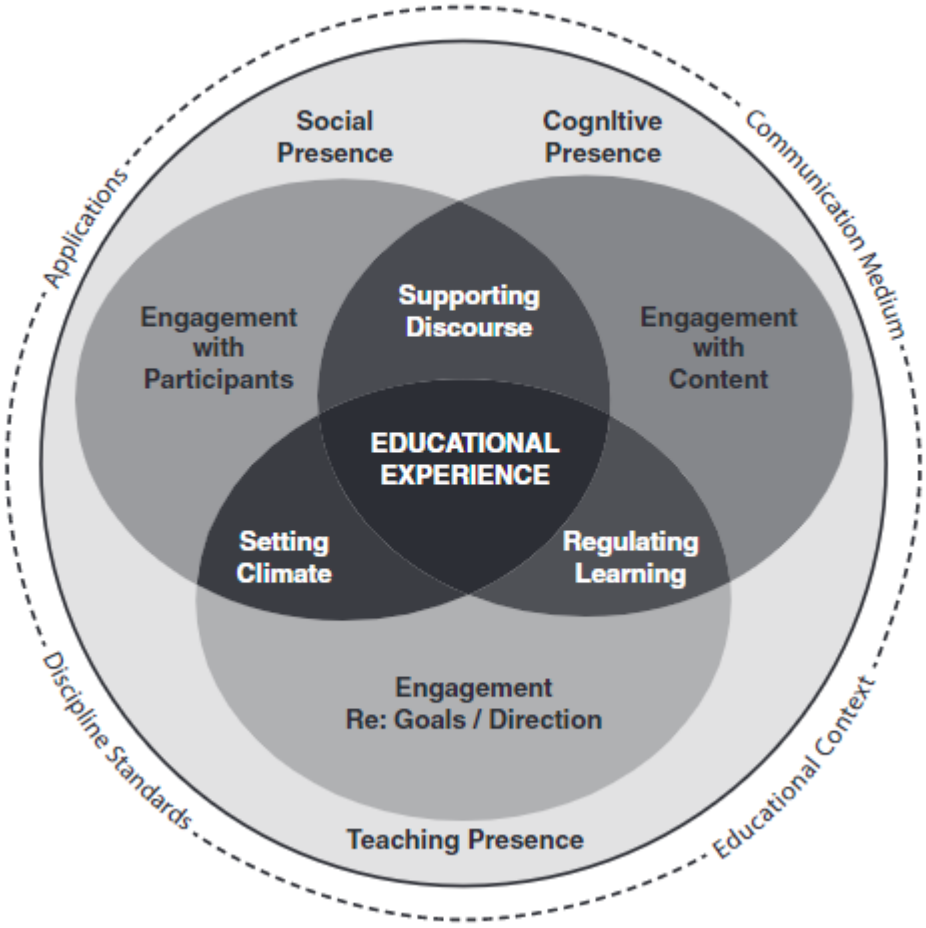
The CoI Framework

The CoI framework is essential to successful distance, open, and online education. The model provides educators with a structure of best practices and sound pedagogy to create an educational community of learners who collaboratively engage in purposeful discussion, and reflection, to establish personal meaning and validate mutual

understanding (Majeski et al., 2018). The CoI is a collaborative-constructivist theoretical framework developed to aid instructors in their goal to support student learning incorporating three core elements: social, cognitive, and teaching (Vourloumis, 2021). The optimal educational experience is at the intersection of these three core elements; however, it is the role of the educator to boost and foster social and cognitive presences (Garrison, 2017). Without a strong teaching presence, a community of inquiry will fall short.

Figure 4

Community of Inquiry Model



Note: This figure was produced by Garrison (2017) and illustrates the Community of Inquiry framework. From E-Learning in the 21st Century, by D. R. Garrison, Copyright 2017 Taylor and Francis, p. 25.

Cognitive Presence

Cognitive presence is the extent to which learners can construct and confirm meaning through sustained reflection and discourse (Castellanos-Reyes, 2020). Improving cognitive presence in blended and online courses can be accomplished by focusing on the breakdown of its four phases: *triggering event*, *exploration*, *integration*, and *resolution* (Szeto, 2014). Triggering events are activities associated with the inquiry process such as connecting ideas, applying new ideas, exchanging information, and a sense of puzzlement (Morrison & Jacobsen, 2023).

Social Presence

Social presence is the capacity of learners to associate with their community, intentionally communicate in a trusting environment, and begin interactive relationships through the projection of their unique personalities (Fiock, 2020). Pifarre et al. (2014) describe social presence as a vital element for supporting cognitive objectives through collaboration via its ability to initiate, assist, and encourage critical thinking in a community of learners. The three categories of social presence are *affective expression*, *open communicatio*n, and *group cohesion* indicated by emotions, risk-free expression, and encouraging discourse (Blayone et al., 2017).

Teaching Presence

There is growing evidence to support the importance of teaching presence. It is seen as a remarkable determinant of learner well-being, perceived instruction, and sense of community (Garrison et al., 2010a). Teaching presence is the design, facilitation, and direction of cognitive and social elements for the purpose of recognizing personally meaningful and educationally valuable learning outcomes (Garrison et al., 2000, 2010a). Fiock (2020) describes the instructor's role when utilizing the CoI framework as a substructure for constructive curriculum planning by creating a "narrative story or path through course design and course content" (p. 140). The three categories of teaching presence include *instructional management*, *building understanding*, and *direct instruction* implemented by defining and initiating, talking points, sharing personal meaning, and fostering discourse (Blayone et al., 2017).

By substituting the word 'teaching' instead of 'teacher' this core element of CoI highlights the possibility of allocating the roles and responsibilities of educators among participants (Garrison, 2017). Pifarre et al. (2014) explain that direct instruction, therefore, "does not refer to transmission and acquisition of knowledge but to the appropriate facilitation of discussion and reflection" (p. 74) such as identifying misinterpretations, consolidating knowledge from various sources, or summarizing the dialogue. A teacher's guidance through the material creates a beneficial learning experience by journeying alongside the student. Together, the educator and learner navigate the elements of the course on a shared path.

In Table 1, Garrison (2017) summarized each presence and their corresponding categories. Examples of their respective uses are included.

Table 1

Categories and Indicators

Elements	*Categories*	*Indicators (examples only)*
Social presence	Personal/affective	Self projection/expressing emotions
	Open communcation	Learning climate/risk-free expression
	Group cohesion	Group identity/collaboration
Cognitive presence	Triggering event	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas
	Resolution	Appling new ideas
Teaching presence	Design and organization	Setting curriculum and methods
	Facilitating discourse	Shaping constructive exchange
	Direct instruction	Focusing and resolving issues

Note: This is a direct copy of the table produced by Garrison (2017) and illustrates the Community of Inquiry categories and indicators. From E-Learning in the 21st Century, by D. R. Garrison, Copyright 2017 Taylor and Francis, p. 28.

The Impact of Teaching Presence

The investment of educators in course design, implementation, assessment, and feedback on learning outcomes must be built on a strong teaching presence. Garrison et al. (2000) identify these components as the design and facilitation of the educational experience. The role of instructors is critical in managing and equipping the learning process, providing appropriate resources, and supplying expert knowledge in each subject

domain. The CoI framework directs teachers to engineer collaboration with and among their students, as well as between parents and students (Borup et al., 2014). Through various forms of collaboration, the teacher's goal is to establish both cognitive and social presence, thereby creating an engaging Community of Inquiry.

Promoting Mathematics with Social Presence and Cognitive Presence

Teaching presence is the element in the CoI framework needed to help "facilitate and to assume managerial responsibilities" because higher-order thinking and collaboration do not always occur on one's own accord (Castellanos-Reyes, 2020, p. 556). Pifarre et al. (2014) call for teachers to give greater pedagogical attention to creating unique instructional activities to help improve students' arguments in their blog posts, and therefore support the creation of a CoI that could marshal worthwhile and collaborative learning. Similarly, Lan and Ah-Teck (2019) claim that "this space for interaction can be achieved through an online learning environment that incorporates computer-mediated communication and/or through forums or social websites that can be used as spaces for exchanging ideas and providing feedback" (p. 3). Individual reflection and collaborative participation through discussion forums promote both cognitive and social presences (Elbers, 2003; Morrison & Jacobson, 2023; Sivalingam, 2020). Incorporating a medium for interacting, and a platform for students to query and provide feedback promotes student learning.

Szeto (2015) shares similar findings as Pifarre et al. (2014). Szeto (2015) conducted research in a blended learning environment that synchronously amalgamated face-to-face instruction and online learning through the implementation of

videoconferencing. The results of this study confirmed Garrison et al.'s (2000) findings that teaching presence plays a critical role in facilitating and managing the effects of social and cognitive presences. Even though both groups of students experienced similar attainment of the intended learning outcomes of the course and received similar results on their assessments, the controlled face-to-face group had "greater knowledge exchanges and sharing" due to a stronger teaching presence (Szeto, 2015, p. 199).

Teacher Engagement

Teacher engagement was created by Borup et al. (2014) using K-12 online research to build on the core element of teaching presence in the CoI framework. The word 'engagement' replaces 'presence' because 'engagement' "emphasizes the caring and committed action" (Borup et al., 2014, p. 795) by teachers which is often needed in K-12 classrooms. This arose from a need for greater analytic and descriptive work to apply the CoI model to the K-12 online learning environment. Borup et al. (2014) quote Garrison et al.'s (2010a) acknowledgment of "this gap when they stated that 'work remains in validating the composition of the presences across various populations (e.g.: colleges, professional development, [and] high schools)' (p. 8)" (p. 795). The authors examined the structure of teaching presence through the viewpoint of prior K-12 online learning research and recognized three teacher roles needing greater emphasis: *nurturing*, *motivating*, and *monitoring*.

Collegial Presence

Sanders and Lokey-Vega (2020) share practical examples describing teacher strategies to instill collegial presence into their practice such as *hooking* students to promote student interest and puzzlement. Collegial presence is defined as colleagues who can establish meaning, allowing them to facilitate the three core elements of the CoI, where 'colleagues' are "any adult who works with course teachers and/or course students to support student learning" (p. 49). Collegial presence "incorporates the participant practices that did not conform to the constructions in the postsecondary Community of Inquiry framework" (p. 48). Participants' practice includes collaboration with parental guardians/learning coaches, teachers, supervisors, and support staff.

The authors emphasize the significance of collegial presence as cited in their K-12 case study. They conclude that collaboration between teachers and students, students and students, and the involvement of parents, was "essential for student success" (Sanders and Lokey-Vega, 2020, p. 52). Fahy (2013) writes that it is the process of students sharing, applying, and thinking critically, in conjunction with a teacher and the learning outcomes, that transforms information to knowledge. He adds that together, "we can be more insightful, more intelligent than we can possibly be individually. The IQ of the team can, potentially, be much greater than the IQ of the individual" (p. 8). Working in collaboration with a mentor-teacher creates a stronger whole because each individual provides unique knowledge and experiences that enrich the process.

Instructional Design

Instructional design is the organized establishment of an online educational program. It assimilates the best presentation of instruction with ideas of how students learn (Booth, 2018). To optimize the design of online courses, Wozney et al. (2006) explained that educators must believe they have the skills necessary to implement an innovation, and, as such, professional development and training are needed to support educators with technology applications. The availability of technology to students promotes dialogue and interaction and, therefore, meaningful learning experiences (Castellanos-Reyes, 2020; Garrison et al., 2000).

Barbour (2019) asserts that "it is often *who* is learning online or *how* that online learning is designed, delivered, and/or supported that account for whether the online learning is as effective as face-to-face instruction" (p. 527). Therefore, educators must also be instructed in how to carefully design and develop online courses to support student interactions and learning, and thereby create a Community of Inquiry.

Zhang et al. (2016) posit that the engagement of online learners depends upon their educators having well-honed skills to create learning activities so that opportunities for learners to make new knowledge and conjectures about the curriculum can happen through collaboration with their classmates. It is the role of the teacher to help their students "generate learning outputs beyond the learning materials and help them engage in socialization and other forms of interactive dialogues" (p. 898).

Feedback

Offering timely and direct feedback guides students in knowledge creation and aids the transferring of these skills and processes to real-life contexts. Morrison and Jacobsen's (2023) study addressed the purpose of feedback in building teaching presence and student self-regulation in online learning. Their qualitative findings suggest that students encountered teaching presence through punctual response time and personal connection with their teachers. The timely feedback helped learners know their "work was being seen and that they were 'on the right track'" (p. 1). Encouragement by the instructors increased student motivation, self-regulation, and engagement. The importance of quick response time to questions asked, and the more frequently a teacher communicates, the greater the sense of community for all participants (Rice, 2012).

Summary

Focusing on the results of this literature review, emphasis must be placed on strengthening teaching presence in the K-12 environment to ensure a strong Community of Inquiry. Special attention by educators must be given to the three roles of *nurturing* (providing social and emotional support), *motivating* (includes constructive praise), and *monitoring* student behaviour (includes students' management of time and progress toward mastery of the learning outcomes) (Borup et al., 2014). Aiming for best practices in distance and online education, the teacher should make a personal connection with each student in each interaction and encounter. Instructors practicing these roles encourage collaboration, motivation, and students' construct of knowledge.

Designing and teaching online courses for K-12 learners requires reconstructions in teaching practices (Harrell & Wendt, 2019; Pulham & Graham, 2018). Educators are not always sufficiently equipped with professional development for building an effectual teaching presence to promote higher-order thinking and to foster learners' participation in online discussions (Wang & Liu, 2019). This includes professional development and teaching of the implementation of the CoI framework adapted to K-12 learning environments by the inclusion of emotional presence (Cleveland-Innes & Wilton, 2018) and collegial presence (Sanders & Lokey-Vega, 2020). The CoI framework was developed for higher online education; therefore, more research is required on adapting this framework to the K-12 setting (Harrell & Wendt, 2019; Pulham & Graham, 2018).

Successful online instruction requires specified skills to keep pace with continuing technological developments and upgrades, adjusting to a change in workload from a different educational approach, and "navigating new types of relationships with students" (Archibald et al., 2020, p. 14). New innovations require time and education to embrace. Therefore, including university coursework in blended and online learning for education degree requirements will ensure future and current teachers understand the advantages and limitations that this new mode of education entails. Positive student success in a global 21st-century world can be realized by properly preparing educators to teach in classrooms of the future (Archibald et al., 2020). Training educators in the importance and implementation of the CoI framework, online course development, and informative feedback are critical to meet the needs of young online learners today.

Working collaboratively in a mathematics Community of Inquiry fosters the exploration and characterization of new insights and the discovery of multiple avenues to

a correct solution. Cognitive presence is realized as learners practice assessing and justifying their mathematical conclusions to their peers and instructors (McDaniel & Caverly, 2010). Social presence materializes as students and teachers "project their personal characteristics into the community, thereby presenting themselves to the other participants as 'real people'" (Garrison et al., 2000, p. 89). A teaching presence emerges through the process of guiding learners through reflection, inquiry, and collaboration (Wang & Liu, 2019). Creating an optimal blended or online learning mathematics environment is realized through the implementation of a Community of Inquiry.

Additional research on the adaptation of the CoI to the K-12 learning environment is needed. Fostering a Community of Inquiry is paramount because the foundation of education is based on the social interaction and relationship between educators and their pupils. In conjunction with a caring teacher, learners in a K-12 social environment develop critical thinking through shared dialogue. Therefore, if a teacher can inspire, challenge, and coax their students to want to learn, and make every student feel valued, success is probable.

Chapter Three: Methodology

Methodological Approach Overview

In social science research, qualitative data encapsulates a different level of reality and human existence from quantitative data. Quantitative data are numbers "analysed by means of mathematically-based methods" (Yilmaz, 2013, p. 311) where each set of data is associated with a distinct numerical value. Its counterpart, qualitative data, represents the unique experience of individuals in the form of non-verbal expressions, words, and pictures (Blodgett-Griffin, 2022). Qualitative methods "aim to answer questions about the 'what', 'how' or 'why' of a phenomenon rather than 'how many' or 'how much', which are answered by quantitative methods" (Brikci & Green, 2007, p. 3).

Inductive research is reasoning from the specific to the general and deductive research is from the general to the specific. Quantitative inquiry is objective and deductive. It assumes the variables can be recognized and the relationships can be measured. Reality is "single, tangible, and fragmentable" (Yilmaz, 2013, p. 314) where knowledge is waiting to be discovered. By contrast, qualitative inquiry is subjective and inductive. It assumes the variables are arduous to measure because they are complex and interwoven. Reality is socially constructed where the phenomenon studied are "multiple, constructed, and holistic" (Yilmaz, 2013, p. 314).

Good qualitative research necessitates empathy for the subject's point of view. It requires a sympathetic understanding of their language and ways of expression. In addition, a researcher must consciously be aware of how their background, culture, and language can influence their understanding of a subject's experiences.

By first understanding the problem, and then designing questions to be asked in the study, researchers "then select the mode of *disciplined inquiry* most appropriate to those questions" (Shulman, 1981, p. 12). Sometimes, aspects of the study require both quantitative and qualitative data to strengthen the findings of the research that a single method alone cannot capture. Poth (2019) suggests that qualitative data provides detailed understandings and quantitative data provides generalized understandings and it is in the integration of both types of data that the strengths and limitations of each offset one with the other. As such, combining inductive and deductive research in a study can expand understanding (Neuman, 2020).

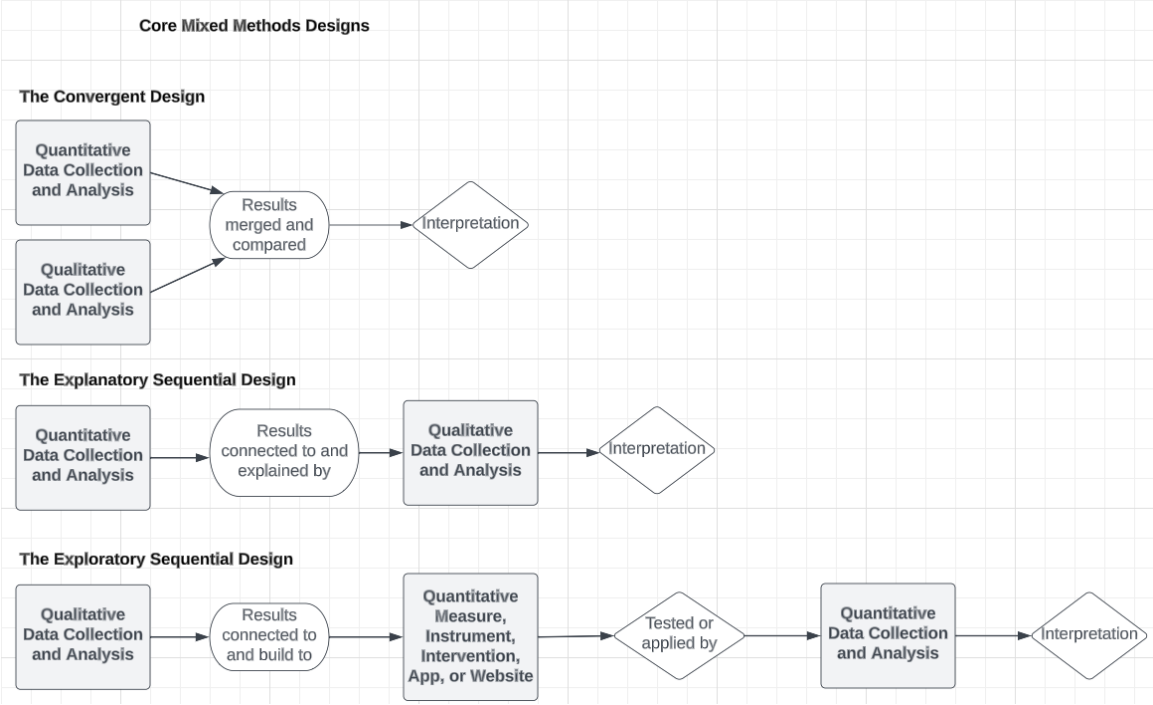
Mixed methods research includes several designs (Creswell & Plano Clark, 2018; Poth, 2019). Mixed methods designs can be predetermined from the beginning and/or materialize during the process of the study. Poth (2019, p. 51) shares five essential characteristics of mixed methods studies:

- the generation of valid insights from the collection, analysis, and integration of qualitative and quantitative data using rigorous procedures.
- the central positioning of the fixed or emergent research design on the mixed methods research procedures.
- the use of ethical research procedures.
- the framing of the research guided by philosophical or theoretical perspectives.
- the research as situated within and shaped by its contexts.

Figure 5 displays Creswell and Plano Clark's (2018) three core mixed methods research designs: convergent, explanatory sequential, and exploratory sequential. The choice of design is based on the objective of the research and on the components "related to the popularity of a specific design within a field or discipline, the research skills of the investigator, the time allocated for the mixed methods project, and the investigator's understanding of the complexity of the design" (p. 98).

Figure 5

Creswell and Plano Clark's (2018) Core Mixed Methods Designs



Note. This figure was adapted from Creswell and Plano Clark (2018) and illustrates the three core mixed methods designs. From Designing and Conducting Mixed Methods Research, by John W. Creswell and Vicki L. Plano Clark, Copyright 2018 SAGE Publications, p. 99.

The convergent mixed methods design was utilized in this study because it is efficient in both time and resources. Each type of data can be collected through the same survey yet analyzed separately. The convergent mixed methods study will report

statistical trends (quantitative data) and give voice to the participants (qualitative data) providing a more thorough and meaningful answer to the research questions.

The Convergent Mixed Methods Design

The convergent mixed methods design merges and compares the results of the quantitative and the qualitative findings with the purpose of acquiring a greater understanding of the research question. The researcher can choose to authenticate one set of data analysis with the other or establish if the participants in the study respond in a homogeneous way to the open-ended qualitative questions and the quantitative prearranged scales (Creswell & Plano Clark, 2018). The convergent design is a popular approach and "is often the first design that comes to mind when a researcher hears *mixed methods*" (p. 68).

The intent of the convergent design is to amalgamate the quantitative statistical results and the qualitative methods for a more complete understanding of the topic of interest. This method can be used to investigate relationships between variables by adding new variables gleaned from the data. A researcher will find the convergent design advantageous if they have limited time to collect data and must gather both quantitative and qualitative in the same visit.

The Convergent Design Procedures

There are four important procedures in the convergent design. First, the researcher must decide whether the two tests will include the same or different participants before gathering quantitative and qualitative data about the research question. These two kinds

of data are collected simultaneously but are separate in their analysis because one type of data does not depend on the outcome of the other. The qualitative data and quantitative data in a convergent design study are usually viewed with equal importance for addressing the topic of inquiry (Creswell & Plano Clark, 2018). Second, the researcher employs separate and independent analytic methods to investigate the two data sets. The researcher merges the quantitative data and the qualitative data in the third phase of the investigation and determines whether additional analysis is needed. In the final phase, the researcher "interprets to what extent and in what ways the two sets of results converge or diverge from each other, relate to each other, and/or combine to create a better understanding in response to the study's overall purpose" (p. 69).

Strengths and Challenges of the Convergent Design

The mixed methods convergent design achieves maximum productivity with minimal time and expense because both types of data are gathered at the same time. Members conducting the study can disclose statistical tendencies (e.g., survey) and communicate the voice of the participants (e.g., follow-up interview to the survey). However, it can be challenging to merge two different sets of data (often numbers and text) in a productive way. If divergence occurs when comparing the data sets, the researcher must decide if additional collection and analysis are needed.

Philosophical Assumptions: Constructivist Worldview

Mixed methods researchers bring to their study a worldview constructed of theories and beliefs about knowledge that guides their inquiry. For the purposes of this

research study, the philosophical assumption of constructivism will be used because the foundation of this research rests in the Community of Inquiry social-constructivist framework. Constructivism is based on the work of Piaget, Vygotsky, Bruner, and others (Juvova, 2015), as well as the prominent work of pioneer educator and philosopher John Dewey (Krahenbuhl, 2016; Roblyer & Hughes, 2019). Constructivist teaching methodologies use teaching methods that encourage student-centered learning focused on the active and experiential learning of the students. Dewey focused on young adolescents and encouraged students to participate in shared dialogue to enhance their personal experiences in the learning process (Garrison et al., 2010a; Simonson et. al, 2019). For Dewey, an interplay exists between an individual and their society's values, norms, and knowledge and, therefore, one cannot be separated from or subordinate to the other. It is in the tension of this non-dualistic thinking and collaboration that a teacher must enter to monitor and manage an "educationally productive balance" (Garrison, 2017, p. 10). "Educationally, the collaborative constructivist approach is realized in the teacher and student transaction" (p. 10).

In constructivism, learners examine the world in which they live, and develop varied and multiple subjective understandings of their experiences (Creswell & Poth, 2018). According to Ally (2008), constructivist theorists postulate that "learners interpret the information and the world according to their personal reality, that they learn by observation, processing, and interpretation, and then personalize the information into personal knowledge" (p. 19). Optimal learning occurs when students can contextualize what they learn and apply it to other areas and to areas of personal interest.

Juvova et al. (2015) claim that historically the student was seen as the object of learning and the teacher was upheld as the central figure in the educational environment. Constructivism shifts to the learner now regarded as "an educational subject who, to some extent, manages his/her education actively and independently (so-called self-controlled/self-regulated learning)" (p. 345). Guiding students to think and act like experts is the goal of constructivist educators (Lan & Ah-Teck, 2019). The teacher now becomes a guide, mentor, and tutor (Anderson & Dron, 2011).

Baviskar et al. (2009) claim that constructivism is made up of four parts: eliciting prior knowledge, creating cognitive dissonance, application of new knowledge with feedback, and reflection on learning. Not all knowledge is generated by a learner's prior knowledge. Therefore, educators must bring awareness to their students about the difference between their prior knowledge and the new knowledge presented. The process of applying the new knowledge to real-life experiences brings interconnectedness between the new knowledge and a variety of contexts. As such, the new knowledge will be permanently ingrained. Finally, through reflection, students become aware of the learning that has transpired.

Creswell and Creswell (2018, p. 8) address assumptions made in discussing constructivism:

1. Human beings construct meanings as they engage with the world they are interpreting. Qualitative researchers tend to use open-ended questions so that the participants can share their views.

2. Humans engage with their world and make sense of it based on their historical and social perspectives-we are all born into a world of meaning bestowed upon us by our culture. Thus, qualitative researchers seek to understand the context or setting of the participants through visiting this context and gathering information personally. They also interpret what they find, an interpretation shaped by the researcher's own experiences and background.
3. The basic generation of meaning is always social, arising in and out of interaction with a human community. The process of qualitative research is largely inductive; the inquirer generates meaning from the data collected in the field.

Schunk (2020) claims that constructivism is not a theory, instead, it is an epistemology, or philosophical perspective maintaining that individuals form what they learn and understand. "Knowledge is not imposed on them from outside people but rather formed inside them" (p. 355). Learners are not empty vessels waiting to be filled with knowledge. They pursue their own learning by actively trying to create meaning (Simpson-Spence, 2021).

The Role of the Researcher

In terms of practice, qualitative researchers recognize how their own background influences their interpretation of the data and, therefore, they position themselves in their research to analyze how their backgrounds can influence their findings (Creswell & Poth, 2018). Participants develop varied and multiple subjective meanings of their experiences. Therefore, inquirers rely as much as possible on the participants' views of the situation being studied and "focus on the specific contexts in which people live and work in order

to understand the historical and cultural settings of the participants" (Creswell & Creswell, 2018, p. 8). In constructivist inquiry, the researcher begins "from the 'bottom' up, using the participants' views to build broader themes and generate a theory interconnecting the themes" (Creswell & Plano Clark, 2018, p. 37).

Alternatively, in quantitative research, the positivist researcher "remains detached, neutral, and objective as he or she measures aspects of social life, examines evidence, and replicates the research of others" (Neuman, 2020, p. 102). The researcher relies on scientific evidence from statistical measurements and experiments to examine if a cause-effect relationship exists among the variables.

A researcher engaged in a mixed-methods study must be "willing to adopt an open worldview, embrace specific learning, adapt to conditions, commit to extensive management, attend to ethical issues, and engage in complex tasks" (Poth, 2019, p. 51). The demands for restructuring used in mixed methods research require the researcher to be competent in both quantitative and qualitative research.

Rationale for the Study

The purpose of the research was to understand the relationship between teaching presence and students' perceptions of their abilities in mathematics and the likeability of the subject. Results from this research can provide further guidance in professional development and teaching practice to aid in creating meaningful learning experiences for high school mathematics learners.

Instrumentation

In research, instrumentation refers to the measurement devices or tools used in the data collection process. Instrumentation concerns the design, selection, establishment, and assessment of the instrument, as well as the circumstances under which the instrument will be utilized (Simpson-Spence, 2021).

The teaching presence component of the CoI survey questionnaire was used as the instrument for conducting the survey. The CoI is a validated instrument (Arbaugh et al., 2008) and has been widely used in research including studies by Simpson-Spence (2021), Stenbom (2018), Vourloumis (2021), and Zhang et al. (2016). The popularity of the CoI framework employed in online teaching and learning increases the validity of the instrument by supporting the elements of the CoI theory.

The survey included a modification of the quantitative Likert questions from the teaching presence section of the CoI framework such as changing the language of some questions to suit younger learners. In addition, it provided opportunities for students to elaborate qualitatively by sharing comments on two long answer questions. The survey also included several demographic questions. The CoI survey is an open resource under the Creative Commons license.

The teaching presence section of the CoI questionnaire is comprised of three components: design and organization, facilitation, and direct instruction. Simpson-Spence (2021) provides tables organized with indicators and their descriptions for each element of teaching presence. The left-hand columns in Tables 2-4 are the content of the Likert questions in the second section of the survey (see Appendix E). The right-hand columns

in the following tables provide an explanation of each aspect that features best-practice measures to be demonstrated in an online learning environment for this purpose.

Design and Organization

To create a worthwhile educational experience, intentionality in the design and organization of an online course is critical. Garrison (2017) writes that "design emphasizes the structural decisions made before the process begins while organization refers to similar decisions that are made to adjust to changes during the educational transaction" (p. 72). To adopt a collaborative constructivist process, learners must have a say in the content to be studied and its approach. Therefore, the delivery of the instruction must flow in continuity with the design; the two must not be separated.

Table 2

CoI Framework (Teaching Presence) Description of Design and Organization Indicators

Design and Organisation	Description
The instructor clearly communicated the important course topics.	At the start of the course, the instructor provided clarification on course content and activities that are relevant to achieving the course learning outcomes as well as a successful learning experience for students.
The instructor clearly communicated important course goals.	At the start of the course the instructor outlined the learning objectives in detail and provided a thorough explanation of the performance expectations necessary to meet the course requirements.
The instructor provided clear instructions on how to participate in course learning activities.	At the start and during the course the instructor provided detailed information on learning activities to help students understand performance expectations, learning opportunities and benefits.
The instructor clearly communicated important due dates/times frames for learning activities.	At the start of the course, the instructor provided a critical path/course schedule detailing due dates and times frames for all graded and ungraded learning activities. During the course the instructor provided updates that communicated course deliverables on a weekly basis.

Note. This table was produced by Simpson-Spence (2021, p. 42) and illustrates the descriptions of the questions included in the design and organization component of the teaching presence element of the CoI framework.

Facilitation

The second element of teaching presence is managing and monitoring purposeful collaboration and reflection (Garrison et al., 2010b) for the purpose of establishing comprehension. Interest, engagement, and learning merge through the convergence of purpose, process, and product (Garrison, 2017).

Table 3

CoI Framework (Teaching Presence) Description of Facilitation Indicators

Facilitation	Description
The instructor was helpful in identifying areas of agreement and disagreement on course topics that helped me learn.	Throughout the course the instructor provided adequate support in the teaching-learning process through instructional directives and self-discovery learning.
The instructor was helpful in guiding the class towards understanding course topics in a way that helped me clarify my thinking.	Throughout the course the instructor used various communication channels to effectively communicate important learning objectives and maintain focus on the course learning outcomes.
The instructor helped to keep course participants engaged and participating in productive dialogue.	Throughout the course activities such as synchronized web conferences and asynchronized discussion forums are incorporated into learning activities to encourage student-to-student interaction.
The instructor helped to keep course participants on task in a way that helped me to learn.	Throughout the course the instructor used a variety of strategies such as weekly group discussions, group projects, weekly media surveys and quizzes, web conferences, PowerPoint presentations and video journals to keep students engaged and create multiple representation to meet the needs of different learning styles.
The instructor encouraged course participants to explore new concepts in the course.	The instructor provided learning opportunities that allowed students to collectively and independently discover industry best practices and new concepts relevant to the course's subject matter.
Instructor actions reinforced the development of a sense of community among course participants.	Throughout the course the instructor regularly encouraged and promoted instructor-to-student and student-to-student interactions to create an online learning environment that help learners feel a sense of presence during their learning experience.

Note. This table was produced by Simpson-Spence (2021, p. 43) and illustrates the descriptions of the questions included in the facilitation component of the teaching presence element of the CoI framework.

Direct Instruction

The third of the primary teaching presence objectives is direct instruction. As educators diagnose the needs and dispense timely information and direction, learners

know and understand the intended learning outcomes (Garrison et al., 2010b). Garrison (2017) posits that "although direct instruction is a legitimate and important authoritative influence, this essential teaching responsibility is often lacking in informal online learning environments" (p. 75).

Table 4

CoI (Teaching Presence) Description of Direct Instruction Indicators

Direction Instruction	Description
The instructor helped to focus discussion on relevant issues in a way that helped me learn.	Throughout the course the instructor provided learning activities that links theoretical concepts to real world practices in a manner that encourages problem-solving, critical thinking and promote learning.
The instructor provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.	Throughout the course the instructor provided detailed clarification on course content. Feedback is also tailored to support the emotional and instructional needs of students in order to help them the meet course requirements.
The instructor provided feedback in a timely fashion.	Throughout the course the instructor consistently provided feedback on a scheduled time frame regarding students' participation, tasks and performance.

Note. This is a direct copy of the table produced by Simpson-Spence (2021, p. 44) and illustrates the descriptions of the questions included in the direct instruction component of the teaching presence element of the CoI framework.

Data Collection Procedures

This study employed the CoI framework and its research methodology to conduct further research into a private secondary online learning environment in British Columbia, Canada. The study focused on secondary online mathematics courses in Grades 9-12 to assess whether the three elements of teaching presence (design and

organization, facilitation, and direct instruction) are impacting students' perceptions of their own abilities in mathematics and the likability of the subject.

The study was conducted during a two-week period in the fall of 2023 and was timed appropriately to avoid the beginning of the school year, reporting periods, and extended school holidays. The intentional timing of the invitation to participate in the study was to optimize student participation. The research focused on a learner population that have taken one or more secondary online mathematics courses. The participants were self-selected for this study.

The vice-principal of the online learning school where the research was conducted sent an announcement to families of Grade 9-12 students inviting them to participate in the research. She provided details including those pertaining to consent to partake in the study. Parents and students were asked to give permission by signing within boxes provided on the consent form. Appendix A and B provide clarity of the steps to do this. The vice-principal is the only person with access to view the parent and student names, and once the signatures were in place, the student clicked on the link to the Lime Survey. The researcher only has access to the anonymous responses to the Lime Survey questions, and not any identifying information.

Data Analysis Procedures

The survey included 13 components that measure teaching presence (Stenbom, 2018). The quantitative data was analyzed using Excel software to compute the teaching presence mean scores by calculating the sum of the 13 items using a five-point Likert-type scale. The Likert scale is used to attribute quantitative values to qualitative data to

make the data responsive to statistical analysis (Simpson-Spence, 2021). A numerical score is assigned to each potential choice for each question in the survey. The mean average for all the responses was calculated at the conclusion of the evaluation (Neuman, 2020).

The Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree) for each of the 13 components in the teaching presence survey. Means near to 1 stipulated less perceived teaching presence and means near to 5 stipulated more perceived teaching presence, while means between 2.5 and 3.5 indicated neutrality (Simpson-Spence, 2021).

The qualitative data was collected from the two long answer questions in the third section of the survey. Transcripts were coded and woven into categories (Charmaz & Belgrave, 2018; Gibbs, 2010, 2015; Strauss & Corbin, 2015).

Both quantitative and qualitative data were collected, analyzed, and merged for the purpose of combining or comparing the results to best understand the research problem (Creswell & Plano Clark, 2018).

Participants

The participants of this study were part or full-time blended or online secondary students in Grades 9-12 enrolled in an accredited independent Provincial Online Learning School (POLS) in British Columbia (BC), Canada. This blended learning school is designed to meet the needs of home-learning families across BC. The school is intentional about building relationships within their communities by providing onsite and

virtual learning opportunities for 1300 students in grades K-12 and, specifically, 300 students in Grades 9-12. Participants fall into one of three categories:

- Educated full-time at home and enrolled in only fully online (asynchronous) courses.
- Enrolled in blended online learning (participating in synchronous Face-to-Face or Livestream classes with an asynchronous component) for all or some of their courses.
- Cross-enrolled students: either attending a local campus school or another online school but enrolled in at least one blended or online course with the school where the survey will be conducted.

Participants included individuals who have been or are currently enrolled in at least one completely synchronous or asynchronous secondary mathematics course. The students were in the age range of 13-18 years old.

Scientific Rigour

A researcher must ensure an unbiased, accurate, and honest interpretation of the data analyzed. This is especially important in mixed methods research where both quantitative and qualitative data are interpreted in a side-by-side comparison or combined to better understand the research problem. In quantitative research, scientific rigour is realized through the measurement of reliability and validity, and in qualitative research, scientific rigour is achieved through the evaluation of authenticity and credibility (Creswell & Plano Clark, 2018).

Reliability and Validity for Quantitative Data Analysis

Reliability and validity are objectives that help ensure the truthfulness and believability of quantitative findings and refer to related and beneficial aspects of measurement. Reliability means consistency or dependability and validity relates to truthfulness (Neuman, 2020). Quantitative reliability means that scores received from individuals are dependable and stable over time and quantitative validity means that the scores obtained from participants are relevant indicators of the data being measured (Creswell & Plano Clark, 2018, p. 217).

Creswell and Creswell (2018, p. 153) recommend researchers ask the following questions to test the validity of their findings:

1. Do the items measure the content they were intended to measure?
2. Do results correlate with other results?
3. Do items measure hypothetical constructs or concepts?

Establishing the validity of the scores in a survey helps researchers determine if an instrument might be a good fit to use in survey research.

Authenticity and Credibility for Qualitative Data Analysis

Credibility is the "quality of being cared for or trusted" and authenticity is the "quality of being genuine or real" (OxfordLanguages, 2022). Neuman (2020) claims that authenticity "means offering a fair, honest, and balanced account of social life from the viewpoint of the people who live it every day" (p. 175). Because a stand-alone truth is not

often obtained through qualitative analysis, the researcher is more concerned with attaining authenticity versus validity.

The credibility of a qualitative study is determined by a researcher's training and experience, the use of careful and diligent methods to produce descriptive and accurate data, and their philosophical beliefs in the merit of qualitative analysis (Yilmaz, 2013). Therefore, collecting generally through convenience sampling (selecting whoever is easiest, closest, etc. to save time, money, and effort) has very low credibility (Moon & Blackman, 2017).

There are three methods field researchers adopt to signify the authenticity and credibility of a study:

- *member checking*: individuals who were studied "read and confirm as being true what the researchers have reported" (Neuman, 2020, p. 472),
- *peer debriefing*: review by another researcher familiar with the study (Richards & Hemphill, 2017), and
- *external auditor*: review by an independent researcher unfamiliar with the study (Yilmaz, 2013).

Although member checking was not formally implemented because the researcher did not have contact with the participants, Dr. Cynthia Blodgett-Griffin acted as the peer debriefer, and Dr. David Neale and Mrs. Joan Mann as the external auditors. Implementing these methods helped to reduce the researcher's biases and assumptions of the findings.

Transferability

In qualitative research, transferability hinges on the researcher providing evidence that the study's findings could be applied to other populations or contexts. "Transferability invites the readers to make connections between elements of the study and their own experience therefore, the research result must provide a highly detailed description of the research situation and methods" (Simpson-Spence, 2021, p. 50).

Generalizability

In quantitative research, generalizability is the degree to which results obtained from one situation or group of people may be assumed in other settings or populations (Shulman, 1981). Rowntree (2018) cautions researchers to avoid drawing hasty conclusions when extending inferences beyond the data from one's limited experience. He notes, "If we want to generalize more confidently, we need more experience - more observations (more data)" (p. 10). By collecting samples that are likely to be as representative as possible of the population, over-generalization can be avoided.

Ethics

This thesis research study was reviewed by the Research Ethics Board (REB) at Athabasca University to ensure that the study conforms to established ethical guidelines. Compliance with the Tri-council policy statement (2014) was observed and the three core principles of respect and concern for persons, welfare, and justice was upheld. An Invitation to Participate letter explained the research and virtual consent forms were sent to each participant. Because the students are underage, parents and/or guardians were also

asked to sign the consent forms. Once signed consent forms were received by the vice-principal, students accessed the link to the online survey. Confidentiality and anonymity were guaranteed to the learners for their survey answers. Learners were able to terminate their participation in the survey at any time and for any reason.

Expected Outcomes

To develop a further understanding of the relationship between teaching presence and students' beliefs about their mathematical abilities and the likeability of the subject, qualitative and quantitative data obtained from student surveys were analyzed utilizing the convergent mixed methods design. Results from this survey yielded information that supports professional development specific to K-12 blended or online education with a special emphasis on the training required for secondary blended or online mathematics educators.

Chapter Four: Findings

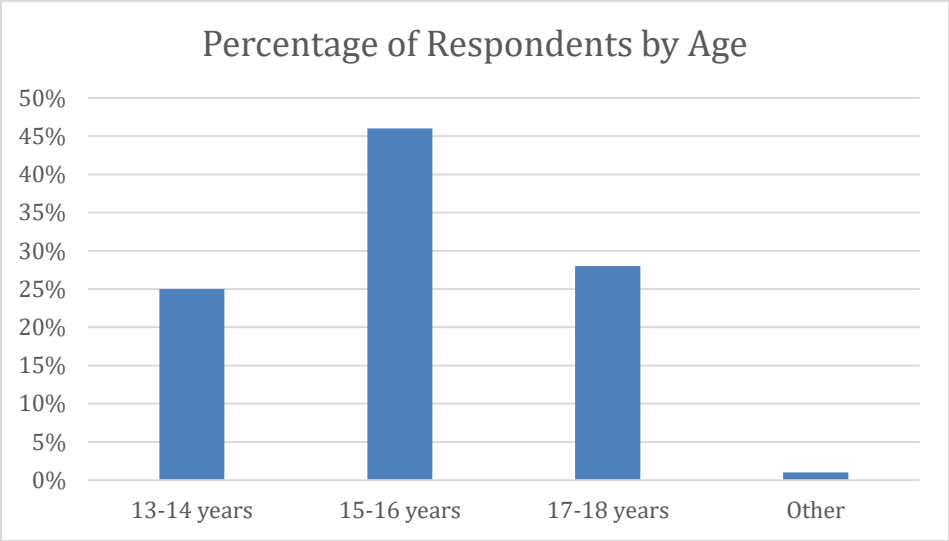
This study surveyed 85 participants out of an approximate total of 300 Grades 9-12 students (≅ 28%) from a Provincial Online Learning School (POLS) in British Columbia that specializes in blended and online learning. The survey invited students to participate in an anonymous web-based survey regarding their experience in their most recently completed blended or fully online secondary mathematics course. It was available to participants for a 2-week period in September 2023 through an email URL. The web survey questions offered through Lime Survey are in Appendix E.

Demographics

The age range of 15-16 (46%) was the dominant age range of participants noted in the study. Students from the age ranges of 13-14 and 17-18 accounted for 53% of the study's participants with 1% in the "other" category.

Figure 6

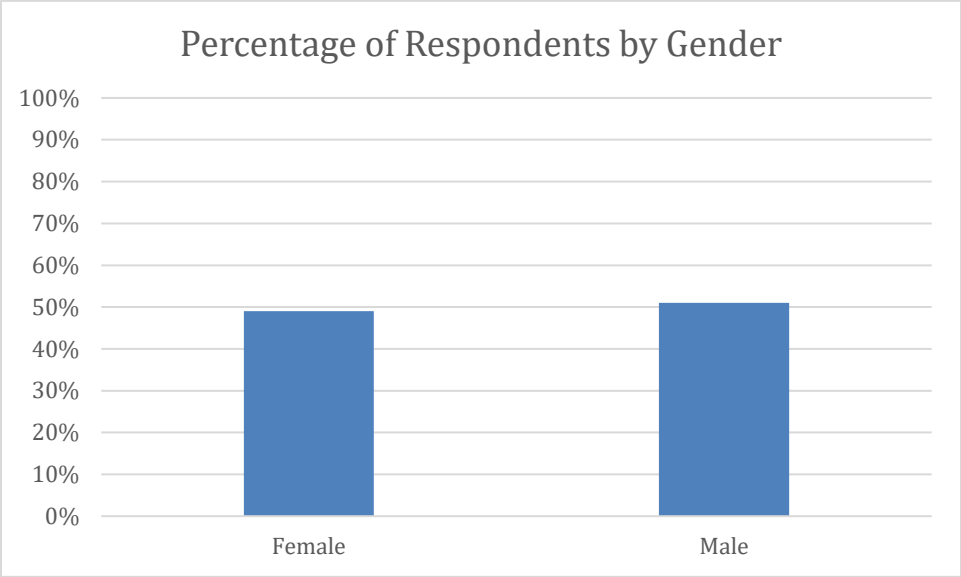
Percentage of Respondents by Age



The study's sample was almost equally split between males (51%) and females (49%) with no participants choosing "other" as a category.

Figure 7

Percentage of Respondents by Gender



The percentage of students who participated in the study were fairly even across grade levels with 29% of respondents in Grade 12, 24% in Grade 11, 25% in Grade 10 and 22% in Grade 9. Figure 8 shows that of the total participants, 25% selected Foundations of Mathematics and Pre-Calculus 10 as their most recently completed online or blended mathematics course, while 22% selected Mathematics 9. Mathematics 8 and Pre-Calculus 11 both had 20% of the student vote, and Workplace Math 10, Workplace Math 11, and Pre-Calculus 12 combined to form the remaining 13%.

Figure 8

Participant's Most Recently Completed Math Course

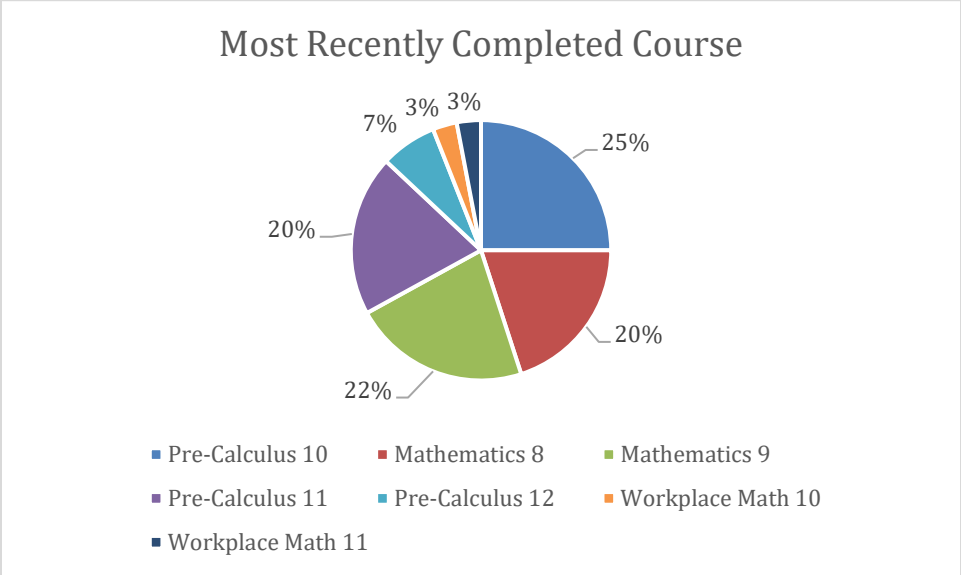
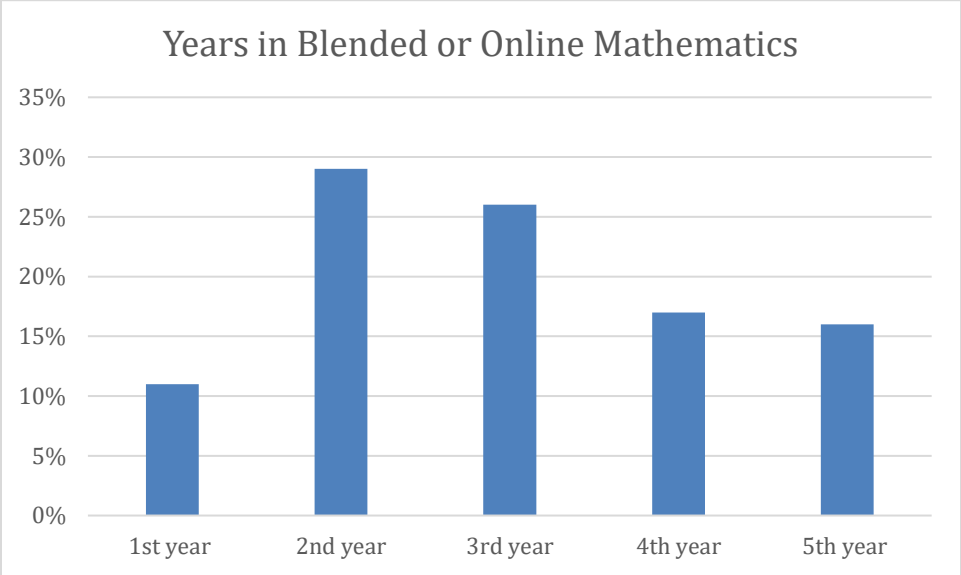


Figure 9 shows that most respondents (55%) were second- or third-year pupils within an online or blended high school mathematics course, and respondents in their first year numbered the least at 11%.

Figure 9

Percentage of Respondents' Years in Blended or Online High School Mathematics

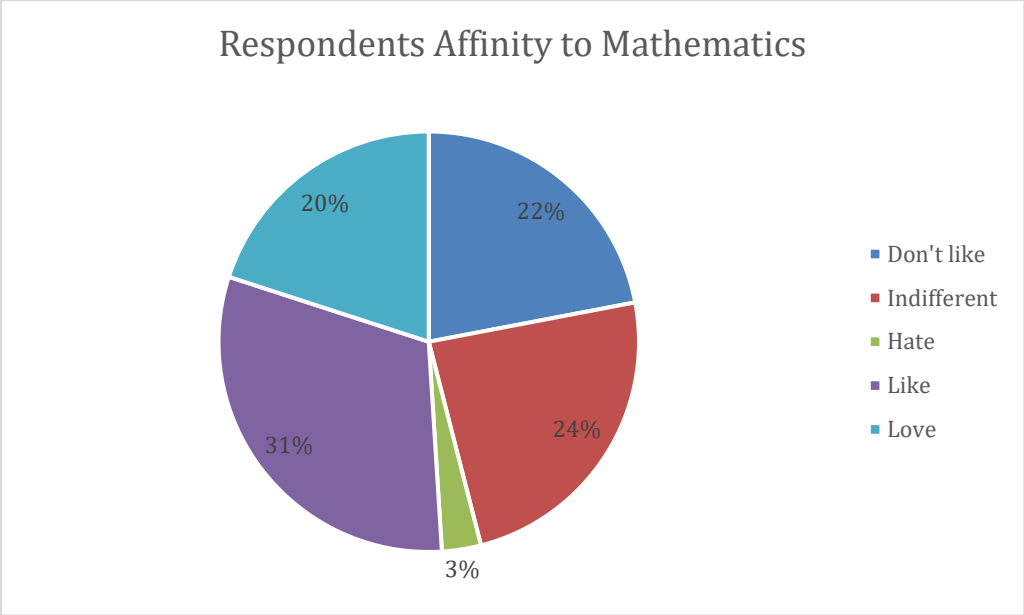


Of the total participants, 41% reported a positive experience in their most recently completed blended or online mathematics course. This was evenly represented across male (17 students or 55%) and female (14 students or 45%) respondents. Forty-five (59%) respondents had both positive and negative experiences with their most recently completed blended or online mathematics course.

Figure 10 displays the respondents' affinity to mathematics. Most of the students (51%) felt positively toward mathematics with 20% loving and 31% liking mathematics. Negative feelings (25%) towards the subject were nearly equal to neutral feelings (24%). Of the number of respondents that either liked or loved mathematics, 38% were female and 62% were male.

Figure 10

Respondents' Affinity to Mathematics



The seventh demographic question asked students to choose an option that best describes their beliefs about their abilities in mathematics. Of the total respondents (n=76), three (4%) chose *excellent*, 41 (54%) selected *very good*, 23 (30%) chose *satisfactory*, eight (11%) selected *passing* and one (1%) chose *failing*.

The majority of participants (59 or 78%) held the view that in their most recently completed blended or online mathematics course their teacher positively influenced their beliefs about their abilities in mathematics. Eleven (14%) respondents were neutral, while only one (1%) held the view that their teacher negatively influenced their beliefs. Of the 11 respondents, 9 (28%) were also indifferent to mathematics. The one respondent who reported that their teacher negatively influenced their beliefs was indifferent to

mathematics as well. Of the 59 students that were positively influenced, 35 (45%) either love or like mathematics.

Most respondents (n=76) indicated that their teacher positively influenced the degree to which they like the subject of mathematics (42 or 55%), while one respondent answered that their teacher negatively influenced them. Fifteen percent of the study's participants felt that they have had both positive and negative experiences that affected how much they like the subject of mathematics from their most recent teacher, while 29% remained neutral.

Table 5 outlines the final high school blended or online mathematics course that students plan to take before graduation. In the province of BC, students can take Workplace Math (applied mathematics) or Pre-Calculus (theoretical mathematics). Students seeking a vocation in the trades are more inclined to take the Workplace route and students planning on entering university are more likely to choose the Pre-Calculus route. Most students (62 or 82%) answered that their final secondary mathematics course would be a Pre-Calculus course (Pre-Calculus 11, Pre-Calculus 12, Calculus 12 or AP Calculus 12), while 6 students (8%) will select a Workplace Math course. Of the eight students (10%) who selected the "other" category, four students (5%) were still deciding, three students (4%) said that they were "not taking any", and one student (1%) wrote "still catching up". The Ministry of Education and Child Care (MoECC) requires each high school student to have a Math 11 credit to graduate; Math 12 is not a necessary requirement for the Graduation Dogwood certificate. Of the total participants' responses, 23% will not take a mathematics course after Math 11, while 67% indicated they will take Math 12.

Table 5

Frequency Table for Participants Final Secondary Mathematics Course

Final Secondary Mathematics Course	**Frequency**	**Percentage**
Workplace Math 11	3	4%
Pre-Calculus 11	14	19%
Workplace Math 12	3	4%
Pre-Calculus 12	22	29%
Calculus 12	25	33%
AP Calculus	1	1%
Other	8	10%

Quantitative Analysis

The quantitative analysis section of this study was generated through Excel, which included central tendency (mean, median, and mode) and variability (frequencies and standard deviation).

Table 6

Frequency Table for Teaching Presence Design and Organization Questions

Design and Organization	**1 = Strongly Disagree** **2 = Disagree**	**4 = Agree** **5 = Strongly Agree**	**3 = Neutral**
The teacher clearly communicated the important course topics.	2 (3%)	64 (86%)	8 (11%)
The teacher clearly communicated important course goals.	2 (3%)	65 (88%)	7 (9%)
The teacher provided clear instructions on how to participate in course learning activities.	3 (4%)	62 (84%)	9 (12%)
The teacher clearly communicated important due dates/timeframes for learning activities.	6 (8%)	64 (86%)	4 (6%)

Note: The table provides the quantitative results of the study based on the frequency and percentages of the number of participants' responses to each question. Results are grouped as: strongly disagree and disagree (negative results); agree and strongly agree (positive results); and neutral.

In the Likert Scale section of the survey, the Design and Organization category included questions 1-4. In the Design and Organization section of the CoI survey each of the four questions received over 60% of students' responses in the agree and strongly agree categories. Question three had the most neutral responses (12%) and question four had the most negative responses (8%).

Q1. The teacher clearly communicated the important course topics.

Largely, the students who participated in the survey either mostly agreed (42%) or strongly agreed (45%) that the teacher clearly communicated the important course topics with only 1% strongly disagreeing and 1% disagreeing. Eleven percent responded neutral. Responses from survey participants were very positive when reporting on the clarity with which their teacher communicated important course topics. There were very few negative responses.

Q2. The teacher clearly communicated important course goals.

Respondents either agreed or strongly agreed that the teacher clearly communicated important course goals with 47% agreeing and 41% strongly agreeing. No students selected that they disagreed with this question; however, 3% strongly disagreed. Nine percent of students responded neutral. Predominantly, participants' responses on whether important course goals were clearly communicated by the teacher were much more positive than negative.

Q3. The teacher provided clear instructions on how to participate in course learning activities.

Fifty-three percent of participants strongly agreed that the teacher clearly communicated important course goals, 31% agreed, 12% responded neutral, followed by 3% who disagreed and 1% who strongly disagreed. Overall, respondents on whether the teacher provided clear instructions on how to participate in the course learning activities were overwhelmingly positive with very few negative responses.

Q4. The teacher clearly communicated important due dates/timeframes for learning activities.

A large percentage of participants strongly agreed (59%) or agreed (27%) that the teacher clearly communicated important due dates/timeframes for learning activities while 8% disagreed and 1% strongly disagreed. In addition, 5% of students responded neutral. Notably, participants' responses were very positive with little neutral or negative responses accounted for.

Table 7

Frequency Table for Teaching Presence Facilitation Questions

Facilitation	**1 = Strongly Disagree** **2 = Disagree**	**4 = Agree** **5 = Strongly Agree**	**3 = Neutral**
The teacher provided adequate support in the teaching-learning process through instructional guidance and self-discovery learning.	2 (3%)	64 (86%)	8 (11%)
The teacher was helpful in guiding the class toward	4 (5%)	56 (76%)	14 (19%)

understanding course topics in a way that helped me clarify my thinking.			
The teacher helped to keep course participants engaged and participating in productive dialogue.	8 (11%)	47 (64%)	19 (25%)
The teacher helped to keep course participants on task in a way that helped me to learn.	6 (9%)	46 (62%)	22 (29%)
The teacher encouraged course participants to explore new concepts in the course.	5 (8%)	58 (78%)	11 (14%)
Teacher actions reinforced the development of a sense of community among course participants.	9 (12%)	43 (58%)	22 (30%)

Note: The table provides the quantitative results of the study based on the frequency and percentages of the number of participants' responses to each question. Results are grouped as: strongly disagree and disagree (negative results); agree and strongly agree (positive results); and neutral.

In the Likert Scale section of the survey, the Facilitation category included questions 5-12. The first question in the Facilitation section (question five in the CoI survey) received the highest percentage of positive responses (86%), and consequently the smallest number of negative responses (3%). Alternatively, the highest percentage of neutral responses (30%) were selected in the final question of this section (question ten in the CoI survey).

Q5. The teacher provided adequate support in the teaching-learning process through instructional guidance and self-discovery learning.

Most participants strongly agreed (51%) that the teacher provided adequate support in the teaching-learning process through instructional guidance and self-

discovery learning, followed by 36% agreeing. No student selected strongly disagree and 1% selected disagree, while 12% selected neutral. Students' responses were significantly positive, with almost zero negative responses.

Q6. The teacher was helpful in guiding the class toward understanding course topics in a way that helped me clarify my thinking.

Exactly 50% of respondents strongly agreed that the teacher was helpful in guiding the class toward understanding course topics in a way that helped them to clarify their thinking. Twenty-six percent of students agreed, followed closely by 18% choosing neutral. In addition, strongly disagree and disagree each received 3% of the student vote. Students were very positive about their teacher being helpful in guiding the class toward understanding course topics in a way that was helpful to clarify their thinking with very few negative responses.

Q7. The teacher helped to keep course participants engaged and participating in productive dialogue.

Participants' responses were very close in the strongly agree, agree, and neutral categories with 34% strongly agreeing, 30% agreeing, and 26% neutral. This question received the highest percentage of negative responses with both strongly disagreeing and disagreeing each receiving 5% of the student vote. Overall, the response of whether the teacher helped to keep the course participants engaged and participating in productive dialogue was positive, but it received more neutral and negative responses than the previous questions.

Q8. The teacher helped to keep course participants on task in a way that helped me to learn.

Students either strongly agreed or remained neutral in their response to the teacher helped to keep course participants on task in a way that helped them to learn with 38% strongly agreeing and 30% responding neutral. Students choosing agree followed at 24%. In addition, the same number of participants (4%) choose disagree and strongly disagree. Responses were mostly positive; however, a large number were neutral. Very few responses were negative.

Q9. The teacher encouraged course participants to explore new concepts in the course.

A large number of participants strongly agreed (41%) or agreed (38%) that the teacher encouraged course participants to explore new concepts in the course. Only 1% of students strongly disagreed, followed by 5% disagreeing. Fifteen percent of students were neutral. Participants' responses were significantly positive while the neutral responses accounted for a lesser percentage.

Q10. Teacher actions reinforced the development of a sense of community among course participants.

Like Question 8, 30% of participants remained neutral, which was a higher percentage than those students who agreed (27%). Strongly agreed received only one percent higher than the neutral category (31%) and, like question 4, 8% disagreed. In addition, 4% strongly disagreed. Overall, participants responded that a sense of community was reinforced by the teacher's actions. However, there were a large number of neutral responses.

Table 8

Frequency Table for Teaching Presence Direct Instruction Questions

Direct Instruction	**1 = Strongly Disagree** **2 = Disagree**	**4 = Agree** **5 = Strongly Agree**	**3 = Neutral**
The teacher helped to focus discussion on relevant issues in a way that helped me learn.	4 (5%)	56 (76%)	14 (19%)
The teacher provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.	5 (7%)	65 (88%)	4 (5%)
The teacher provided feedback in a timely fashion.	3 (4%)	62 (84%)	9 (12%)

Note: The table provides the quantitative results of the study based on the frequency and percentages of the number of participants' responses to each question. Results are grouped as: strongly disagree and disagree (negative results); agree and strongly agree (positive results); and neutral.

In the Likert Scale section of the survey, the Direction Instruction category included questions 11-13. The first question in the Direct Instruction section (question 11 in the CoI survey) received the highest percentage of neutral responses (19%). The second question in this category (question 12 in the CoI survey) received the highest percentage of positive responses (88%) and negative responses (7%). The lowest percentage of negative responses was in response to the final question of this section (question 13 of the CoI survey).

Q11. The teacher helped to focus discussion on relevant issues in a way that helped me learn.

Most participants agreed (46%) that the teacher helped to focus discussion on relevant issues in a way that helped them learn, followed by 30% strongly agreeing. Additionally, 19% responded neutral and 5% disagreed. No one strongly disagreed with this question. The majority of students responded positively with very little responding negatively.

Q12. The teacher provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.

A substantial number of respondents selected strongly agree (47%) or agree (41%) that the teacher provided feedback which helped them to understand their strengths and weaknesses relative to the course's goals and objectives. Very few students selected neutral (5%), disagree (4%) or strongly disagree (3%). Participants' responses were significantly positive while the neutral and negative responses accounted for small percentages.

Q13. The teacher provided feedback in a timely fashion.

Students reported very positively (65%) related to teacher feedback provided in a timely manner. Similar percentages were acquired for agree (19%) and neutral (12%) with only 4% disagreeing. There were no participants who strongly disagreed. Predominantly, participants' responses on whether the teacher provided feedback in a timely fashion were much more positive than negative.

Summary of Responses

Notably, out of the 13 questions in the CoI survey, the second question from the Design and Organization category: *The teacher clearly communicated important course*

goals tied for receiving the highest positive response (88%) with question twelve from the Direction Instruction category: *The teacher provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives*. In addition, the final question in the Facilitation category (question ten in the CoI survey): *Teacher actions reinforced the development of a sense of community among course participants* received the overall highest percentage of negative responses (12%) and neutral responses (30%).

Table 9

Measures of Frequency for Teaching Presence Component

Teaching Presence Components	**1 = Strongly Disagree** **2 = Disagree**	**4 = Agree** **5 = Strongly Agree**	**3 = Neutral**
Design and Organization	(5%)	(86%)	(9%)
Facilitation	(8%)	(70%)	(22%)
Direct Instruction	(5%)	(82%)	(13%)

Note: This table provides a breakdown of participants' responses by percentage based on the three components of the teaching presence element. Results are grouped as: strongly disagree and disagree (negative results); agree and strongly agree (positive results); and neutral.

Design and Organization received the highest percentage of positive responses (86%), followed by Direct Instruction (82%) and Facilitation (70%). The greatest number of neutral responses were selected in the Facilitation category. Facilitation had the highest percentage of negative responses (8%) with Design and Organization and Direction Instruction both receiving 5% of negative responses.

Qualitative Analysis

The qualitative data transcripts from the two long answer questions in the third section of the survey were coded and woven into themes (Charmaz & Belgrave, 2018; Gibbs, 2010, 2015; Strauss & Corbin, 2015). The themes reflect a shift in students' mindsets about the likability of mathematics. They were created to capture human communication and experience that was not implicitly stated in the text. This approach allowed the researcher to be the voice of interpretation by "listening" to each written response and asking, *"What is this person trying to say?"* and *"What are the underlying assumptions?"* (Gibbs, 2015).

Recurring Themes

The first qualitative question asked students to explain the impact their most recent blended or online mathematics teacher had on their beliefs about their abilities in the subject. The second question asked students to explain whether their most recent blended or online mathematics teacher changed their likability of mathematics. Table 10 displays the ten recurring themes derived from the two research questions. Shared themes of *Teacher Support*, *Explanation*, *Real-Life Examples*, and *Lack of Teacher Contact* were common to both questions, while the themes of *Correction*, *Encouragement*, and *Teacher's Beliefs about Students' Abilities* were derived from Q1 and the themes of *Teacher's Enthusiasm of Mathematics, Engagement*, and *Predetermined Mindset* were derived from Q2. Of the ten themes, eight were positive aspects about the teacher, one was negative, and one was neutral or indifferent.

Table 10

Qualitative Recurring Themes

Recurring Themes	**Q1: Teacher Impact on Students' Beliefs About Their Abilities in Mathematics**	**Q2: Teacher Impact on Students' Likability of Mathematics**
Correction (positive)	X	
Teacher's Beliefs About Students' Abilities (positive)	X	
Encouragement (positive)	X	
Teacher's Enthusiasm of Mathematics (positive)		X
Engagement (positive)		X
Teacher Support (positive)	X	X
Explanation (positive)	X	X
Real-Life Examples (positive)	X	X
Lack of Teacher Contact (negative)	X	X
Predetermined Mindset (neutral)		X

Correction

This theme captured the participants' views on the importance of receiving corrective feedback on their mistakes in a way that was positive and constructive. Adjectives such as *kind*, *uplifting*, *gentle*, and *precise* were used to describe the qualities of correction that were most beneficial to students. Receiving encouraging corrections to their mistakes on their assessments encouraged students to continue to foster a positive mindset about their abilities in the subject.

> *My teacher was very supportive and helped me understand when I made a mistake. My teacher helped me improve my mathematical abilities in a way that I appreciated and in a way that was uplifting and helpful.*
>
> *They were encouraging and gentle when correcting me on what I'd done wrong. I would not be as confident in my math skills and abilities if it wasn't for them.*
>
> *My teacher made my experience of math better by being precise about what I got wrong and giving me helpful feedback.*
>
> *My teacher helped me understand many concepts in mathematics and when I was confused gave me detailed explanations on how to improve. This helped me feel more encouraged and made me feel better towards mathematics.*

Learners cited the advantages of receiving positive and detailed corrections when more clarity was needed, therefore decreasing negative perceptions attached to their mathematical abilities. In addition, gentle and friendly feedback helped the students to learn the material through the process of revision. Some participants shared that they appreciated the opportunity to redo an assessment to improve their marks.

> *If I get an answer wrong he knows how to make me feel less judgmental of myself.*
>
> *They also helped me to correct my mistakes in a positive way that encouraged me to keep trying.*
>
> *My last teacher has done an excellent job in helping me see how I can do a better job with math if I take my time and read the questions carefully. I would always look forward to her comments because she would tell me exactly what I could do next time to get a better mark and her comments were always positive and friendly.*
>
> *I was also allowed to resubmit assignments when I had not done them properly and I learned a lot through this.*

Participants shared that when a teacher creates a safe environment to ask questions and share answers without the pressure to provide accurate solutions, the process of correction can comfortably take place between the teacher and the learner or between the teacher and the whole class. As such, the creation of a safe environment

leads to more questions being addressed and corrected, which increases knowledge, which increases the learner's beliefs about their abilities in mathematics. The qualitative responses showed the thread of positive correction by the teacher leading to positive beliefs about their abilities of mathematics by the learner.

> *She was kind and very clear. I could ask any questions and she would take time to explain it to the class. She made it very safe to ask questions.*
>
> *When a subject becomes understandable and is a safe place to get things wrong, it is a lot easier to like a subject. This teacher was very kind and I felt valued as a student.*

Teacher's Beliefs About Students' Abilities

This theme encapsulated the idea that teacher's beliefs about the learners' mathematical abilities positively changed learners' beliefs about their own abilities. If a teacher believed the student capable of learning the material, the learner believed they were capable. Students noted that even if mathematics was not their favourite subject, being told they could grasp the new concept gave them confidence to try and remain engaged with the material.

> *Yes, my most recent math teacher did. They showed me that I could do anything in the course I set my mind too and would be there to help.*
>
> *My teacher never made me feel like I could not do the questions and made me feel a bit more confident that I could do the questions.*

Respondents noted identification by their teacher of their strengths and weaknesses helped them to improve their skills. As a result, learners began to believe in their abilities to accurately solve mathematical questions and feel confident in their

abilities. Participants appreciated their teacher giving specific advice curtailed to the students' learning needs.

> *My teacher from grade 11 math was incredible when it came to telling me my strengths and the things I was good at. Because of their class, I started to believe in my abilities when it comes to math.*
>
> *My teacher was able to show me my strengths and weaknesses. They were able to help me enjoy math more then* [sic] *I had in the past.*
>
> *My recent math teacher had a positive impact on my belief in my abilities when it comes to mathematics. They were able to identify my strengths in the subject through my assignments and communication and were supportive in all areas where I needed improvement.*
>
> *My teacher helped me to improve in my skills in mathematics. I think my teacher helped me to not only improve my skills but to also realize that I had improved. When compared with the other students I was at about the same place as most of them with my skills in math. Perhaps it helped me to see I wasn't terrible at the subject. My teacher also helped me to see this.*

Participants were positively impacted when their teacher encouraged them to continue to engage with the course. It was the underlying faith of the teacher in the students' capability that positively shifted the respondents' mindset toward their own abilities in the subject. The presence of a teacher who motivated their learners to persevere when feeling discouraged about their abilities proved fruitful. Respondents commented how this process increased their confidence in their mathematical skills and knowledge.

> *My teacher did make me feel more confident about my mathematic abilities by helping me prove myself my abilities.*
>
> *My teacher positively impacted my beliefs about my abilities. I was pushed, helped, and encouraged when needed.*

Encouragement

Participants expressed that receiving affirmation and encouragement helped to change their beliefs about their abilities in mathematics. Encouragement came in the form of specific praise to the student, positive feedback, quick responses to student assessments, and encouragement about the process of learning mathematics. There were many responses that were akin to describing a teacher as an enthusiastic coach motivating and encouraging students from the beginning to the end of their blended or online course; an effective teacher who journeyed alongside the student in an encouraging way.

> *The teacher's encouragement and focus on helping me do my best, in all areas of the subject, and in all assignments has left a lasting impression on me. Their praise and advice have helped me gain confidence and the wisdom to excel in this subject, and I am grateful for their thoughtfulness throughout my learning journey.*
>
> *My teacher was really encouraging, and she helped me look at math as a process. This made me feel less stressed about always getting the correct answer.*
>
> *My teacher encouraged me to get started and really built me up with positive comments and encouragement. I was surprised at how much I learned and that I could do trigonometry. She made me actually enjoy math.*
>
> *She was very encouraging of any effort we made and also gave lots of positive feedback. She encouraged me a great deal.*

Teacher's Enthusiasm About Mathematics

This theme focused on the connection between a teachers' personal enthusiasm for mathematics and its positive impact on their pupils. A teacher's passion for a subject is important to communicate in a blended and online environment. The lack of student-teacher time in the week can leave students feeling less motivated to work on a subject

they may not feel favourable towards. Respondents expressed that their new love and acceptance of mathematics was directly related to the level of keenness their teacher felt towards the subject. The qualitative responses showed a level of surprise by some of the students that their previously held beliefs about mathematics could positively change.

> *My most recent teacher has been my math teacher for three years and shows a level of enthusiasm for the subject that might even be higher than my own.*
>
> *My most recent math teacher helped me to think that math wasn't a stupid subject.*
>
> *Yes, her love of the subject comes through, so it makes us like it. She is excited when we get it and so we are eager to try. She makes even hard things easy.*

Engagement

This theme emphasized the participants' views that their likability of mathematics was positively changed through an engaging teacher. Learners felt that if the environment that the teacher fostered was fun, creative, and enjoyable, they looked forward to each class, and therefore, began to like mathematics. In addition, the act of the teacher hooking students through personal connection and story increased their likability of the subject.

> *My teacher definitely helped me like mathematics. They made the course work fun and easy to understand and because of that, I went from absolutely hating math, to really enjoying and liking the subject.*
>
> *The teacher in my most recently completed math course also thoroughly impacted my opinion of mathematics. I used to abhor it, but now I both like and appreciate most of it. I still am not accustomed to workplace math, but I absolutely love algebra! My teacher caused my experience to be fun and productive!*

Participants shared that if the teacher provided fun assessments, projects, technology, and games, learners were more attracted to the subject. The objective of providing an engaging class in the course is to better enrich the participants' learning

experience. By making the class appealing through different mediums and by promoting participation, some participants noted a drastic shift in their likability of mathematics.

> *My most recent teacher made the experience fun and enjoyable. Incorporating games and graphics into the lesson.*
>
> *I love math and my most recent teacher only made me love it more. He took time to make fun assignments that were creative that I hadn't seen before, but still helped me understand the concepts we were learning. I looked forward to his class and it was a highlight in my week and it got me excited to learn math!*
>
> *My teacher encouraged my liking of mathematics by continually making it fascinating.*

Teacher Support

This theme captured the participants' views on the importance of support from their instructor impacting their beliefs about their abilities of mathematics and their likability of the subject. Respondents appreciated their teacher's feedback on their assessments. The qualitative responses on the instructor's feedback included in this theme are more general in comparison to the responses listed in the specific category of corrective feedback specific to students' mistakes. Teacher feedback in this category has more general adjectives such as *helpful, excellent,* and *encouraging*.

> *My teacher's feedback was clear, concise, helpful, and again, encouraging.*
>
> *My most recent math teacher provided excellent feedback and instructions that helped me become more engaged in the course and helped me excel more in the course.*
>
> *Yes, my teacher positively influenced my beliefs in my abilities. By supplying positive and constructive feedback and encouraging me to challenge myself, I gained a more positive perspective on my abilities in mathematics.*

Additional resources provided to the learners by the teacher were noted by participants as helpful to achieve understanding in the subject. Mathematics often requires supplemental support such as one-on-one tutoring and/or extra instructional videos or worksheets. Providing alternate resources to students in combination with what is provided in class can be the extra boost needed for learners to gain understanding. In addition, respondents appreciated that each livestream session was recorded so that they could go back and review the lesson's concepts. Having the ability to pause, re-wind, and re-watch each lesson allowed learners to work at their own pace with as much review as needed.

> *Last year I started the year with little to no understanding of the concepts. My teacher gave me resources and helped me to catch up very quickly on what I had missed. By the end of the year, I really enjoyed them, and was acing most of my tests. My teacher helped me to get to that point and be confident in my abilities.*
>
> *I have a hard time focusing in class often, but the videos were recorded, so I was able to rewatch them on my own time. Because I have a hard time focusing, I would get frustrated sometimes at myself for not understanding concepts. But after I watched the video and listened to his explanation again, I understood almost immediately and that made me feel a lot more confident in my math abilities. I started approaching math with confidence.*

Respondents noted that receiving help from their teacher when stuck on a question or on an entire topic was critical to their understanding and enjoyment of mathematics. The extra time provided by the teacher outside of the livestream sessions, or to fully online students in the form of communication was critical to students' overall learning experience. Specifically, students who were behind in their course were able to catch up with the class schedule through an encouraging and positive process provided by their teacher's personal help.

> *I've always loved math, so I appreciated the help my teacher gave in getting me back to a point where I could do the equations happily.*
>
> *My math teacher was the best math teacher I ever had. She made me love math and even inspired me to become a teacher myself. I went from hating math and thinking it was dumb to wanting to do it in my free time for fun. I think math is my favorite subject in school and honestly doing math for fun has become a hobby for me. Without her help I would have still been hating math and not understanding how I learn better to get better grades.*
>
> *My teacher consistently provided extremely helpful and encouraging feedback throughout the year. My teacher was extremely supportive and available to help me understand topics that I was unclear on.*

Explanation

This theme encapsulated participants' perspectives that thorough explanations from their instructor impacted their beliefs about their abilities of mathematics and their likability of the subject. Adjectives such as *clear*, *guided*, and r*edirect* were used to describe the attributes of the teacher's explanation that provided clarity to the student. Mathematics is a subject that requires meticulous step-by-step calculations with written explanations to guide the student in mastery of the concepts. Respondents noted that when their teacher clearly explained the process to arrive at the answers, they gained understanding of the material. This understanding created a likeness toward, and confidence in, mathematics not previously experienced.

> *I appreciated being properly guided through new equations and word questions (which I particularly dislike), which helped me improve my own proficiency on the subject.*
>
> *I always would think that I would never be able to get through math smoothly or without having a really hard time, but my last teacher was able to explain things very clearly to me and helped me understand the math much better and so I was able to gain some confidence.*

> *Math has never been my favourite subject but after having my last teacher explain it in a very clear way, I have been able to look at mathematics in a more positive way.*

Students referenced the importance of a teacher approaching the subject more than one way to arrive at the correct solution. Students concluded that having more than one method for solving a mathematical problem led to a greater understanding of the subject, resulting in good grades. Mathematics can be presented concretely, pictorially, symbolically, and contextually. Providing multiple avenues to a solution provides greater understanding of the question. One method of solving can be used to double-check or strengthen the other method, thus resulting in less mistakes and a more thorough answer.

> *Yes, I felt she was a good teacher because she showed different ways of doing things with different methods, it was not boring.*

> *My last teacher was really good, I liked them. Where I struggled the most with my teacher was that they would explain a topic only one way. Before, I have had other teachers who understood I wasn't understanding the topic so they would show me a different way to do it or explain it differently if it was applicable.*

Real-Life Examples

Participants expressed that they were positively impacted in their beliefs about their abilities of mathematics and their likability of the subject if their teacher demonstrated real-life contexts to the mathematical content being presented. When instructors showed the connection of a topic to how it relates outside of the classroom, learners were more engaged with the subject, and, as such, this investment positively impacted their beliefs in their own abilities.

> *I would say that my love for math grew a little bit near the end of my grade 12 year because I started to thoroughly understand it as well as be able to apply it directly to what I enjoyed, engineering.*

> *Before I just did workbooks and now with the video explanations and the teacher instructions have helped me understand why I am learning the math and how it relates to real life. This has really helped me.*
>
> *The assignments that my teacher gave me were practical that you could use in real-life situations, and some of them were quite difficult but I managed to do them, so it showed me that I can complete difficult math problems.*

Respondents commented on the importance of understanding that a knowledge of mathematics is a valuable skill to acquire for functioning in everyday life activities. Learners began to see how mathematics is a necessary skill for practical living.

> *My recent math teacher was incredibly supportive and helped foster my love for learning more about mathematics. Through assignments and projects, they provided excellent examples of how this subject is vital in all aspects of life. Mathematics is an essential skill that enables us to analyze and break down any problem or inquiry we encounter. I am eager to continue exploring this subject and expanding my knowledge. Thanks to my teacher, I have grown to appreciate and enjoy mathematics even more.*
>
> *My teacher in my most recently completed math course quite thoroughly impacted my beliefs and abilities regarding mathematics. My comprehension of math improved significantly. I began to see the importance of it, even when I believe it can be pointless. I completed my homework with a positive attitude toward the subject, which caused me to enjoy more, which caused my grades to improve.*

Lack of Teacher Contact

This theme captured respondents' views that the absence of teacher connection created no impact on their beliefs about mathematics. Comments were from students in fully online courses and students in blended courses where they met with a teacher twice a week in a virtual setting. If a student did not have a personal connection with their teacher or little communication with their teacher throughout the life of the course, they did not see a positive change in their beliefs about their abilities in mathematics or develop a greater affinity to the subject.

> *They affected my enjoyment of math just as much as they did my belief in my abilities. They didn't have any effect because we had hardly any contact.*
>
> *I don't get a lot of contact with my teacher so they didn't impact how much I like math.*

Some respondents noted a transactional distance experienced within an online setting. This sense of disconnect with the teacher can negatively impact engagement with course content. Despite teacher feedback given to students regarding their assignments, the type of communication can contribute to a negative experience.

> *…because when you take an online course, it sometimes feels like the teacher isn't really there, not because they aren't kind or helpful, but because it's just hard to connect with someone when the only way to communicate is through email. So in that course, I also felt like that, and since math is a difficult subject for me, it makes me feel even more alone and scared of it.*
>
> *My instructor for my online math class did not impact my beliefs on mathematics. The course was twice a week over zoom and there was very little one on one time between the instructor and students, therefore I did not feel I had received very specific or adequate feedback around my math mistakes in order to gain a new belief around math. The instructor I had seemed inexperienced and his methods were still very textbook, as was his guidance.*
>
> *I felt that my teacher did not greatly influence my abilities in the subject of math. I received feedback on my assignments but I don't feel there was significant communication that changed my views on my abilities in the subject of mathematics.*

Some participants took partial ownership of having little contact with their teacher due to their lack of courage to reach out to their instructor for help on their questions. The lack of relationship between teacher and learner did not create a feeling of safety for students to ask for help when needed.

> *Since the class I took was completely online, I never really interacted with the teacher, so they weren't able to impact my beliefs about my abilities in the subject. Although they did say I could email them if I had any questions about the course*

> *or/and the subject, I was too shy to do it, so I never did. The only way I got their feedback was from the comments they left on my assignments and tests, and I don't think those comments impacted my beliefs about my abilities in the subject.*

Even though the survey question asked students to comment on their most recent mathematics teacher, comparisons to previous teachers were made to contrast how contact from, and communication with, their teachers created different outcomes for learners.

> *My most recent online math teacher didn't really impact my beliefs about my abilities in math. It was an online course and we did not have any verbal communication. I did the tests and received my mark but there was no formative feedback on my work. My previous math teacher distinctly helped, encouraged and communicated with me online. I really became more confident with my previous math teacher than my most recent math teacher.*

> *…and then [he'd] leave us to do our homework for 30 to 40 minutes. We usually understood the first concept well enough, but by the second concept he was definitely losing us, by the third we were like deer in the headlights and had no idea how to do the homework. I felt like I must not be that good at math even though I had done really well the year before. Teachers definitely impact students' beliefs about their math abilities.*

Predetermined Mindset

A few respondents commented that no matter who their math teacher was, it did not impact previously held perspectives on mathematics likeability. Some participants have an intrinsic love of the subject, some are indifferent to it, and others despise it. These students do not believe that their teacher impacted how they feel about the subject.

> *My beliefs have always been the same I love math and will always love it.*

> *No, they didn't because I wouldn't let anyone change the way that I think about math.*

> *I think they did not have an impact very much in how much I like math I still don't like math too much but I'm mostly neutral about it.*
>
> *I like math because I understand it and like solving problems. I don't feel like I have been influenced by an online teacher.*
>
> *No, my teacher didn't change how I feel about math. I don't like it, and I don't think I ever will.*
>
> *I'm not sure if I can say I like it more or less than before but I do feel like I'm more motivated to do it and it is less of a burden to start my assignments.*

Mixed Methods Analysis

A significant part of this study is to employ the convergent mixed methods design with the purpose of merging and comparing results of the quantitative results and the qualitative findings to gain a broader understanding of the research questions (Creswell & Plano Clark, 2018). The mixed methods analysis establishes if the participants in the study respond in a homogeneous way to the open-ended qualitative questions *and* the quantitative prearranged scales, by validating one set of findings with the other.

The survey results and student statements reflected a wide range of responses from strongly disagree to strongly agree; however, the majority of responses across all questions were overwhelmingly positive. Of all survey respondents, 25% agreed or strongly agreed across all 13 Likert scale questions. Convergence was observed between the demographics quantitative data, the Likert scale quantitative questions, and the qualitative responses to the two open-ended questions.

Of the 31 respondents that have only had a positive experience with blended and online learning, 61% agreed or strongly agreed across all Likert scale questions, 100% agreed or strongly agreed that the teacher clearly communicated the important course

topics, and 100% agreed or strongly agreed that the teacher clearly communicated important course goals. Ninety percent of those respondents agreed or strongly agreed that the teacher provided clear instructions on how to participate in course learning activities. Eighty one percent of those respondents agreed or strongly agreed that the teacher clearly communicated important due dates/timeframes for learning activities, and 76% of those responded agreed or strongly agreed on all four statements. Of these same 31 respondents, 95% agreed or strongly agreed that the teacher provided adequate support in the teaching-learning process through instructional guidance and self-discovery learning. Ninety-five percent agreed or strongly agreed that the teacher was helpful in guiding the class toward understanding course topics in a way that helped them clarify their thinking. Finally, 81% of these respondents agreed or strongly agreed that the teacher helped to keep course participants engaged and participating in productive dialogue.

Responses from the qualitative section of the survey confirmed the results of the quantitative sections, which validates that the participants responded to each section in the survey in a homogeneous way. Additionally, recurring themes from the qualitative questions such as corrective and encouraging feedback, real-life applications, and teacher engagement converged with the literature reviewed in this study.

One interesting observation is that the findings presented a strong link between the teacher, the students' perceptions in their own beliefs about their abilities in mathematics, and the students' affinity to the subject. Several students melded aspects of each research question into one answer. This overlap demonstrated that with the fostering

of a teacher, students began to like mathematics more when they believed themselves to be better at it. Similarly, as their confidence in their knowledge of the material increased, they began to feel more positive towards mathematics.

> *They created a learning experience and class community that was positive and engaging. This allowed for me to get feedback on my mistakes and improve my abilities in mathematics, making it a fun and intriguing subject to learn.*
>
> *My teacher was supportive and encouraging of my mathematics abilities which further nurtured my love of the subject.*
>
> *I completed my homework with a positive attitude toward the subject, which caused me to enjoy more, which caused my grades to improve.*
>
> *… when she helped me and guided me through it, I understood it better which caused me to like it more and to think better of my abilities in math.*
>
> *I used to think math was dumb and a waste of time but then she taught me that I just had a different learning style than what they were teaching me at my old school. With her help I started to become really good at math and my views on it totally changed. I'm now really passionate about math and even want to be a teacher because of her.*

In summary, the analyzing and comparing of the quantitative results with the qualitative findings provided a more thorough and meaningful answer to the research questions that neither methods could have independently provided (Creswell & Plano Clark, 2018).

Chapter Five: Conclusions and Recommendations

This chapter includes discussion and analysis results of the study, followed by the study's conclusion and implications for further research. The aim of the research is to provide new knowledge and understanding about teacher impact on online secondary students' beliefs about mathematics. Outcomes from this study can provide further guidance in teaching practice and professional development to support educators in creating meaningful learning experiences for high school mathematics learners.

Discussion and Analysis

Respondents' answers to the CoI survey questions are further analyzed by examining the measures of central tendency and standard deviations for the three elements of teaching presence: Design and Organization, Facilitation, and Direct Instruction. In addition, possible suggestions will be discussed for contribution to learners' shift in beliefs about their abilities in mathematics and the likeability of the subject.

Design and Organization

The Community of Inquiry (CoI) theoretical framework reflects the fundamental values and beliefs that reveal and guide a worthwhile educational experience for teaching and learning (Garrison, 2017). The design and organization of an online community of inquiry is the macro-level structure and process that begins before the course launches. The course content and architecture require a substantial investment of time and experience prior to student access. Garrison (2017) asserts that the design occurs prior to the beginning of the process, while the organization occurs during the educational transaction.

Table 11 illustrates the measures of central tendency and standard deviation for the four questions in the Design and Organization section of the CoI survey. The means, medians, and modes for each question are primarily positive and the standard deviations suggest there was very little range in the answers. Most answers selected were agree or strongly agree. The standard deviation for question 4 that reported participants agreeing that their teacher clearly communicated important dates is slightly higher than the standard deviations of the first three questions; indicating a wider variance of answers; however, the median and mode are in the strongly agree range suggesting a strongly disagree outlier.

Table 11

Measures of Central Tendency for Teaching Presence Design and Organization Questions

Design and Organization	**Mean**	**Median**	**Mode**	**STD**
The teacher clearly communicated the important course topics.	4.30	4.00	5	0.82
The teacher clearly communicated important course goals.	4.20	4.00	4	0.84
The teacher provided clear instructions on how to participate in course learning activities.	4.30	5.00	5	0.89
The teacher clearly communicated important due dates/timeframes for learning activities.	4.40	5.00	5	0.96

Range: 1 & 2 = 0 - 2.5; 3 = 2.5 - 3.5; 4 & 5 = 3.5 - 5

Overall, participants' responses were positive for the Design and Organization component. The data suggests that students perceived their teacher to have effectively and consistently applied the Design and Organization process during their most recent

blended or online mathematics experience. Most respondents agreed that their teacher clearly communicated course topics, goals, instructions, and dates for the learning activities.

Facilitation

Garrison (2017) posits that teaching presence plays a vital role in facilitating discourse in an online learning environment because it "goes to the heart of the learning experience" (p. 73). The overarching objective of teaching presence applications are to ensure progression toward educational goals by considering the nature and timing of feedback and the monitoring of communication. A positive learning environment is as important as cognitive development and teaching presence must "see content, cognition and context as integral parts of the whole" (Garrison, 2017, p. 74). Instructional guidance, promoting engagement, and encouraging self-discovery learning are essential responsibilities in the facilitation of a blended or online course. If this approach is carried out successfully, teaching presence has the appropriate balance of control where students progress in taking ownership of their learning. The teacher assumes the role of "guide on the side" and less "sage on the stage" (p. 74).

Table 12 reports the measures of central tendency and standard deviations for the Facilitation questions of the CoI survey. The data suggests that the respondents answered more negatively within quantitative responses for the Facilitation component in comparison to the Design and Organization component. Although the means scores for all six questions were positive, participants responded less positively to questions three, four, and six in the Facilitation component. The modes were unanimously strongly agree, and all median scores were in the agree and disagree range; however the standard

deviation indicates that answers ranged from strongly disagree to strongly agree. The results of the Teaching Presence questions for Facilitation indicate that the absence of facilitation created a disadvantage for some students.

Table 12

Measures of Central Tendency for Teaching Presence Facilitation Questions

Facilitation	**Mean**	**Median**	**Mode**	**STD**
The teacher provided adequate support in the teaching-learning process through instructional guidance and self-discovery learning.	4.07	4.50	5	1.08
The teacher was helpful in guiding the class toward understanding course topics in a way that helped me clarify my thinking.	4.18	4.50	5	1.01
The teacher helped to keep course participants engaged and participating in productive dialogue.	3.81	4.00	5	1.13
The teacher helped to keep course participants on task in a way that helped me to learn.	3.88	4.00	5	1.10
The teacher encouraged course participants to explore new concepts in the course.	4.11	4.00	5	0.94
Teacher actions reinforced the development of a sense of community among course participants.	3.73	4.00	5	1.11

Range: 1 & 2 = 0 - 2.5; 3 = 2.5 - 3.5; 4 & 5 = 3.5 - 5

In summary, responses were positive for the Facilitation component. The data suggests that students perceived their teacher to have effectively and consistently adhered to the Facilitation process during their most recent blended or online mathematics

experience. Most respondents agreed that their teacher set a favourable climate for learning, drew in participants which promoted discussion, helped students reach consensus and understanding, and encouraged, acknowledged, or reinforced student contributions. These findings seem to indicate that these mathematics educators are, overall, serving students well in facilitation.

Direct Instruction

Garrison (2017) states that it is not possible for the attributes of Direct Instruction to be executed without an experienced and knowledgeable teacher. Direct Instruction includes the indicators: present content/questions; summarize the discussion; diagnose misconceptions; and respond to technical issues. It is the educator's responsibility to proactively direct and support an effective and efficient learning experience for online learners (Garrison, 2017).

Table 13 illustrates the measures of central tendency and standard deviation for the Direct Instruction component of the CoI survey for Teaching Presence. Like Design and Organization, all questions in this section have mean, median, and mode scores in the agree to strongly agree range. The scores of each standard deviation indicated little variance in the selected answers; however, the second question describing a teacher providing feedback to students on their strengths and weaknesses had a greater range of answers in comparison to questions one and three. This data suggests that there were a few more students who answered less positively about their teacher providing feedback on their strengths and weaknesses.

Table 13

Measures of Central Tendency for Teaching Presence Direct Instruction Questions

Direct Instruction	**Mean**	**Median**	**Mode**	**STD**
The teacher helped to focus discussion on relevant issues in a way that helped me learn.	4.00	4.00	4	0.84
The teacher provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.	4.26	4.00	5	0.94
The teacher provided feedback in a timely fashion.	4.45	5.00	5	0.86

Range: 1 & 2 = 0 - 2.5; 3 = 2.5 - 3.5; 4 & 5 = 3.5 - 5

Overall, participants' responses were positive for the Direct Instruction component. The data suggests that students perceived their teacher to have effectively and consistently applied to the Direct Instruction process during their most recent blended or online mathematics experience. Most respondents favorably agreed that their teacher helped to focus the class discussion on relevant issues in a way that helped them learn, provided feedback to help them understand their strengths and weaknesses, and gave timely feedback.

Research Questions

The research questions ask: *"What are students' perceptions of a relationship between teaching presence and their beliefs about their own abilities in mathematics?"* and *"What are students' perceptions of a relationship between teaching presence and the likability of mathematics?"*

For this study, a total of 85 students responded that they have had experience in blended or online secondary mathematics. A further analysis of the 68 qualitative responses yielded the following:

1. Nineteen students commented that when their teacher offered encouragement, positive feedback, or helped identify their strengths, their confidence in their mathematical abilities increased. Among students who identified one of these themes as their experience, nine were female and ten were male. All 19 students liked or loved mathematics.
2. Nine students shared that their teacher positively influenced their beliefs about their abilities in mathematics by strong instruction and explanation of concepts. Of those students, all liked or loved mathematics.
3. Seven students commented that even though their teacher did provide feedback on their assessments and answered emails, the lack of personal connection and regular contact did not influence them significantly to shift their beliefs about their abilities in mathematics. Of those students, four also indicated that their lack of teacher contact negatively influenced how much they like the subject of mathematics.
4. Nine participants spoke to both research questions in their answer to the first question indicating that they perceived a relationship between their teacher, their beliefs about their abilities in mathematics, and how much they like the subject. Of these nine respondents, four referenced this symbiotic relationship in their responses to the second research question.

Implications for Future Research

There are ongoing opportunities for continued or future research in the adoption of the CoI framework in the K-12 setting. This study was limited to one BC Provincial Online Learning School (POLS) with an approximate participation rate of 28%. Because parental consent was needed for the students of minor age to participate, some students may not have been afforded the opportunity to engage in this study if their parent or guardian was unwilling to give permission. Conversely, some parents may have made their child's participation in the survey mandatory, which may have affected how the student responded to the questions.

Theoretical vs Applied Mathematics

Eighty-seven percent of respondents' most recently completed blended or online mathematics course was a theoretical course in the Pre-Calculus stream, while only 13% of students had most recently completed an applied course in the Workplace stream. Eighty-two percent of students answered that their final secondary mathematics course would be a Pre-Calculus course, while 8% planned to take a Workplace Math course. This data may suggest that with such a high percentage of survey respondents either having just completed, or continuing with, a Pre-Calculus course, students may have a more natural love of the subject or believe themselves to be capable of completing the more theoretical courses. Subsequent research is required with students in the applied Workplace mathematics stream to determine the impact of the teacher on their beliefs about mathematics.

Young Participants

Almost all participants were between the ages of 13-18. Even though the language was modified in the CoI survey to suit young participants, respondents may have had

difficulty in understanding what was being asked in each question. In the qualitative section of the survey, two students answered: “already answered in the multiple choice section”, therefore, missing the opportunity to expand in writing on their experiences. In addition, certain questions in the CoI survey may not have been applicable to each student’s situation. Taking a mathematics course fully online creates a different classroom experience from those who learn in a blended environment. For example, a learner in a fully online course may not be able to speak to question three in the Facilitation component: *The teacher helped to keep course participants engaged and participating in productive dialogue* if dialogue was not intentional in the course design. Interviewing students within a one-on-one setting is needed to determine individual learning environments and how these unique dynamics impact student experiences as they pertain to mathematics. This approach would provide more accurate feedback, especially for younger learners. Older participants may be better at deciphering each question’s intent even if the question is not completely applicable to their situation.

Teacher Presence or Teaching Presence

As previously stated, *teacher* presence focuses on the efforts of the teacher. *Teaching* presence fosters a collaborative approach to learning that includes participation of the instructor and the student in the teaching-learning process. These are two separate, but related entities. Students were not previously instructed on the differences between the two, and as such, answered the survey questions with the understanding their teacher was responsible for the Design and Organization, Facilitation, and Direct Instruction of their learning. Some students’ teachers may not have been responsible for the instructional design of the course they were overseeing. Aspects of the course design and

delivery may be influenced by the instructional design features of the course and not the teacher-oriented activities within the course (Simpson-Spence, 2021). The data suggests that participants' responses regarding their blended or online secondary mathematics experiences were directly linked to *teacher* presence rather than *teaching* presence. Therefore, further research could be helpful within a framework of greater clarification for pupils as to the difference between the two entities.

Conclusions

Blended and online courses and programs are improving as research continues to increase on the implementation of the CoI theoretical framework in the K-12 setting. The research findings from this mixed methods study suggest that the teaching presence element of the framework is widely applied in the Design and Organization, Facilitation, and Direct instruction processes at this BC POLS. The quantitative scores for the Facilitation component of the teaching presence section of the CoI survey were slightly lower than the scores for the Design and Organization and Direction Instruction components. However, all three components' scores were very positive. The qualitative comments for both research questions were overwhelmingly positive with very few negative responses.

The results of this study confirm that the benefits of an engaged Community of Inquiry are obvious. For most respondents, the important features of a mathematics learning environment were having a teacher who personally connected to their students, provided opportunities for collaboration and social participation, was encouraging, gave quick and precise feedback, and who met students' needs with one-on-one time. In addition, strong teacher instruction providing multiple avenues to a solution combined

with real-life applications, increased students' confidence with the material. Clear explanations and feedback, the teacher's enthusiasm for the subject, and the students' relationship with their teacher positively fostered students' beliefs in their own abilities in mathematics and the likability of the subject.

This study validates that teachers are the "binding element" (Borup et al., 2014, p. 793) of online communities, with students more likely to succeed with a strong teaching presence.

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Appendix A: Invitation to Participate

The Impact of the Teacher on Online Secondary Students' Beliefs About Mathematics

September 11, 2023

Principal Researcher: K. Elise Hoeppner (khoeppner1@learn.athabascau.ca)

Supervisor: Dr. Cynthia Blodgett-Griffin (cynthiab@athabascau.ca)

I am Elise Hoeppner, a student working towards a master's degree in Open, Digital, and Distance Education at Athabasca University. To complete my thesis, I am conducting a research study exploring students' perceptions surrounding teacher presence, beliefs about their own abilities in, and how much they like, high school online mathematics. This research is under the supervision of Dr. Cynthia Blodgett-Griffin.

You are invited to participate in this research because you are currently enrolled in a blended or online high school mathematics course. Participation in this research will allow you to share your experiences with online or blended mathematics instruction.

As a participant, you will be asked to complete a self-administered online survey. The objectives are to gain insight into the three elements of teaching presence (design and organization, facilitation, and direct instruction) and determine the impact on your abilities in mathematics. As well, the survey seeks information related to your attitude towards the subject of mathematics. The survey consists of three sections: a demographic questionnaire, questions on your perception of teaching presence, and questions to

address your perception about your own beliefs in, and the likeability of, high school online mathematics. Participation in the survey will take approximately 20 – 30 minutes.

Please be assured that your involvement in this research is entirely voluntary. The data collected will not include identifying information. You have the right to refuse to participate and to withdraw at any time during this research.

Thank you for considering this invitation. If you would like to participate in this study, you give your consent by entering your names (parent and student) below.

PARENT'S NAME

STUDENT'S NAME

LINK TO SURVEY

If you have any questions please do not hesitate to contact me by email at khoeppner1@learn.athabascau.ca or my professor at cynthiab@athabascau.ca.

Thank you,

K. Elise Hoeppner

Appendix B: Participant Consent Form

The Impact of the Teacher on Online Secondary Students' Beliefs About Mathematics

Thank you for taking the time to participate in this research project.

The survey questionnaire captures information on exploring students' perception of teaching presence and their beliefs about their own abilities in, and the likability of, high school online mathematics. The Master's thesis research study will seek to determine whether the three elements of teaching presence (design and organization, facilitation, and direct instruction) impact students' perception of their learning experience and the likability of mathematics.

Please enter your responses to the survey questions, taking the time to provide written comments to the long answer questions.

Note: The completion of this survey questionnaire and its submission is viewed as your consent to participate.

Appendix C: Ethics Approval

Athabasca University
RESEARCH CENTRE

CERTIFICATION OF ETHICAL APPROVAL

The Athabasca University Research Ethics Board (REB) has reviewed and approved the research project noted below. The REB is constituted and operates in accordance with the current version of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2) and Athabasca University Policy and Procedures.

Ethics File No.: 25345

Principal Investigator:
Mrs. K. Elise Hoeppner, Graduate Student
Faculty of Humanities & Social Sciences\Master of Education in Open, Digital, and Distance Education (MDDE)

Supervisor/Project Team:
Dr. Cynthia Blodgett-Griffin (Supervisor)

Project Title:
The Impact of the Teacher on Online Secondary Students' Beliefs About Mathematics

Effective Date: August 22, 2023 **Expiry Date**: August 21, 2024

Restrictions:

Any modification/amendment to the approved research must be submitted to the AUREB for approval prior to proceeding.

Any adverse event or incidental findings must be reported to the AUREB as soon as possible, for review.

Ethical approval is valid *for a period of one year*. An annual request for renewal must be submitted and approved by the above expiry date if a project is ongoing beyond one year.

An Ethics Final Report must be submitted when the research is complete *(i.e. all participant contact and data collection is concluded, no follow-up with participants is anticipated and findings have been made available/provided to participants (if applicable))* or the research is terminated.

Approved by: **Date: August 22, 2023**

Paul Jerry, Chair
Athabasca University Research Ethics Board

Athabasca University Research Ethics Board
University Research Services Office
1 University Drive, Athabasca AB Canada T9S 3A3
E-mail rebsec@athabascau.ca
Telephone: 780.213.2033

Appendix D: Letter of Permission from RCOA

Alisha Hadley
#107-19 Dallas Rd.
Victoria, BC, V8V 5A6
June 7, 2023

To Whom It May Concern:

It is my pleasure to confirm that I, Alisha Hadley, High School Vice-Principal of Regent Christian Online Academy, a Provincial Online Learning School in the province of British Columbia, give permission for K. Elise Hoeppner of Athabasca University's Master of Open, Digital, and Distance Education to survey our Grades 9-12 students in the fall of 2023 on The Impact of the Teacher on Online Secondary Students' Beliefs About Mathematics.

Please feel free to contact me by email at ahadley@rcoa.ca, or by telephone at 250-216-8876 if you require further information.

Sincerely,

Alisha Hadley
High School Vice Principal
Regent Christian Online Academy

Appendix E: Survey

There are three sections to this survey: Sections 1 and 2 are multiple choice and Section 3 is written response. The survey should take approximately 20-30 minutes to complete.

SECTION 1: Demographic Questionnaire

The following section aims to gather profile data. Please select the appropriate choice.

1. Age

- 13-14
- 15-16
- 17-18
- Other: please specify

2. Gender

- Male
- Female
- Other

3. Current Grade Level

- Grade 9
- Grade 10

- Grade 11
- Grade 12

4. My Most Recently COMPLETED Math Course

- Mathematics 8
- Mathematics 9
- Foundations and Pre-Calculus 10
- Workplace Math 10
- Pre-Calculus 11
- Workplace Math 11
- Pre-Calculus 12
- Workplace Math 12
- Calculus 12
- Other: please specify

5. Please describe the number of years you have been enrolled in online or blended high school math courses, where 'blended' is defined as partly online and partly Face to Face or Livestream learning

- This is my 1st year taking an online or blended high school math course
- This is my 2nd year taking an online or blended high school math course
- This is my 3rd year taking an online or blended high school math course
- This is my 4th year taking an online or blended high school math course
- This is my 5th year taking an online or blended high school math course

6. How would you describe your online or blended mathematics experience to date?

- I have only had positive experiences with online or blended mathematics learning
- I have had positive and negative experiences with online or blended mathematics learning
- I have only had negative experiences with online or blended mathematics learning

7. Please choose an option that best describes your beliefs about your abilities in mathematics

- Excellent
- Very Good
- Satisfactory
- Passing
- Failing

8. **Teaching Presence and Beliefs About Your Abilities.** Please assume you are answering about your **most recently completed** online or blended mathematics course and its teacher.

- My teacher did not influence my beliefs about my abilities in mathematics
- My teacher positively influenced my beliefs about my abilities in mathematics
- My teacher negatively influenced my beliefs about my abilities in mathematics

- I have had positive and negative influences in my beliefs about my abilities in mathematics from my teacher

9. Please choose an option that best describes your attitude about the subject of mathematics. For example: You could have excellent math skills, but not like mathematics, or you could be poor in mathematics, but love the subject.

- I love mathematics
- I like mathematics
- I am indifferent towards mathematics
- I don't like mathematics
- I hate mathematics

10. **Teaching Presence and Influence on how much you like Mathematics.** Please assume you are answering about your **most recently completed** online or blended mathematics course and its teacher.

- My teacher did not influence how much I like the subject of mathematics
- My teacher positively influenced how much I like the subject of mathematics
- My teacher negatively influenced how much I like the subject of mathematics
- I have had positive and negative experiences that affected how much I like the subject of mathematics from my teacher

11. High School Mathematics Final Course that you plan to take:

- Workplace Math 11 will be my final mathematics course in high school
- Pre-Calculus 11 will be my final mathematics course in high school
- Workplace Math 12 will be my final mathematics course in high school
- Pre-Calculus 12 will be my final mathematics course in high school
- Calculus 12 will be my final mathematics course in high school

- Other: please specify

SECTION II: Teaching Presence Questionnaire

Teaching Presence Questionnaire

Questions adapted from *Arbaugh et al., (2008) Community of Inquiry (CoI) questionnaire on teaching presence which focuses on the viewpoint of the student on the importance of the instructor's role in their online learning experience.*

Each statement below describes an element of teaching presence that corresponds to online learning. The Likert scale questions represent numbers that range from strongly disagree to strongly agree. Based on the scale, please select the number that best reflects

your response to the statement. Please keep in mind that online teachers may communicate in classes and through written instructions in your course.

Please take the time to thoroughly answer the following Teaching Presence questions about the **most recently completed** online or blended mathematics course and its teacher.

Design and Organization	**Strongly Disagree** **1**	**Disagree** **2**	**Neutral** **3**	**Agree** **4**	**Strongly Agree** **5**
The teacher clearly communicated the important course topics.					
The teacher clearly communicated important course goals.					
The teacher provided clear instructions on how to participate in course learning activities.					
The teacher clearly communicated important due dates/timeframes for learning activities.					

Facilitation	**Strongly Disagree** **1**	**Disagree** **2**	**Neutral** **3**	**Agree** **4**	**Strongly Agree** **5**
The teacher provided adequate support in the teaching-learning process through instructional guidance and self-discovery learning.					
The teacher was helpful in guiding the class toward understanding course topics in a way that helped me clarify my thinking.					
The teacher helped to keep course participants engaged and participating in productive dialogue.					
The teacher helped to keep course participants on task in a way that helped me to learn.					
The teacher encouraged course participants to explore new concepts in the course.					
Teacher actions reinforced the development of a sense of community among course participants.					

Direct Instruction	**Strongly Disagree** **1**	**Disagree** **2**	**Neutral** **3**	**Agree** **4**	**Strongly Agree** **5**
The teacher helped to focus discussion on relevant issues in a way that helped me learn.					
The teacher provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.					
The teacher provided feedback in a timely fashion.					

SECTION III: Long Answer

Please take the time to thoroughly answer the following long answer questions about the **most recently completed** online or blended mathematics course and its teacher.

1. Thinking about your blended or online high school mathematics experience, did your most recent teacher impact your beliefs about your abilities in the subject? Please explain.

[Note: please do not identify your teacher by name]

Comments:

2. Thinking about your blended or online high school mathematics experience, did your most recent teacher impact how much you like the subject of mathematics? Please explain.

[Note: please do not identify your teacher by name]

Comments:

SUBMIT

Thank you for your participation in this survey!